Book of ABSTRACTS

9th International Conference on Magnetic Materials and Applications

ICMAGMA-2026

3rd-5th June 2026 • NIT Goa, India

National Institute of Technology Goa
National Institute of Technology Warangal
Magnetics Society of India

Quantum Design

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Director's Message



Prof. O. R. Jaiswal
Director, NIT Goa

It gives me immense pleasure that the International Conference on Magnetic Materials and Applications (ICMAGMA-2026) is jointly organized by the National Institute of Technology Goa and the National Institute of Technology Warangal in association with the Magnetics Society of India (MSI) at the National Institute of Technology Goa during 3-5 June 2026. This conference aims to bring together eminent scientists, academicians, researchers, and industry professionals from across the globe to exchange ideas and discuss recent advancements in the field of magnetism, magnetic materials, and their diverse applications.

Magnetic materials continue to play a vital role in emerging technologies, including energy systems, defense, electronics, healthcare, data storage, and sustainable innovations. ICMAGMA-2026 provides an excellent platform for interdisciplinary collaborations, knowledge sharing, and fostering research partnerships in academics and industry that can contribute to scientific and technological progress.

I sincerely appreciate the efforts of the organizing committee, speakers, participants, and sponsors for making this conference a reality. I am confident that the deliberations and interactions during the conference will inspire innovative research and meaningful collaborations.

I wish the conference great success and hope all the participants will have a productive and enriching experience at NIT Goa.

With best wishes,

Prof. O. R. Jaiswal
Director, NIT Goa

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Message



I am pleased to note that the 9th International Conference on Magnetic Materials and Applications (ICMAGMA-2026) is being jointly organized by the National Institute of Technology Goa and the National Institute of Technology Warangal, in association with the Magnetics Society of India, during June 3–5, 2026 at National Institute of Technology Goa.

ICMAGMA-2026 comes at a time when magnetic materials and advanced functional devices are playing an increasingly significant role in strategic technologies, sustainable energy systems, next-generation electronics, intelligent sensing, data storage, electric mobility, biomedical engineering, and quantum technologies. The conference will provide an important international platform for scientists, academicians, industry leaders, technologists, research scholars, and students to deliberate on emerging research trends and technological innovations in magnetism, spintronics, magnetic thin films, magnetic nanostructures, multifunctional materials, modelling and simulation, additive manufacturing, and device-oriented applications.

The conference is expected to foster high-quality research interactions and strengthen international collaborations among universities, national laboratories, R&D organizations, and industries working in frontier areas of magnetic materials and allied technologies. Such interactions are essential for accelerating translational research, promoting interdisciplinary innovation, establishing joint research initiatives, and enabling the development of globally competitive technologies and advanced manufacturing capabilities. ICMAGMA-2026 will also provide valuable opportunities for young researchers and students to engage with leading experts from across the world, thereby encouraging scientific excellence, collaborative research culture, and innovation-driven learning.

National Institute of Technology Warangal has consistently emphasized research excellence, global academic engagement, technology development, and industry-oriented innovation. Our association with ICMAGMA-2026 reflects this commitment and reinforces our vision of strengthening international R&D partnerships and advancing high-impact research in emerging materials and advanced engineering technologies.

I congratulate the organizing teams of National Institute of Technology Goa, National Institute of Technology Warangal, and the Magnetics Society of India for their dedicated efforts in bringing together eminent researchers, scientists, academicians, industry experts, and innovators from different parts of the world for this prestigious international conference. I warmly welcome all distinguished speakers, delegates, researchers, industry participants, and students, and wish ICMAGMA-2026 grand success with highly productive deliberations, impactful collaborations, and meaningful research outcomes for the global scientific community.

(Bidyadhar Subudhi)

MESSAGE FROM THE ORGANIZERS

It gives us immense pleasure to present the book of abstracts of the 9th International Conference on Magnetic Materials and Applications (ICMAGMA-2026), being held from June 3 to 5, 2026, at NIT Goa, Goa, India. The 9th edition of ICMAGMA is jointly organized by NIT Goa and NIT Warangal, in association with the Magnetics Society of India. (DMRL, Hyderabad).

ICMAGMA-2026 brings together researchers, academicians, scientists, technologists, industry professionals, and scholars working in the important and rapidly advancing field of magnetism, magnetic materials, and their applications. The conference aims to provide a vibrant platform for scientific interaction, exchange of ideas, presentation of recent findings, and identification of emerging directions in magnetic materials research and its technological applications.

The conference themes cover a wide range of topics, including soft and hard magnetic materials, magnetic recording, memory and spintronics, magnetic thin films, functional magnetic materials, magnetic particles and nanostructures, cooperative magnetic phenomena, novel magnetic materials and device applications, modelling and simulation, interdisciplinary magnetism, magnet industry and products, and additive manufacturing of magnetic materials. The contributions included in this abstract book reflect the diversity, depth, and contemporary relevance of these areas.

The conference features plenary lectures, invited talks, oral presentations, and poster sessions by distinguished speakers and delegates from India and across the globe. It is envisaged to create meaningful opportunities for academic networking, collaborative research, and knowledge exchange among participants at different levels of their scientific careers.

We sincerely thank the Chief Patron, Patrons, Chairperson, Co-Chairpersons, Organizing Secretaries, advisory committee members, Magnetics Society of India, invited speakers, reviewers, sponsors, volunteers, scholars, service providers and all the participating institutions for their valuable support in shaping ICMAGMA-2026. We also express our appreciation to all the authors who submitted their research work and contributed to the scientific richness of this conference.

We hope that this book of abstracts will serve not only as a record of the scientific deliberations of ICMAGMA-2026 but also as a useful reference for researchers, scholars and students working in the field of magnetism, magnetic materials and applications. We wish all the participants a productive, inspiring, and memorable conference at NIT Goa.

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ICMAGMA-2026

ICMAGMA 2026

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About the conference

The International Conference on Magnetic Materials and Applications (ICMAGMA) is a prominent event organized by the Magnetics Society of India (MSI) in association with other academic and research institutions. This conference serves as a flagship platform for knowledge sharing and fostering innovation in the field of magnetism, magnetic materials and its applications. The objective of the conference is to provide an ideal platform for all those pursuing a career in magnetism, magnetic materials, and applications to come together, discuss, disseminate, and assess the recent developments in the area of magnetism. The 9th edition of the International Conference on Magnetic Materials and Applications (ICMAGMA-2026) is jointly organized by the National Institute of Technology Goa (NIT Goa) and the National Institute of Technology Warangal (NIT Warangal), in association with the Magnetics Society of India (MSI). The event will take place from June 3–5, 2026, at NIT Goa, Goa, India. ICMAGMA-2026 will feature a broad spectrum of topics in magnetism, including plenary sessions, invited talks, oral presentations, and poster sessions. The conference is expected to attract over 500 delegates from India and abroad, providing an excellent platform for networking, collaboration, and knowledge exchange in the field of magnetism, magnetic materials and applications. Through this endeavor, the conference aims to disseminate awareness among young researchers, faculty, scientists, technologists and industrialists about the latest advancements in magnetism and related applications.

Thematic Areas

- Additive Manufacturing of Magnetic Materials
- Advanced Materials for Magnetic Applications
- Fundamental Magnetic Properties and Cooperative Phenomena
- Interdisciplinary Topics in Magnetism
- Magnetic Recording, Memory, and Spintronics
- Magnetic Thin Films, Functional Magnetic Materials
- Magnetic Particles and Nanostructures
- Modeling and Simulation in Magnetic Materials
- Magnet Industry and Products
- Novel Magnetic Materials and Device Applications
- Recycling and Sustainability of magnetic materials
- Soft and Hard Magnetic Materials

About MSI

The Magnetics Society of India (MSI) is a professional organization dedicated to promoting research, development, and applications in the field of magnetism and magnetic materials. MSI was established in November 1973 by the late Dr. R.V. Tamhankar, former Director of DMRL, and serves as a platform for scientists, engineers, academicians, and industry professionals to exchange knowledge and collaborate on advancements in the entrusted areas of magnetism and magnetic materials. The society organizes national and international conferences to foster interaction between researchers and industries, encouraging innovation in areas such as magnetic storage, sensors, spintronics, and biomedical applications. With its network of experts from various institutions and industries, the society plays a vital role in guiding research directions and supporting young scientists by bringing them together.

About NIT Goa



The National Institute of Technology Goa (NIT Goa) is a premier national-level technical institute in India established in 2010 by an act of parliament (NIT Act, 2007 and NIT (Amendment) Act, 2012). NIT Goa is an autonomous institute functioning under the aegis of Ministry of Education (MoE), Government of India, and has been declared an "Institute of National Importance". The Institute is dedicated to its academic excellence and aims to produce quality Engineers and Scientists. The Institute offers five undergraduate programmes and three postgraduate programmes in Engineering Departments. The Institute also offers Ph.D. degree in various stream of Engineering, Applied Sciences, Technology and Humanities & Social Sciences. All the faculty members are dedicated to training the students with a world-class education. Faculty members are actively engaged in cutting-edge research and have successfully executed numerous sponsored R&D projects. Their work has resulted in the publication of several research articles, book chapters, and books, as well as several patents.

About NIT Warangal



National Institute of Technology Warangal (an Institute of National Importance), formerly known as Regional Engineering College, was established in 1959. Pandit Jawaharlal Nehru laid the foundation stone for this institute on 10th October, 1959, the first in the chain of 32 NITs in the country. The Institute is well known for its dedicated faculty, staff and state-of-the-art infrastructure conducive to a healthy academic and research environment. The institute is constantly striving to achieve higher levels of technical excellence. Evolving a socially relevant and yet internationally competing curriculum, implementing innovative and effective teaching methodologies and focusing on the wholesome development of the students are the primary concerns of the Institute. Thanks to UNESCO, UK assistance and the World Bank Assistance under the Technical Education Quality Improvement Programme (TEQIP) in the past, which are a timely help in the overall development of the Institute.

The institute currently has fourteen academic departments and a several advanced research centres in various disciplines of engineering, sciences, and management, with about 100 laboratories organized in a unique pattern of functioning. It is a fully residential campus sprawling over 250 acres with excellent infrastructure like a central library with state-of-the-art facilities, two spacious auditoriums, guest houses, student hostels & activity centre, mega computer centre, indoor games complex, big stadium, seminar halls complex with high end infrastructure, dispensary with state of art of facilities, etc. Faculty of repute, brilliant student community, excellent technical and supporting staff, and an effective administration have all contributed to the pre-eminent status of NIT Warangal. The institute offers eight UG programmes (B.Tech.) in engineering, 32 PG programmes (M.Tech., M.Sc (Tech), M.Sc., MCA and MBA) in engineering, sciences and management and research programmes in engineering, sciences, humanities, physical education and management. The institute is well-known for its Research and Development, Industrial consultancy, Continuing education and Training programmes for teachers and industrial personnel. About 7000 students across the country and about 500 international students study in the campus. The institute has demonstrated remarkable foresight in securing substantial high-quality research and consultancy projects during the last few years.

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Plenary Lecture - 1

HYBRID MAGNON MODES

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Abstract: Magnons readily interact with a wide variety of different excitations, including microwave and optical photons, phonons, and other magnons. The resulting hybrid magnon dynamic excitations have recently gained increased interest due to their potential impact on coherent information processing [1]. This in turn opens new pathways for hybrid quantum information systems [2–4]. I will discuss specific examples and strategies, where we developed fully integrated devices that form the essential building blocks for more complex integrated coherent quantum systems. Towards this end, we demonstrated strong magnon-photon coupling in scalable coplanar devices using coplanar superconducting microwave photon resonators [5]. Based on this concept we have shown how two magnon resonators can be coupled over macroscopic distances, and using local time-resolved detection, we demonstrate coherent, Rabi-like, energy exchange between them [6]. Conversely, photons in two separate coplanar waveguides can be transmitted in a directional manner via nonreciprocal coupling to magnons [7]. Lastly, I will show how a superconducting qubit can be used for sensitively detecting magnon populations over a broad dynamic range [8]. These measurements illustrate the potential of using magnons for coherently controlled interactions ultimately even in the single quantum limit.

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Keywords: Magnons, superconducting microwave devices, magnon-phonon coupling, magnetic damping

References:

[1] Y. Li, *et al.*, J. Appl. Phys. 128 (2020) 130902.
[2] D. D. Awschalom, *et al.*, IEEE Quantum Engin. 2 (2021) 5500836.
[3] Y. Li, *et al.*, 2022 IEEE Intern. Electr. Dev. Meeting, (2022) 14.6.1.
[4] Z. Jiang, *et al.*, Appl. Phys. Lett. 123 (2023) 130501.
[5] Y. Li, *et al.*, Phys. Rev. Lett. 123 (2019) 107701.
[6] M. Song, *et al.*, Nat. Commun. 16 (2025) 3649.
[7] Y. Li, *et al.*, Appl. Phys. Lett. 123 (2023) 022406.
[8] S. Rani, *et al.*, Phys. Rev. Appl. 23 (2025) 064032.

Plenary Lecture - 2

MAGNETIC MULTILAYERS FOR MAGNETOELECTRIC SENSORS – MAGNETO-OPTICAL MICROSCOPY AND MAGNETIZATION CONTROL

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Abstract: Magnetoelectric composite magnetic field sensors aim to detect magnetic fields in the picotesla range. Advanced magneto-optical microscopy with high temporal resolution is used to optimize these devices. Magnetospatial analysis reveals how magnetization changes during operation by focusing on domain nucleation, domain wall resonances, bending modes, and spin-wave-like phenomena. These effects are mapped by operando imaging across various sensor types, including surface acoustic wave and delta-E effect systems that are excited from kilohertz to gigahertz frequencies.

Magnetic flux-closing multilayer structures and stabilized single-domain layers practically eliminate magnetic noise. Improvements involve combining sensing and pinning multilayer stacks with specific parallel, antiparallel, or noncollinear magnetization arrangements to virtually eliminate electrical carrier noise. The shown advancements enable ultra-low-noise sensors that can detect weakest magnetic signatures. Sensors are now approaching fundamental detectability limits.

We will discuss additional noise effects that extend beyond standard domain activity. This includes nonlinear magnetoelastic effects and limitations due to self-emerging periodic magnetic domains for high-sensitivity magnetoelectric sensors.

Keywords: Magnetic Sensors, Magnetic Domains, Magneto-Optical Microscopy. Magnetic Multilayers.

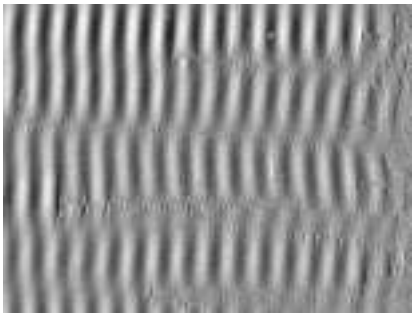


Fig. 1: Dynamic imaging of interactions of propagating surface acoustic waves with magnetic domain walls**.**

References:

[1] D. Seidler, et al., “Noise Minimization for Low Detectability Converse Magnetoelectric Film Sensors by Magnetic Moment Compensated Sensing Layers” (submitted)
[2] C. Dorn, et al., “Self-emergence of undulating magnetic domains in magnetostrictive films” (submitted)
[3] J. McCord, N. O. Urs, and M. Vogel, Applied Physics Letters 127, 180501, 2025.
[4] L. Thormählen et al., Applied Physics Letters 124, 17, 2024.
[5] E. Spetzler, B. Spetzler, and J. McCord, Advanced Functional Materials, 34, 2309867, 2023.
[6] V. Schell et al., Scientific Reports 13, 8446, 2023.
[7] C. Müller et al., Advanced Electronic Materials 8, 2200033, 2022.

Plenary Lecture - 3

HARNESSING BERRY CURVATURE IN HEUSLER AND HIGH-ENTROPY MAGNETIC ALLOYS FOR TRANSVERSE THERMOELECTRIC PHENOMENA

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Abstract: Magnetic materials with complex electronic band structures provide fertile ground for Berry-curvature-driven transport phenomena that couple charge, spin, and heat currents. Heusler compounds and emerging high-entropy magnetic alloys offer exceptional opportunities to engineer electronic topology and magnetic order through compositional design. In this invited talk, I will present recent results from our group on anomalous transverse transport phenomena in these tunable magnetic systems, focusing on the anomalous Hall effect (AHE), Spin Seebeck effect (SSE), and anomalous Nernst effect (ANE) [1,2]. Through systematic alloy synthesis, structural characterization, and detailed magnetotransport measurements, we investigate how chemical substitution, lattice tuning, and compositional disorder influence Berry curvature near the Fermi level and generate enhanced transverse responses. In several Heusler systems we observe large anomalous Hall conductivities and strong thermomagnetic signals linked to spin–orbit coupling and nontrivial band topology. Extending these studies to high-entropy alloys, we demonstrate that multi-principal-element compositions stabilize robust ferromagnetism while enabling tunable anomalous Hall and thermomagnetic coefficients. These findings establish Heusler and high-entropy alloys as versatile platforms for Berry-curvature engineering and the development of magnetic materials for thermomagnetic energy conversion, waste-heat harvesting, and next-generation spin-caloritronic technologies.

Keywords: Heusler alloys, High-entropy alloys, Anomalous Hall effect, Anomalous Nernst effect, Berry curvature, Thermomagnetic transport

References:

[1] Chanda, J. Nag, A. Alam, K.G. Suresh, M.H. Phan and H. Srikanth, *Physical Review B (LETTER)* **107**, (2023) L220403

[2] R. Roy Chowdhury, N.F. Shkodich, T. Roy, T. Smoliarova, D.K. Le, E. Kasotakis, M. Shirai, M. Farle, M.H. Phan and H. Srikanth, *ACS Nano* 19, (2025) 32967

Plenary Lecture – 4

SPINTRONICS MATERIALS FOR BRAIN-INSPIRED COMPUTING

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Abstract: Neuromorphic, or brain-inspired, computing is emerging as a promising approach to overcome the energy inefficiency inherent in the traditional von Neumann architecture, particularly for artificial intelligence applications. To realize spin-based neuromorphic systems in practice, it is crucial to design and fabricate electronic analogues of biological neurons and synapses. A synaptic device must exhibit multiple resistance states to emulate synaptic weight modulation, while a neuron device should be capable of integrating multiple input signals and generating a pulse output once a threshold is exceeded. Our group has been investigating domain wall (DW) devices, where DWs can be manipulated by spin–orbit torque or orbital torque, as potential candidates for implementing such spintronic neuron and synapse functionalities.

In this talk, I will provide a brief introduction to brain-inspired computing and the role of spintronic devices in realizing such systems. I will provide the advances in emerging materials such as Orbital torque materials and altermagnets for applications in spin-based neuromorphic computing.

Keywords: spintronics, orbital torque, altermagnets, synapses, neurons

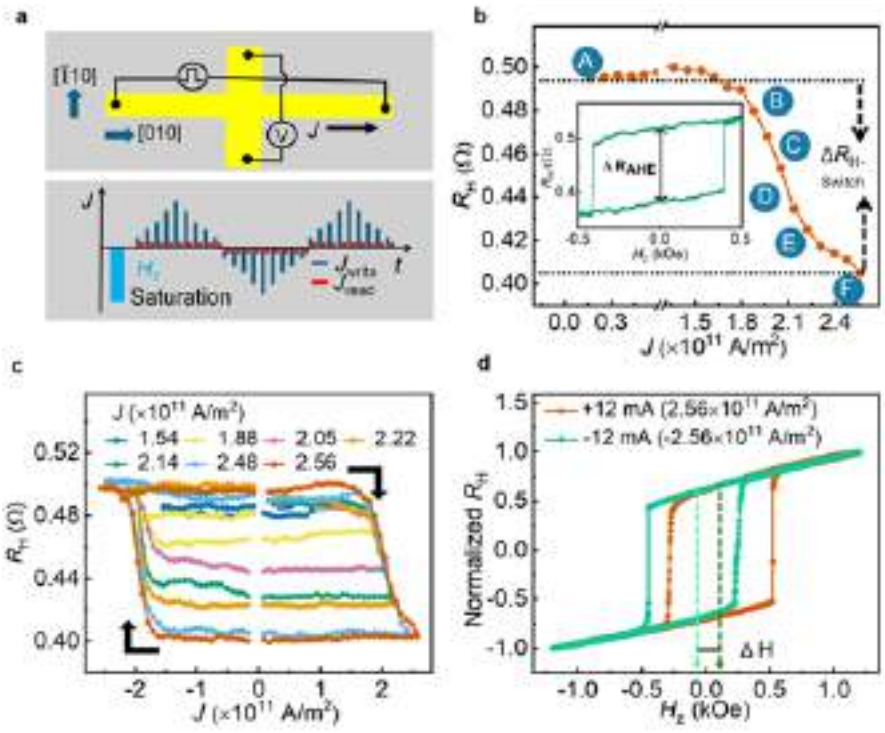


Fig. 1: SOT-driven field-free magnetization switching and current-induced hysteresis loop-shift measurement of altermagnetic RuO_2-based heterostructure.

References:

[1] B. Sekh, H. Rahaman, R. Maddu, P.K. Mishra, T. Jin and S.N. Piramanayagam, (2025) https://arxiv.org/abs/2501.12593

Plenary Lecture – 5

CONTROLLING MAGNETIZATION AND SPINTRONIC BEHAVIOUR VIA BULK AND INTERFACE EFFECTS IN MULTILAYERED SYSTEMS

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Abstract: Spintronics and nanomagnetism in multilayered systems critically depends on the electronic structure of the individual magnetic and non-magnetic layers and the interactions that take place across the interfaces between these layers, which are determined by the physical structure within the layers and across the interfaces. This talk is divided into two parts: the first focuses on proximity-induced magnetization (PIM) in Pt and its impact on interfacial spin transport [1, 2] and interlayer coupling [3], while the second addresses the role of controlled local compositional variations on reduced damping in Cr doped Co [4] and magnetization depth profiles and anisotropy in rare-earth–transition-metal (RE:TM) ferrimagnetic alloys [5, 6, 7]. In Pt-based FM/NM heterostructures, interfacial hybridisation governs spin pumping, magnetic damping, spin–orbit torque efficiency, interfacial anisotropy and Dzyaloshinskii–Moriya interactions. Studies of CoFe/Pt and NiFe/Pt multilayers show a strong correlation between Pt PIM and the spin-pumping-enhanced damping [1, 2], while recent XMCD/XRMR measurements demonstrate that when the two interfaces in FM/Pt/FM systems are brought into closer, the induced Pt moments interact, enhancing total PIM and giving rise to PIM-mediated interlayer coupling that drives a transition from two-step to single-step magnetization reversal [3]. The second part examines compositional variational within layers, looking first at the reduction of damping in local Cr doping of Co thin-films [4]. For RE:TM alloys depth-resolved structural and magnetic analysis shows that nominally uniform thin films exhibit significant compositional variations [5] that may strongly influence magnetization, compensation, anisotropy and spin transport. In compositionally graded RE:TM films, resonant x-ray and neutron reflectometry reveal a complex magnetization landscape with regions of in-plane and out-of-plane anisotropy [6], shaped by both the local RE concentration and the transition-metal environment, which is crucial for engineering field-free SOT switching. Together, these studies demonstrate how interfacial hybridisation in Pt systems and local compositional engineering of alloys provide complementary pathways for controlling anisotropy, damping and spin-transport behaviour.

Keywords: spintronics, Pt, spin transport, Damping, GdCoFe, XRMR, proximity-induced-magnetization

References:

[1] C Swindells, H Głowiński, Y Choi, D Haskel, PP Michałowski,… D Atkinson Appl Phys Letts 119 (2021)
[2] C Swindells, H Głowiński, Y Choi, D Haskel, PP Michałowski, …D Atkinson Phy Rev B 105, 094433 (2022)
[3] D Rianto, B Nicholson, M Kowacz, P Kuświk, L Bouchenoire… "*The Role of Proximity-Induced-Magnetization in Interlayer Coupling in Ferromagnetic/Heavy Metal/Ferromagnetic Multilayers*" D Atkinson *under review* (2026)
[4] S Azzawi, A Umerski, LC Sampaio, S A Bunyaev, G N Kakazei, D Atkinson APL Materials 11 (8) (2023)
[5] O Inyang, C Swindells, D Rianto, L Bouchenoire, RJH Morris,... D Atkinson Appl Phys Letts 123 (12) (2023)
[6] D Rianto, B Nicholson, AW Hodgkiss, AJ Caruana, CJ Kinane, ...D Atkinson Comms Mater 6, 264 (2025)

Plenary Lecture – 6

SYNTHETIC ANTIFERROMAGNETS FOR SPINTRONIC APPLICATIONS

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Abstract: Ferromagnetic/non-magnetic/ferromagnetic heterostructures with antiferromagnetic interlayer exchange coupling, known as synthetic antiferromagnets (SAFs), have attracted significant attention due to their potential applications in spintronic devices, including giant magnetoresistance random-access memories, sub-THz spin-torque nano-oscillators, and magnetic skyrmion-based racetrack memories. The electric field control of interlayer exchange coupling in SAFs has been demonstrated using magnetoionic effects [1], allowing the orientation of the two ferromagnetic layers to be switched relative to each other and enhancing the functionality of energy-efficient spintronic devices. In this talk, we present our recent work investigating the electric field effect on interlayer exchange coupling in Co/Ru/Co/ferroelectric PMN-PT heterostructures. We demonstrate that inverse piezoelectric strain transfer from the PMN-PT layer to the Co/Ru/Co layer induces modulation of the interlayer exchange coupling, and that the magnitude of this modulation is associated with the thickness of the Ru interlayer [2]. This is consistent with the results of our first-principles calculations. Additionally, we will present our recent findings on the formation of high-density magnetic skyrmions in $[Co/Ru/Co]_n$ SAF multilayers. Our results show that the size of magnetic skyrmions depends strongly on the thickness of the Ru interlayer and the number of repetitions, resulting in magnetic skyrmions with a diameter of ~78 nm. These results provide a basis for developing low-energy skyrmion-based memory devices. This work was supported in part by JST CREST (Grant No. JPMJCR18J1), JSPS KAKENHI (Grant Nos. JP24H00380, JP24K21732, JP23KK0086, JP24KJ1306 and JP24K01144), JSPS JRP-LEAD with UKRI (Grant No. JPJSJRP20241705), JST FOREST (Grant No. JPMJFR212V) and MEXT DXMag (Grant No. JPMXP1122715503).

Keywords: Synthetic antiferromagnet, artificial multiferroic heterostructures, electric field effect, magnetic skyrmions

References:

[1] E. Kossak, M. Huang, P. Reddy, D. Wolf, G. S. D. Beach, Sci. Adv. **9** (2023) add0548.

[2] Y. Hisada, S. Komori, K. Imura, C. Shen, Y. Gohda, C. C. I. Ang, W. S. Lew, and T. Taniyama, Adv. Sci. **13**, (2026) e17798.

Plenary Lecture – 7

HIGH-ENTROPY ALLOY THIN FILMS FOR SPINTRONICS

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Abstract: High-entropy alloys (HEAs) have attracted considerable attention for their applications as structural materials owing to their excellent mechanical properties, heat resistance, corrosion resistance, and irradiation resistance. In recent studies, the benefit on the concept of HEAs has been expanded to include electronic materials such as magnetic, thermoelectric, and superconducting materials. However, most studies to date have been conducted using bulk samples, and studies on thin films remain very limited.
My presentation provides an overview of the studies on HEA thin films for spintronics. HEAs, which consist of five or more metallic elements of approximately equimolar concentrations exhibiting a single-phase solid solution, may be regarded as an assembly of local symmetry-breaking systems with significant lattice distortion; therefore it is expected that magneto-transport phenomena such as spin Hall effect, anomalous Hall effect and anomalous magnetoresistance, all originating from spin-orbit interaction, will be enhanced.
Our group recently reported a spin Hall angle exceeding 0.1 in Mn-Nb-Mo-Ta-W HEA films using spin Hall magnetoresistance measurements of HEA/CoFeB bilayers [1]. Furthermore, it was demonstrated by another group that Ir-based HEA served as an effective source of spin-orbit torque by spin-torque ferromagnetic resonance and harmonic Hall measurements [2].
Our group has also worked on ferromagnetic HEAs: FeCoNiCuPd. These HEA films demonstrate increases in the anomalous magnetoresistance ratio, anomalous Hall conductivity, and anomalous Nernst conductivity with the content of Pd which possesses a relatively large spin-orbit interaction [3, 4], suggesting that spin-dependent transport in HEAs can be tuned by the content of heavy elements with large spin-orbit interactions.

Keywords: High-entropy alloys, Thin films, Spintronics, Spin-dependent transport, Spin Hall effect, Spin-orbit interaction

References:

[1] T. Kubota, K. Z. Suzuki, Y. Hirayama, S. Takahashi and K. Takanashi, Phys. Rev. Mater., 9 (2025) 084408.
[2] P. Wang, A. Migliorini, Y.-C. Li, H. Deniz, I. Kostanovski, J.-C. Jeon and S. S. P. Parkin, Adv. Mater., 37 (2025) 2416820.
[3] K. Z. Suzuki, T. Kubota and K. Takanashi, APL Materials, 13 (2025) 101108.
[4] H. Isshiki, K. Z. Suzuki, M. Imai, Z. Dong, H. Chudo, Y. Otani, K. Takanashi and J. Ieda, High-Entropy Alloys & Materials, in press.

Plenary Lecture - 8

UNLOCKING QUANTUM SPIN COHERENCE AT ROOM TEMPERATURE

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Abstract: Quantum correlations are central to quantum technologies but are typically fragile and rapidly suppressed by thermal fluctuations. Overcoming this intrinsic thermal fragility remains a fundamental challenge, limiting both the exploration of correlated quantum matter and the realization of practical, temperature-resilient quantum devices. Combining structural, magnetic, spectroscopic, and thermodynamic measurements with theoretical analysis, we show that a delicate balance of exchange interactions in suitable low dimensional spin systems can overcome thermal decoherence over an extended temperature range. In my talk, I shall reveal experimental evidence of persistence of quantum coherence up to room temperature. The talk will then highlight a general strategy for exploiting lattice geometry and exchange topology to realize quantum spin materials operable at ambient condition. My talk will also outline the technological relevance of such entangled spin states in emerging quantum technology.

Plenary Lecture - 9

MULTIFUNCTIONAL PROPERTIES OF HEUSLER ALLOYS

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Abstract: Ever since the re-emergence of Heusler alloys has occurred a couple of decades ago, many interesting developments, both in terms of fundamental aspects and application potential, have been reported. This is due to the multifunctional properties arising from the constituents as well as the disorder present in many of these alloys. The interest in these alloys is increasing day by day due to the discovery of novel properties. Spintronics, magnetic recording, magnetic refrigeration, permanent magnets are some of the areas of application. By virtue of the topological properties exhibited by some of these, topotronics is also being projected as an application. The electronic band structure and its tuning play a crucial role in determining the underlying properties. In this talk, I will give a review of such properties and the applications on the basis of the latest results, obtained experimentally and theoretically.

Plenary Lecture - 10

FIELD-LIKE PERTURBATION ENABLED SIX-STATE READOUT IN TRIAXIAL $\alpha-Fe_2O_3|Pt$ Bi-LAYERS

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Abstract: Understanding current-induced spin–orbit torques provides a route for all-electrical control of antiferromagnetic (AFM) order. Here, we demonstrate six-state memory reading in canted anti-ferromagnetic $\alpha-Fe_2O_3|Pt$ bilayers stabilized by easy-plane triaxial anisotropy. Conventional spin Hall magnetoresistance (SMR) readout cannot distinguish states separated by 180◦, limiting detection to only three states. We show that a static field-like perturbation– via external field lifts this degeneracy of opposite states in $\alpha-Fe_2O_3|Pt$, enabling unambiguous resolution of all six states in the first-harmonic SMR signal. Our analytical and numerical modelling elucidate the role of canting in lifting such degeneracy in $\alpha-Fe_2O_3|Pt$. We demonstrate that dual-modulation SMR measurements (simultaneous current and field excitations) are effective in mitigating thermal drifts in the signals and are essential for reliable readout. Furthermore, our computations of the second-harmonic SMR reveal the interplay of competing interactions governing the decisive lifting of the degeneracy of states. Finally, we propose a two-step current-only protocol for six-state readout in canted AFM $\alpha-Fe_2O_3|Pt$ bilayers.

Plenary Lecture - 11

ENGINEERING MULTIFERROIC PERFORMANCE OF NANOCRYSTALLINE BISMUTH FERRITE THROUGH STRATEGIC DOPING

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Abstract: Nanocrystalline Bismuth ferrite ($BiFeO_3$) has attracted immense attention as a room-temperature multiferroic material owing to its simultaneous ferroelectric and antiferromagnetic ordering. However, its practical implementation is often limited by high leakage current, weak magnetization arising from spiral spin structure, and secondary phase formation. Strategic doping at the A-site (Bi^{3+}) and/or B-site (Fe^{3+}) has emerged as an effective approach to tailor the structural, electrical, magnetic, and optical properties of nanocrystalline $BiFeO_3$.This talk presents a systematic investigation of the influence of various dopants—such as rare-earth ions (La^{3+}, Nd^{3+}, Sm^{3+}), transition metals ($Mn^{2+/3+}$, Co^{2+}, Ni^{2+}), and alkaline-earth elements (Ca^{2+}, Sr^{2+}, Ba^{2+})—on the phase stability, microstructure, and multifunctional properties of nanocrystalline $BiFeO_3$ synthesized via controlled chemical routes. Doping-induced lattice distortion, suppression of impurity phases, and reduction of oxygen vacancies significantly influence grain size and crystallinity. Magnetically, dopant incorporation disrupts the cycloidal spin structure, leading to enhanced weak ferromagnetism and improved magnetoelectric coupling at room temperature. Electrically, optimized doping reduces leakage current density and enhances remanent polarization by mitigating defect states and improving resistivity. Optical studies reveal bandgap tuning through dopant-induced electronic structure modification, broadening potential applications in photocatalysis and optoelectronics. Overall, controlled doping in nanocrystalline $BiFeO_3$ offers a versatile pathway to engineer multifunctional properties for applications in spintronics, non-volatile memory devices, sensors, energy harvesting systems, and visible-light-driven photocatalysis. The presentation highlights the critical role of dopant type, concentration, and nanoscale effects in designing high-performance multiferroic materials for next-generation technological applications.

Keywords: Nanocrystalline multiferroics, Chemical route, Magnetoelectric coupling, Bismuth ferrite.

Invited Lecture – 01

MAGNETIC LONG-RANGE ORDER IN THE PURELY ORGANIC TRIANGULAR MAGNET TNN·CH_3CN

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Abstract: Equilateral spin triangles have long been a topic of interest in quantum magnetism, offering a fertile ground to explore phenomena such as frustration [1], spin-electric coupling [2], and multiferroic ordering [3]. Despite substantial progress, realizing ideal triangular spin networks remains a challenge, often hindered by structural distortions. The organic compound TNN·CH_3CN overcomes these limitations with its isotropic organic radical spins, free from Jahn-Teller effects, allowing uniform exchange interactions. This makes TNN·CH_3CN an ideal candidate for exploring novel quantum phases. In fact, the study of its magnetic phase diagram reveals multiferroic behavior, which is the first example for equilateral spin triangles [4].
However, while macroscopic characterization measurements yield valuable insights, they fall short in providing intricate details about the magnetic structure which is developed at atomic or molecular scale within TNN. In this work, we focus on the determination of its magnetic structure at zero-field using single crystal neutron diffraction (SCND) and muon spin relaxation (μSR) experiments. At zero field, the magnetic signal is too weak to be observed in SCND experiments. Nevertheless, by making use of a computational model and DFT calculations, the absence of oscillations in the μSR spectra is shown to be compatible with a high-symmetry magnetic structure at the muon site. The proposed magnetic configuration is consistent with previous studies, as well as with theoretical predictions of its multiferroic nature [5].

Keywords: Neutron scattering, molecular magnetism, muon spin rotation, spin densities

References:

[1] J. F. Nossa and C. M. Canali, Phys. Rev. B, **89**, 235435 (2014).
[2] S. Nakatsuji *et al.*, Science, **309**, 1697-1700 (2005).
[3] Y. Kamiya and C. D. Batista, Phys. Rev. Lett., **108**, 097202 (2012).
[4] C. P. Aoyama, PhD thesis, University of Florida (2015).
[5] M. Pardo-Sainz, PhD thesis, University of Zaragoza (2024).

Invited Lecture - 02

INTRINSIC AND EXTRINSIC CONTRIBUTIONS TO THE ANOMALOUS NERNST EFFECT IN MAGNETIC THIN FILMS

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Abstract: The anomalous Nernst effect (ANE) in magnetic materials, a transverse thermoelectric phenomenon, has attracted growing interest for applications such as energy harvesting and heat flux sensing [1,2]. This interest is motivated by recent discoveries of large thermoelectric responses associated with nontrivial electronic band topology [3]. However, for practical use, materials exceeding the current transverse thermopower limit of ~10 μV/K are still required [4]. Although intrinsic ANE driven by topological electronic structures is regarded as the most promising route, several important questions remain unresolved: (i) to what extent do extrinsic mechanisms, such as skew scattering, affect the ANE? and (ii) how well does the experimentally observed ANE agree with the theoretically predicted intrinsic ANE?

To address these issues, we have systematically studied the ANE in various composition-gradient magnetic thin films. In Fe_3Co films with an Ir composition gradient, we found that trace Ir concentrations (<2 at.%) induce a skew-scattering contribution that strongly modifies the anomalous Nernst conductivity [5]. This result provides the first qualitative evidence that dilute heavy-element doping can significantly affect the ANE.

We further investigated MnAlGe, a quasi-two-dimensional ferromagnet with strong uniaxial magnetic anisotropy. Our analysis reveals that spin fluctuations characteristic of low-dimensional systems influence both the anomalous Hall effect (AHE) and the ANE through coupled intrinsic and extrinsic mechanisms [6]. In addition, we examined the role of on-site Coulomb interaction *U* in achieving more accurate theoretical predictions of the ANE. For Co-based Heusler alloys, Co_2MnGa and Co_2FeSi [7], a comparative study between experiments and theoretical calculations shows that introducing *U* on the Co site consistently improves the agreement, highlighting the importance of *U* for reliable theoretical prediction of the ANE.

Keywords: anomalous Nernst effect, skew scattering, heat flux sensor, composition-graded film.

References:

[1] Y. Sakuraba, Scr Mater 111, 29 (2016).
[2] W. Zhou and Y. Sakuraba, , Applied Physics Express 13, 043001 (2020).
[3] A. Sakai et al., Nat Phys 14, 1119 (2018).
[4] K. I. Uchida, W. Zhou, and Y. Sakuraba, Appl Phys Lett 118, (2021).
[5] R. Toyama, W. Zhou, and Y. Sakuraba, Phys Rev B 109, 054415 (2024).
[6] N.K.Gupta, et al., (under review)
[7] W. Zhou, K. Masuda, K. Sumida, Science and Technology of Advanced Materials 25, 2564061 (2025).

Invited Lecture - 03

COMPUTATIONAL MODELING OF TOPOLOGICAL, ALTERMAGNETIC, AND OTHER NOVEL MAGNETIC MATERIALS

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Abstract: Theoretical methods based on density functional theory (DFT) are widely employed for computational modeling and prediction of novel materials. Structural, electronic, transport and magnetic properties of different classes of materials are accurately investigated. Recent advances of computational DFT-based studies will be discussed. Especial attention is given to novel quantum materials, including topological insulator Bi_2Se_3 [1] and Weyl semimetal WTe_2 [2]. Another tellurium-based hexagonal compound MnTe is a bright representative of the emerged class of magnetic materials – altermagnets, with the peculiar altermagnetic band structure preserved under pressure [3]. Computational modeling of such materials requires spin-orbit coupling and strong electronic correlations taken into account within DFT+U(+SOC). Based on DFT and a machine learning model developed using physical properties databases, doubled half-Heusler alloys with promising combinations of low thermal conductivity and optimal lattice thermal conductivity, the Grüneisen parameter, and other characteristics are predicted [4]. Theoretical and experimental studies of ternary and quaternary Heusler alloys are focused on prediction and optimization of their properties [5,6]. The work is supported within the state assignment of the Minobrnauki of Russia for IMP UrB RAS.

Keywords: First-Principles Methods, Machine Learning, Topological Insulators, Weyl Semimetals, Altermagnets, Heusler Alloys

References:

[1] B.M. Fominykh, S.T. Baidak, A.N. Perevalova, E.I. Shreder, A.V. Lukoyanov, S.V. Naumov, E.B. Marchenkova, V.V. Marchenkov, Solid State Sci. 175 (2026) 108237.
[2] B.M. Fominykh, A.N. Perevalova, S.T. Baidak, A.V. Lukoyanov, S.V. Naumov, E.B. Marchenkova, V.V. Marchenkov, J. Alloys Compd. 1039 (2025) 182966.
[3] E.D. Chernov, A.V. Lukoyanov, Materials 18 (2025) 2637.
[4] A.N. Filanovich, A.V. Lukoyanov, A.A. Povzner, Adv. Theory Simul. 9 (2026) e01464.
[5] N.S. Solovyev, A.V. Lukoyanov, Phys. Solid State 67 (2025) 1055-1066.
[6] E.I. Shreder, E.D. Chernov, A.V. Lukoyanov, P.C. Korenistov, B. Bandyopadhyay, A. Alam, K.G. Suresh, Phys. Met. Metallogr. 126 (2025) 1820-1826.

Invited Lecture - 04

MATERIAL SELECTION IN HIGH-ENTROPY AND TUNABLE ENTROPY OXIDES: PATHWAYS TO MULTIFUNCTIONALITY

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Abstract: Tunable entropy oxides (TEOs) represent a rapidly emerging class of materials that extend the concept of high-entropy oxides (HEOs) by tailoring configurational disorder to achieve multifunctional properties. Unlike conventional HEOs, which rely on the stabilization of multiple cations in a single lattice through high configurational entropy, TEOs exploit compositional tunability and selective cation inclusion to fine-tune structural, electronic, dielectric responses, etc. This enables the design of oxides with tailored functionalities ranging from giant dielectric, enhanced ionic conductivity, magnetic and catalytic versatility, etc. Recent studies highlight that the choice and proportion of constituent oxides critically influence cock-tail effect, thereby opening pathways to engineer materials for applications. The ability to modulate entropy not only broadens the design space but also provides a framework for correlating structure–property relationships in complex oxides. Furthermore, TEOs overcome limitations of traditional HEOs, such as restricted properties and unpredictable phase stability, by introducing controlled compositional degrees of freedom. In this work, we present the successful synthesis of TEOs with giant dielectric (ε_r) using varying combinations of MnO, NiO, Fe_2O_3, ZnO, and Al_2O_3 through a cost-effective ball-milling technique followed by annealing. All compositions exhibit an A_3O_4-type spinel structure (see-Figure) with tunable mixed valence states, yielding ε_r values on the order of 10^4–10^7 and conductivity of 10^{-5}–10^{-8} S/cm. Triboelectric nanogenerators fabricated with TEOs deliver high electrical outputs (210–283V, 0.2–0.291µA, 18–27nC, and 9.56–79.24µW) under biomechanical activity, alongside large magnetodielectric responses, establishing TEOs as promising multifunctional materials for energy harvesting and sensor applications.

Keywords: Tunable entropy oxides, Energy harvesting, Magnetodielectric, Spinel

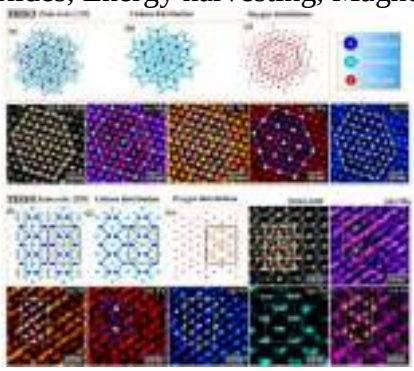


Fig. 1: Atomic-level EDS mapping of TEOs with (a-h) three (TEO-3) and (i-r) five (TEO-5) oxides along with predicted spinel structure.

References:

[1] Alok Kumar Sahu et al, Adv. Func. Materials 35 (52) (2025) e18131.
[2] Alok Kumar Sahu et al, Appl. Phys. Lett. 127 (2025) 231903.

Invited Lecture – 05

EXPLORING MN-BASED TOPOLOGICAL QUANTUM MATERIALS FOR DEVICE APPLICATIONS FROM FIRST-PRINCIPLES STUDIES

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Abstract: The advancement of next-generation quantum technologies relies critically on topological quantum materials that enable energy-efficient operation, high-speed processing, and robust quantum information storage. These functionalities arise from the interplay of magnetism, topology, and electronic correlations, particularly in systems exhibiting nontrivial electronic and phononic spectra. MnRuAs, based on a distorted kagome lattice, displays complex magnetic and electronic behavior, where DFT+U calculations stabilize a ferromagnetic ground state and reveal a quasi-one-dimensional Fermi surface together with a nodal sphere [1]. MnPdGe further enriches this landscape by hosting nodal lines, Weyl nodal rings, and triple-point fermions. The inclusion of spin–orbit coupling generates strong Berry curvature, resulting in a large anomalous Hall effect, anomalous Nernst effect, sizable spin Hall conductivity, and a pronounced polar magneto-optical Kerr effect (MOKE) of about 1.2° [2]. Beyond bulk systems, MnGaGe has been proposed as a two-terminal quantum transport device [3], while the MnAlGe/TiO_2 (001) heterostructure exhibits proximity-induced metallization and Ohmic contact formation with a spin-injection efficiency of 43% under a 0.2 V bias. In addition, the two-dimensional MXene Mn_2CF_2 demonstrates promising spin-dependent transport properties in van der Waals heterostructures. Lateral 2H-MoS_2/Mn_2CF_2 devices exhibit Ohmic contact with nearly perfect spin filtering and linear current–voltage characteristics. In vertical magnetic tunnel junctions (MTJs), Mn_2CF_2 functions as a spin-filter barrier with 1T-MoS_2 electrodes. A four-layer 2H-MoS_2 barrier yields a maximum tunnel magnetoresistance (TMR) of 7.21×10^5% with a large peak-to-valley current ratio, while even a single-layer barrier maintains a TMR of 10^3% at higher bias. Collectively, these findings highlight the strong potential of Mn-based topological materials for quantum computing, energy-efficient electronics, and next-generation spintronic technologies.

Keywords: Topology, Quasi-1D, Kagome, Magneto optical kerr effect, Spintronics, Spin-filter barrier, Spin-flip transition.

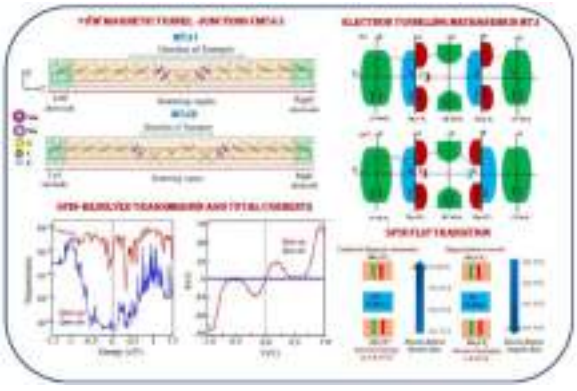


Fig. 1: Schematic illustration summarizing the key findings of this work.

References

1. C. V. Anusree *et al.*, **Phys. Rev. B 111**, 035125 (2025).
2. Pradhan, S. S., **Kanchana, V.** ***Journal of Physics: Condensed Matter*** *(*2026).
3. C. V. Anusree, S. Pradhan et al., **J. Phys.: Condens. Matter 36**, 155501 (2024).

Invited Lecture – 06

RARE EARTH MAGNETS FOR INDIAN EV MARKET – CHALLENGES AND SOLUTIONS

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Abstact: India in its serious pursuit of reducing the carbon footprint has drawn an ambitious road map for the e-mobility program thanks to Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme. The target set is 30% of all vehicle sales to be electric by 2030. Sintered Nd-Fe-B magnets discovered by Sagawa [1] have been the champion magnets for more than 4 decades with an unrivalled energy product in the range of [35 – 55 MGOe]. Currently about 90% of electric vehicles (EV) adopt the high energy efficient BLDC motor technology for the purpose of traction. Nd-Fe-B (NIB) magnets are in-dispensable for the manufacture of these motors and these magnets are required to operate typically at 150 – 200 °C

The Challenges: In this context the uneven distribution of rare earth ores lead to geopolitical complexities in establishing a dependable supply chain. The limitation of the Nd-Fe-B magnets in operating at elevated temperatures requires the addition of heavy rare earth like Dy and Tb. These rare earths are not only costly but also leads to compromise on the magnetic properties in terms of energy product. As regards the Indian context, the lack of extraction technologies and established magnet manufacturing technologies offer additional challenges.

The Solutions: In this presentation we shall discuss some of the efforts pursed at ARCI to address the mentioned challenges. Some of the strategies adopted are

1. Enrichment of Nd content at the grain boundaries by infiltration using eutectic Nd source.
2. Grain growth restrictions using grain boundary refiners
3. Minimal usage of Dy by grain boundary diffusion
4. Adopting new processing techniques to produce high coercive magnets.

Advanced characterization techniques like 3 dimensional atom probe and transmission electron microscopy have proven to be very useful in understanding the underlying phenomena which yields such enhancement in coercivity. These powerful techniques were capable to produce direct evidence of microstructural changes like the enrichment of Nd at grain boundaries resulting in effective decoupling of the magnetic grains hindering the propagation of reversal domains or the formation of precipitates of Nb hindering the grain growth of Nd-Fe-B grains during grain boundary diffusion aiding coercivity enhancement.

References:

[1] M. Sagawa; S. Fujimura; N. Togawa; H. Yamamoto; Y. Matsuura, Journal of Applied Physics 55, 2083 (1984).

Invited Lecture – 07

xMR BASED MAGNETIC SENSORS FOR LINEAR SENSING APPLICATIONS

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Abstract: xMR sensors are becoming popular for linear sensing technology due to their higher sensitivity and lower noise compared to Hall sensors. Among them, Tunneling magnetoresistance (TMR)-based magnetic tunnel junctions (MTJs) have established themselves as a leading platform for high-performance magnetic sensing due to their large magnetoresistance ratio, linearity over a wide operating range, and low power consumption, and have reported field detectivity as low as the sub-pT range.
In this report, the fabrication of xMR (x = A, G, and T)-based highly linear ICs is emphasized through device-circuit co-design, rather than focusing on a single component, enabling reproducible, application-ready output responses [1]. These results establish a practical pathway towards xMR ICs suitable for industrial applications that require high linearity and a reversible output. The deposited ultrathin multilayer stack on a 4-inch wafer was subjected to a microfabrication process using a several-step ultraviolet photolithography and ion milling technique to create an engineering design that achieves a differential bipolar linear output as a function of the externally applied field. Figure 1 presents the different types of xMR linear devices, and the highest sensitivity was achieved in the TMR-based sensor, with 7 mV/V/Oe in the field-operating range of ±20 G. These sensors are being developed to produce products such as speed, current, position, and angle for industrial applications

Keywords: Magnetic sensor, GMR, TMR, Magnetic multilayer

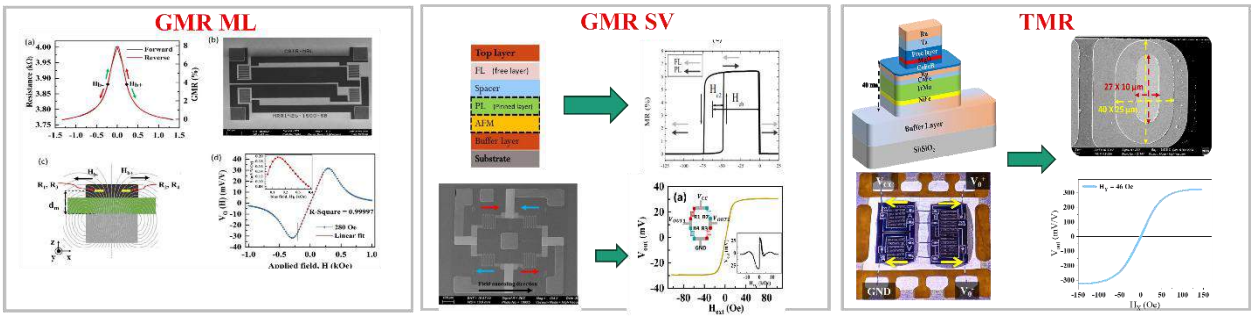


Fig. 1: Transfer characteristics of the linear and biopolar devices of the xMR devices.

References:

[1] Bhagaban Behera, Umesh P. Borole, Jakeer Khan, Harish C. Barshilia, P. Chowdhury, Microelectronic Engineering 298 (2025) 112311

Invited Lecture – 08

EFFECT OF CHEMICAL SUBSTITUTION ON MAGNETIC PROPERTIES OF γ′-$Fe_{4-x}Ni_xN$ AND $CoCr_yFe_{2-y}O_4$ NANOMATERIALS FOR MAGNETIC DATA-STORAGE APPLICATION

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Abstract: Magnetic properties of few selected model material systems; such as: γ′-Fe-Ni-N and Cr substituted $CoFe_2O_4$ materials will be presented. Because of their high values of saturation magnetization and low coercive force, these systems have potential applications in data storage industry. The seminar will emphasis on structure elucidation of the material systems and their relation to the observed tuning of magnetic properties. As synthesis and processing of the materials are very sensitive to nanostructured development and structural deformation, a discussion on synthetic technique involved would be in order. γ′-$Fe_{4-x}Ni_xN$ ($0.2 \leq x \leq 0.8$) nano-structures were fabricated using mixed metal precursors, synthesized by novel chemical route and its subsequent nitridation using NH_3(g) [1]. We were able to synthesize and characterize γ′-$Fe_{4-x}Ni_xN$ nanomaterials which possess very high values of magnetization, i. e. in the range of minimum 144 emu/g (for x = 0.8) to maximum 181 emu/g (for x = 0.6). Cr substituted $CoFe_2O_4$ materials were synthesized via sol-gel auto-combustion route[2]. Cr being magnetic ion which can show variable oxidation state, can alter the magnetic characteristics of $CoFe_2O_4$ materials. We could get a maximum saturation magnetization and coercivity values of 77.4 emu/g (y = 0.0, RT) and 8304 Oe (y = 0.1, 5 K) in $CoCr_yFe_{2-y}O_4$. In γ′-$Fe_{4-x}Ni_xN$, generation of high moment Fe atoms is associated with lattice expansion due to interstitial nitrogen leading to enhanced exchange interactions. For $CoCr_yFe_{2-y}O_4$ materials, magnetism is dominated significantly by magnetic dilution and cation redistributions.

Keywords: Nitride, Ferrite, Chemical Synthesis, Magnetic properties, Data Storage.

References:

[1] Pragnya P. Mishra, M. Manivel Raja and Rabi N. Panda, J. Supercond. Nov. Magn. 29 (2016) 1347

[2] Anagha B. Patil and **Rabi N. Panda, Mater. Chem. Phys.** 348 (2026) 131694. .

Invited Lecture – 09

QUASI-TWO DIMENSIONLITY DRIVEN BY JAHN-TELLER DISTORTION IN THE FERROMAGNETIC INSULATOR CSMNF$_4$

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Abstract: Layered transition-metal fluorides provide an ideal platform to explore the interplay between lattice, orbital, and spin degrees of freedom in low-dimensional magnets. In this work, we investigate the structural and magnetic properties of $CsMnF_4$, a quasi-two-dimensional magnetic system, using a combined theoretical and experimental approach. First-principles density functional theory calculations reveal that the high-symmetry prototype phase of $CsMnF_4$ is dynamically unstable and undergoes a structural distortion driven by Jahn–Teller active Mn^{3+} ions. Phonon analysis identifies unstable modes that condense to stabilize a tetragonal P4/n ground state characterized by cooperative octahedral rotations and orbital ordering. Our results predict a ferromagnetic insulating ground state with strong in-plane exchange interactions and weak interlayer coupling, indicating quasi-two-dimensional ferromagnetism with an estimated Curie temperature of 22 K. These theoretical predictions are subsequently validated through synchrotron X-ray diffraction and neutron powder diffraction experiments, which confirm the P4/n crystal structure and the presence of Jahn–Teller distorted MnF_6 octahedra. Magnetization measurements reveal a magnetic transition at 18.8 K, in close agreement with theoretical estimates. Neutron diffraction further establishes ferromagnetic spin alignment within the ab plane with an ordered moment of 3.76 μB per Mn. The excellent agreement between theory and experiment demonstrates that Jahn-Teller distortion–driven orbital ordering plays a crucial role in stabilizing quasi-two-dimensional ferromagnetism in $CsMnF_4$. This study provides fundamental insights into structure-property relationships that highlights pathways for designing low-dimensional magnetic materials.

Keywords: Density Functional Theory, Neutron Diffraction, Phonon Condensation, Jahn Teller distortion, Quasi-two dimensionality.

Invited Lecture – 10

FIELD-INDUCED METAMAGNETIC AND SPIN-STATE TRANSITIONS IN KAGOME LATTICE

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Abstract: Magnetic ordering in spinels (AB_2O_4) with corner-sharing tetrahedra and mixed-valent rare-earth perovskites (ABO_3) is complex and intriguing due to their unique lattice arrangements and electronic structures [1–3]. Among spinel oxides, the nature of magnetic ordering in pyrochlore (Pyl)-like lattice structures has attracted significant research interest because of their inherent magnetic frustration and the presence of exclusive exchange pathways that mediate a wide variety of magnetic interactions [4]. For example, $GeCo_2O_4$ (GCO) has received considerable attention owing to its Pyl structure, which realizes Kagome (KGM)- and triangular (TRI)-like spin arrangements, leading to magnetic-field-induced transitions [2-4]. Such transitions provide an opportunity to gain deeper insight into microscopic magnetic exchange interactions, complemented by detailed magnetization measurements. In the present talk, we mainly focus on a systematic comparison of field-induced effects on the global magnetic behavior, as revealed by magnetization versus field (M–H) hysteresis measurements (Figure 1), in selected Pyl-spinels and rare-earth manganites ($AMnO_3$). The latter systems exhibit field-induced metamagnetic transitions as well as spin-state transitions [4].

Keywords: Metamagnetic Transitions, Manganites, Spinels, Antiferromagnetism.

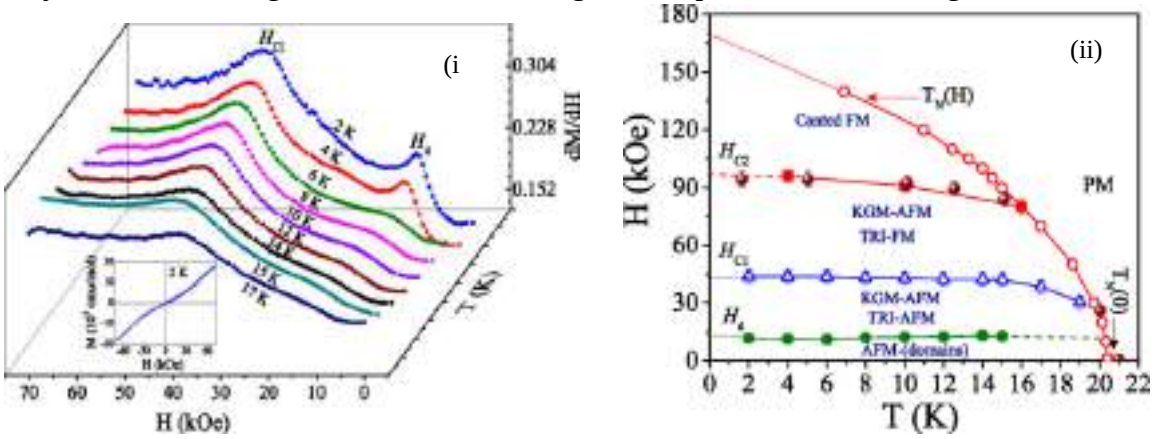


Fig. 1: (i) Field-induced magnetic transitions (FIMTs) determined from the M–H isotherms and their derivatives, dM/dH versus H, measured at different temperatures (T). **(ii)** Temperature dependence of the FIMTs, clearly demarcating the different magnetic structures.

References:

[1] P. Pramanik, *et. al.* Phys. Rev. B **104**, 014433,(2021)
[2] P. Pramanik, *et. al.* Phys. Rev. B **99**, 134422 (2019)
[3] S. Ghosh, *et. al.* Phys. Phys. Rev. B **98**, 235119 (2018)
[4] S. Das, *et. al.* Phys. Rev. Materials 0**7**, 084410, (2023)

Invited Lecture – 11

EMERGENT STRONG FERROMAGNETISM IN COBALT INTERMETALLICS

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Abstract: Intermetallic compounds of rare earth elements (*R*) and cobalt (Co) are used as magnetic materials, including permanent magnets. Cobalt primarily contributes to their magnetism, which increases as the Co/*R* ratio rises. However, cobalt poses supply risks due to its uneven distribution. Similarly, using *R* is undesirable for practical applications. Among *R*-Co intermetallics, the Laves phase RCo_2 does not possess spontaneous Co magnetism. Instead, the magnetic moment is induced by the molecular field of *R*. Recently, we discovered that $YMgCo_4$, a site-ordered (C15b-type) Laves phase in which half of the Y sites in the nonmagnetic YCo_2 are substituted with Mg, exhibits strong ferromagnetism with a Curie temperature (T_C) of 405 K and a magnetic moment of ~1 μ_B/Co [1]. Furthermore, studies involving the continuous variation of Y and Mg compositions revealed that T_C can reach 665 K [2], which exceeds that of Y_2Co_7 (600–650 K). These changes are ascribed to Mg-substitution-induced hole doping. This demonstrates that Mg substitution can serve as a guiding principle for magnetic enhancement in *R*-Co intermetallics. Successful growth of single crystals of the site-ordered $RInCo_4$ enabled detailed studies of magnetic anisotropy [3, 4]. $LuInCo_4$, for example, is an isotropic ferromagnet with a T_C near room temperature that exhibits peculiar behavior: magnetic anisotropy develops rapidly below ~100 K [3]. $DyInCo_4$ has a compensation temperature near room temperature [4], making it a promising candidate for spintronics applications. Therefore, Mg- or In-substituted RCo_2 provide a fascinating new group of materials from both a fundamental and an applied perspective.

Keywords: Cobalt intermetallics, Laves phase, Strong ferromagnetism, Site-ordered phase

References:

[1] T. Shiotani et al., J. Alloys Compd. 961 (2023) 170990.
[2] T. Waki et al., in preparation
[3] T. Shiotani et al., Phys. Rev. Mater. 8 (2024) 114409.
[4] T. Shiotani et al., Phys. Rev. Mater. 9 (2025) 124411.

Invited Lecture – 12

STRAIN-DRIVEN TUNING OF PROPERTIES IN MAGNETIC THIN FILMS: TOWARDS FLEXIBLE SPINTRONICS

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Abstract: The rapid development of flexible electronics has stimulated strong interest in flexible spintronics, where mechanical strain can actively tune magnetic properties. Since flexible devices conform to curvilinear surfaces, externally applied strain can significantly modify their structural and magnetic behavior. Here, we investigate strain effects in perpendicular magnetic anisotropy (PMA) thin films and in plane Heusler-alloy-based systems deposited on flexible polyimide substrates. Symmetric (Pt/Co/Pt, Pd/Co/Pd, $[Pd/Co]_n$) stacks were fabricated on rigid Si and flexible substrates. Controlled tensile and compressive strains were introduced via convex and concave bending (Fig. 1 (a)). By varying, tensile and compressive strains oppositely modify magnetization reversal, relaxation, and domain wall dynamics due to magnetoelastic coupling (Fig. 1 (b)). XMCD measurements reveal an enhanced orbital-to-spin moment ratio under strain, indicating modified orbital quenchingin Co/Pd system [1]. A strain-assisted spin reorientation transition is achieved in Co/Pd and Co/Pt systems, demonstrating potential for low-power spintronic switching [2]. Micromagnetic simulations further confirm strain tunability of PMA and interfacial Dzyaloshinskii–Moriya interaction in $[Co/Pd]_n$ multilayers. All modulations remain reversible within the elastic strain limit, while excessive strain induces film cracking and buckling inevitably alters the electronic and magnetic properties of the samples [3]. In addition, PMA-based synthetic antiferromagnets (Pt/CoFeB ,Pt/Co with Ru,Ir spacer) on flexible substrates exhibit a strain-driven transition from antiferromagnetic to ferromagnetic coupling under tensile strain. Extending strain engineering to Heusler alloys, we study Al-rich Co_2FeAl-derived Fe–Co–Al thin films. Unlike stoichiometric Co_2FeAl, compressive strain enhances saturation magnetization, whereas tensile strain suppresses it. First-principles calculations attribute this inverted response to strain-induced competition between exchange splitting and crystal-field effects in an Al-enriched environment. Overall, compositional and strain engineering provide an effective pathway for energy-efficient, strain-controlled spintronic devices.

Keywords: Anisotroy , Domain, Heusler alloys,Syntheticantiferomagnet

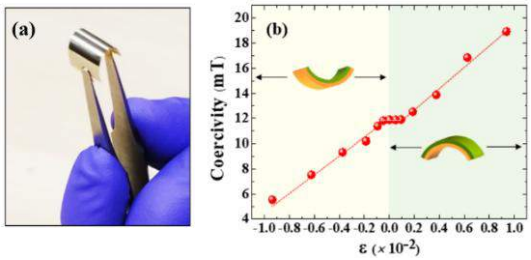


Fig. 1: (a) Image of a flexible film, (b) modulation of coercivity via strain.

References:

[1] E. Pandey and S. Bedanta et al., (manuscript in preparation)
[2] E. Pandey et al., Nano Ex. **01**, 010037 (2020)
[3] E. Pandey and S. Bedanta et al., J. Phys. D: Appl. Phys. **58** 175003 (2025)

Invited Lecture – 13

STRAIN ENGINEERED MAGNETIC FILMS FOR TUNABLE MICROWAVE FILTER APPLICATIONS

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Abstract: In high-frequency communication devices, a microwave filter is an important component. In general, these devices are based on ferromagnetic resonance (FMR), enabling us to tune the centre frequency by varying the external magnetic field. Due to the requirement of a high magnetic field, the resultant device is bulky. Moreover, to vary the magnetic field, one has to vary either the distance between the ferrite and the permanent magnet or the current through the electromagnet. To improve this, a two-step method is employed. The first is to use a voltage control for tuning, and the second is to reduce the required magnetic field.

The use of magnetoelectric layered composites is popular for magnetic field sensing and energy harvesting. In this, two materials, one a magnetostrictive and the other a piezoelectric, are bonded such that the strain induced in one is effectively transferred to the other. The electric field applied to the piezophase creates a strain that gets coupled to the magnetostrictive phase, thereby effectively modifying the internal magnetic field by inducing an anisotropy and changing the FMR frequency.

In the FMR, the anisotropic field plays a crucial role in influencing the resonant frequency, especially in thin films. If this anisotropy field is modified by a strain-induced process, it is expected to reduce the external magnetic field. By choosing an appropriate substrate, it is possible to induce a strain of the order of 3-5%. In this talk, the method of strain engineering through a combinatorial epitaxial process and its effect on the control of ferromagnetic resonant frequency are discussed.

Keywords: Ferromagnetic Resonance, Liquid Phase Epitaxy, Strain Induced Anisotropy, Microwave MicroStrip Line, Microwave Filters

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References:

[1] Liu, Y., Zhou, P., Bidthanapally, R., Zhang, J., Zhang, W., Page, M.R., Zhang, T., and Srinivasan, G., J Comp. Sci. 6 (2022),203.

[2] Chaitrali Kshirsagar, Rao Bidthanapally, Ying Liu, Peng Zhou, Aruna Bidthanapally, Hongwei Qu, Deepa Xavier, Subhabrat Samantaray, Sahana Mukund, Venkatachalam Subramanian, Michael R. Page, Gopalan Srinivasan, Crystals, 15 (2025), 953.

Invited Lecture – 14

RARE-EARTH-FREE PERMANENT MAGNETS

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Abstract: Global interest in electric vehicles and remotely located self sustainable devices—where permanent magnets (PMs) are essential components—has created an unprecedented demand for high-performance nanostructured magnetic materials. While rare-earth (RE) magnets, particularly Neodymium-Iron-Boron (NdFeB), remain the industry standard for ultra-high-performance applications, several factors have catalyzed a global shift toward rare-earth-free (RE-free) alternatives. These include extreme price volatility, environmental degradation from mining, the scarcity of RE elements, and geopolitical supply chain vulnerabilities [1-2]. This talk provides an overview of the current landscape of various RE-free PMs, focusing primarily on manganese-based alloys (MnAl, MnBi) and FePt-based magnets. These materials are notable for their high magnetocrystalline anisotropy, positive temperature coefficients of coercivity, and high theoretical maximum energy products, $(BH)_{max}$ [1-2]. We will further discuss the critical role of nanostructured interfacial engineering in "hard-soft" bilayers. These structures utilize exchange coupling to achieve high remanence and coercivity—and consequently a higher $(BH)_{max}$ —without relying on critical minerals.

Keywords: Permanent Magnets, Rare-earth-free Magnets, Maximum Energy Product



Fig. 1: Rare-earth free permanent magnets with their theoretical BH_{max} values [1]

References:

[1] D. Rajbanshi, N. Deka, S. Sarkar, S. K. Srivastava, J. Alloys Compd. 1037 (2025) 182388.

[2] B. Mallik, S.K. Srivastava, Next Materials, 10 (2026) 101501.

Invited Lecture – 15

MAGNETIZATION DYNAMICS OF FE-NI BASED EXCHANGE COUPLED MULTILAYERS MOKE AND FMR

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Abstract: The increasing demand for faster, non-volatile and high-density technology has lead to the investigation of magnetization at femtosecond (fs) time scales and nanometer (nm) spatial resolution which are critical in designing and understanding the devices. The time dependent behavior of magnetic moments in magnetic materials referred to as Magnetization dynamics is very important for spintronic devices. The dynamics however depends on the choice of the multilayers and our group is involved in with the study of exchange coupled multilayers viz. L_{10}FePt/A1FePt, L_{10}FePt/FeCo, L_{10}FePt/FeNi. Understanding the dynamics using the ferromagnetic resonance (FMR), time resolved Magneto Optic Kerr effect (tr-MOKE) of Exchange coupling based soft-hard magnetic multilayers of Fe-Ni/FePt prepared by magnetron sputtering will be discussed. FePt/permalloy systems will be presented. The dynamics observed in visible tr-MOKE for FeNi have, depends on the interplay of spin interactions and the impact of quantum fluctuations on magnetization dynamics. The ultrafast magnetodynamics of the FeNi/FePt composite system by pump-probe tr-MOKE measurements depends on the thickness of the FeNi multilayer. Recent advancements have bridged the gap between basic magnetization theory and practical application to understand and prepare devices in the form of multilayer magnetic films.

Keywords: Magnetisation dynamics, exchange coupling, interface, MOKE, FMR

References

[1] K Dev, A Kadian, VR Reddy, R Medwal, S Annapoorni - Journal of Superconductivity and Novel Magnetism, 37 (5), 1243-1255 (2024)

[2] K Krishnan, K Dev, S Kumar, S Bera, S Annapoorni, Journal of Physics D: Applied Physics, 58 (35), 355002 (2025)

[3] Richa Bhardwaj, Antonio Caretta, Simone Laterza, Gabriele Coltrioli, Francesco Cautero, Amardeep Bharti, Kapil Dev, Pietro Parisse, Cinzia Di Giorgio, Subramanian Annapoorni, Asokan Kandasami & Marco Malvestuto, Scientific Reports, 15, 21155 (2025)

Invited Lecture – 16

GIANT MAGNETOSTRICTION IN TRANSITION METAL OXIDES

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Abstract: Magnetostriction (MST) refers to mechanical strain induced in a material upon magnetization. Magnetostrictive materials can function as actuators and sensors. While MST is of the order of 10^{-5} in elemental ferromagnets like Fe, it is much larger ($\sim 10^{-3}$) in Tb and Dy based metallic alloys owing to spin-orbit coupling associated with 4f electrons of rare-earth ions. Although MST in oxides is much smaller than 4f ion-based metallic alloys, their mechanical, chemical stabilities over a wide temperature range combined with lower manufacturing cost make them attractive. The inverse spinel Co_2FeO_4 holds a record of the highest MST (λ ~100-400 $x10^{-6}$) at room temperature but it decreases to a smaller value at 10K. MST of perovskite (ABO_3-type) oxides has been overlooked for a long time since the orbital moment of a 3d transition metal ion is assumed to be quenched by the crystalline electric field due to surrounding oxygen ions. However, giant MST of the order 10^{-3} has been discovered recently in some bulk Mn, Ru and Co based ABO_3 oxides even in the absence of strong spin-orbit interaction[1-3]. In this talk, I will give an overview of giant magnetostriction in selected perovskite oxides and some unconventional mechanisms involved.

Keywords: Transition Metal Oxides, Magnetostriction, Spin-orbit interaction.

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References

[1] M. R. Ibarra et al., Phys. Rev. B. **57**, R3217 (1998); H. Szymczak, J. Magn. Magn. Mater, **211**, 186 (2000).
[2] M. Roter et al. Sci. Rep. **4**, 7003 (2012).
[3] M. Manikandan and R. Mahendiran, AIP Advances **14**, 015056 (2024);M. Manikandan, A. Ghosh, R. Mahendiran, Appl. Phys. Lett. **123**, 022403 (2023).

Invited Lecture – 17

PREPARATION OF MAGNETIC OXIDE THIN FILMS AND MAGNETO-OPTICAL MEASUREMENTS AND APPLICATIONS

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Abstract: The magneto-optical (MO) effect, which occurs due to the interaction between light and magnetism, is an important keyword not only for evaluating the physical properties of magnetic materials, but also for optical applications. In this presenation, in addtiion to thin film preparation technique called the metal organic decomposition (MOD) method, I will talk about MO measurement techniques and MO applications. The MOD method is a simple technique to prepare high-quality thin films using MOD solutions consisting of solutions of metal-organic acid solts and several equipments such as a spin-coater, a hot-plate and a furnace. High quality bismuth-substituted magnetic garnet thin films and yttrium manganees oxide thin films were successfully obtained [1,2]. For characterization of magnetic materials, a novel magneto-optical spectroscopy [3], MO imaging measureing magnetization vector or magnetic field vector distribution were developed [4,5]. Finally, I will talk about recent results. We have suceeded to switch magnetication by a femto-second pulse laser without applying magnetic field [6]. This new finding is expected to be utilzed in novel optical devices such as high-speed spatial light modulators and optical AI devices. For MO applications, we have developed a diffractive neural network device. This device utilizes the light diffraction and phase modulation due to the MO effect to achieve high-speed, low-power neural network calculations [7].

Keywords: Magneto-optical effect, Magnetic Garnet, All optical magentization switching, Neural network

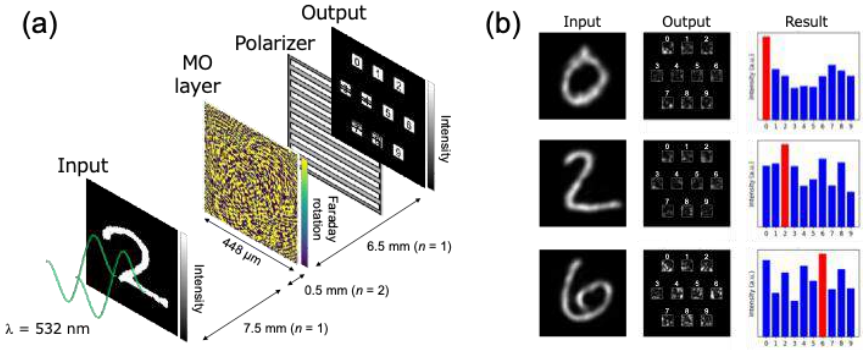


Fig. 1: (a) Schematic of MO-DNN device and (b) experimental result of classification of handwritten digits [7].

References:

[1] T. Ishibashi, J. Magn. Soc. Jpn., 44 (2020) 108-116.
[2] K. Watanabe, H. Sakaguchi, F. Z. Chafi, et al., Jpn. J. Appl. Phys. 63 (2024) 11SP16.
[3] S. Wang, H. Onoda, J. Harbovsky, et al., J. Mag. Soc. Jpn., 47 (2023) 137-143
[4] H. Sakaguchi, R. Oya, S. Wada, T. Matsumura, et al., J. Mag. Soc. Jpn., 46, (2022) 37-41.
[5] T. Ishibashi, S. Asai, I. Wakamatsu, H. Sakaguchi, et al., J. Phys.: Conf. Series, 3161 (2026) 012040.
[6] R. Asatani, S. Suzuki, A. Hata, M. A. A. Masud, et al., J. Mag. Soc. Jpn., 50 (2026). (in press)
[7] H. Sakaguchi, K. Watanabe, J. Ikeda, S. Sumi, et al., Sci. Rep. (2026). (accepted).

Invited Lecture – 18

AMORPHOUS TECHNOLOGY FOR EFFICIENT TRANSFORMERS: ENERGY SAVINGS AND REDUCED CARBON FOOTPRINT

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Abstract: The growing demand for energy efficiency and sustainability in the power transmission system has accelerated the adoption of Amorphous steels as an advanced material for transformer cores. Amorphous steel is characterised as noncrystalline glassy structure, responsible for zeroing down the magnetocrystalline anisotropic properties. As a result, magnetic hysteresis loop becomes further thinner than that of conventional CRGO steel cores. Therefore, amorphous cores offer a transformative solution for reducing 70% core losses in distribution and power transformers. This improvement directly translates into substantial energy savings across the grid, lowering electricity consumption and operational costs. Moreover, the deployment of amorphous core transformers contributes to a reduced carbon footprint by minimizing greenhouse gas emissions associated with power transmission. Their long-term environmental benefits align with global initiatives for decarbonization and sustainable energy infrastructure.

This paper highlights the principles of amorphous technology, its advantages over traditional materials, and role in enabling energy-efficient transformers that support both economic and ecological goals. The technology of the amorphous alloys includes processing of Fe(Co)-Si(Zr,Nb,Cu)-B(P) based alloy steels through rapid solidification (RS) route where the cooling rate exceeds million degrees per second. One of the RS processes, termed as planar flow melt spinning is adopted in this technology, which is a one step process to make quality and continuous amorphous ribbons in a bulk quantity, suitable to make transformer cores directly from the melt. The paper also emphasises challenges that are confronted during processing, followed by process optimisation through a series of simulations and experimentations to overcome the difficulties.

Invited Lecture – 19

THIN FILM GROWTH AND DEFECT ENGINEERING IN EPITAXIAL MAGNETIC MATERIALS

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Abstract: Structural defects are used to manipulate functional properties of materials. Materials design using thin-film techniques offers a rich playground for defect engineering [1]. Using controlled defects and orientation in epitaxial thin films, materials with different ordered magnetic states are fabricated [2-7]. In this talk, I will address our recent works on the physical vapor deposition of perovskite oxides, intermetallics, and van der Waals materials using various growth techniques, viz. Pulsed laser deposition (PLD), molecular beam epitaxy (MBE), and a hybrid PLD [2-7]. Highlights will be given to the growth of van der Waals ferromagnet $Cr_{(1+\delta)}Te_2$ by hybrid PLD, which is a conventional PLD equipped with molecular beam sources and an RF plasma source. By increasing the flux rate of the Te source, we fabricated $Cr_{(1+\delta)}Te_2$ of various Cr intercalants, δ [3]. The films exhibit δ-dependent ferromagnetism, switching of magnetic easy axes, and sign changes of ordinary and anomalous Hall effects (AHE) [3],[AG Palakkal, unpublished]. The T_C of $CrTe_2$ ($\delta = 0$) was found to be ~125 K, which increased to 325 K for Cr_2Te_3 ($\delta = 1/3$) [3]. The magnetic easy axis was switched from out-of-plane to in-plane with $\delta = 1/3$. An increase in the T_C of $CrTe_2$ and the emergence of a second magnetic phase (similar to Cr_2Te_3) upon annealing in UHV were also observed due to the Te atoms leaving the lattice, eventually increasing δ. From magnetoresistance and Hall measurements, it was clear that the Cr intercalants effectively dope electrons, and the majority of charge carriers switch from holes to electrons when $CrTe_2$ is converted to Cr_2Te_3. Similar to gate-voltage-controlled electron doping and band-driven magnetization switching in $CrTe_2$ [8], a PMA switch and an increase in T_C were achieved through materials design.

Keywords: Thin films, Epitaxy, Perovskites, van der Waals, Magnetism, Defect engineering.

References:

[1] J. Palakkal, A. Arzumanov, R. Xie, Z. Li, N. Hadaeghi, T. Wagner, T. Jiang, Y. Ruan, G. Cherkashinin, L.M. Luna, H. Zhang, L. Alff, Adv. Funct. Mater., 35 (2025) 2419990.

[2] J.P. Palakkal, T. Faske, M. Major, I. Radulov, P. Komissinskiy, L. Alff, J. Magn. Magn. Mater., 508 (2020) 166873.

[3] A. Tschesche, P. Henning, T. Meyer, J. Palakkal, Preprint at Research Square (2024), doi: https://doi.org/10.21203/rs.3.rs-4861088/v1.

[4] J.P. Palakkal, L. Alff, Perovskite Ceramics: J.L.C. Huamán, V.A.G. Rivera (Eds.), Elsevier (2023), 383-400, doi: https://doi.org/10.1016/B978-0-323-90586-2.00002-4.

[5] G. Gkouzia, D. Günzing, R. Xie, T. Weßels, A. Kovács, A.T. N'Diaye, M. Major, J.P. Palakkal, R.E. Dunin-Borkowski, H. Wende, H. Zhang, K. Ollefs, L. Alff, Inorganic Chemistry, 62 (2023) 16354-16361.

[6] J.P. Palakkal, L. Zeinar, M. Major, P. Komissinskiy, T. Schneider, L. Alff, IEEE Trans. Magn., 57 (2021) 1-5.

[7] S. Dasgupta, P. Komissinskiy, P. Nukala, I. Radulov, A. Rogalev, F. Wilhelm, M. Major, J.P. Palakkal, A. Radetinac, L. Alff, J. Magn. Magn. Mater., 539 (2021) 168330.

[8] H. Matsuoka, S. Kajihara, T. Nomoto, Y. Wang, M. Hirayama, R. Arita, Y. Iwasa, M. Nakano, Science Advances, 10 (2024) eadk1415.

Invited Lecture – 20

DESIGNING $La(Fe,Si)_{13}$ MAGNETOCALORIC ALLOYS USING MACHINE LEARNING FOR SUSTAINABLE REFRIGERATION

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Abstract: The advancement of efficient magnetocaloric materials is crucial for the evolution of next-generation eco-friendly refrigeration systems, which have the potential to replace traditional gas-based cooling technologies that contribute to greenhouse gas emissions [1-2]. Experimental optimisation of $La(Fe,Si)_{13}$ alloys is limited by the complexities of synthesis, high costs associated with characterisation, and the availability of limited datasets. This work outlines a framework for materials design that is driven by data. It incorporates data derived from literature, the generative datasets, and the application of machine learning techniques to expedite the discovery of optimised compositions. Experimental datasets that needed cleaning were augmented by using the Gretel.ai platform to maintain statistical correlations. Subsequently, Gradient Boost and Support Vector Regression models were developed to predict Curie transition temperature (Tc) and entropy change (S_2T, S_5T). The Gradient Boost model produced RMSE values of 45.9 for Tc, 6.9 for S_2T, and 5.6 for S_5T, with mean absolute error percentages ranging from 0.11 to 0.33, indicating a high level of predictive accuracy. The results indicate that machine learning is capable of reliably predicting magnetocaloric performance and efficiently screening potential alloys, thereby significantly decreasing the experimental workload [3-4]. The research emphasises the significant impact of data-driven methodologies as a fourth-paradigm approach within the field of materials science, facilitating the scalable, cost-efficient, and sustainable development of advanced cooling materials.

Keywords: Magnetocaloric effect; Magnetic refrigeration; $LaFe_{13-x}Si_x$ alloys; Gradient boost; support vector machines, Curie transition temperature.

References:

[1] Agrawal, A., & Choudhary, A. (2016). *Materials informatics and big data: Realization of the fourth paradigm of science in materials science.*
[2] Shen, B.G. et al. (2009). *Recent progress in exploring magnetocaloric materials.* Advanced Materials, 21(45), 4545–4564.
[3] Liu, Y. et al. (2017). *Materials discovery and design using machine learning.* J Materiomics, 3(3), 159–177.
[4] Song, Z. et al. (2020). *Machine learning in materials design: Algorithms and applications.*

Invited Lecture – 21

SPIN-PHONON COUPLING, MAGNETO-CALORIC EFFECT AND CRITICAL PHENOMENA IN $Ga_{1-x}Al_xFeO_3$ ORTHOFERRITE

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Abstract: Due to the interplay between the spin degrees of freedom, lattice dynamics and electric polarization, $GaFeO_3$ orthorhombic perovskite presents a unique opportunity to probe into the complex physical phenomena such as the spin-phonon coupling (SPC), multiferroic orders and the coupling between them. To this end, the thermally-induced shifts in the wavenumbers corresponding to the positions of the Raman-active (RA) peaks, the magneto-caloric effect and critical phenomena near the ferromagnetic (FM)–paramagnetic (PM) phase transition in the orthoferrite compound $Ga_{1-x}Al_xFeO_3$ have been extensively investigated. Several unambiguously identified RA modes are shown to provide clear evidence for SPC. The isothermal magnetic entropy change, $-\Delta S_M(T)$, peaks at T^{pk}, which is close to the Nèel temperature (T_N). Like T_N, T^{pk} increases linearly with the Al concentration (x). In this work, the existence of a universal $\Delta S_M/\Delta S_M^{pk}$ curve and the validity of the Banerjee criterion assert that the ferrimagnetic-PM and the FM-PM phase transitions occurring at T_N and curie temperature (T_C), respectively, in the present case, are of second order. These transitions are characterized by the mean-field critical exponents. In this talk, after the brief introduction to multiferroics the structural, magnetic, dielectric properties of Al substituted $GaFeO_3$ with emphasis on Spin-phonon coupling, magnetocaloric effect and critical phenomena will be presented.

Keywords: Multiferroic, GaFeO3, spin-phonon coupling, magneto-caloric effect, critical phenomena.

References:

[1] Effect of Al substitution at the Ga site on the structural and magnetic properties of $GaFeO_3$, S. Dulgaj, P.D. Babu, S.N. Kaul, S. Srinath, J. Magn. Magn. Mater 587, (2023) 171333. https://doi.org/10.1016/j.jmmm.2023.171333

[2] Spin-phonon coupling, magneto-caloric effect and critical phenomena in $Ga_{1-x}Al_xFeO_3$ orthoferrite, Saarthak Dulgaj, Anshu Gaur, Vasanth Sathe, P D Babu, S. N. Kaul and S. Srinath, J. Magn. Magn. Mater 634 (2025) 173578 https://doi.org/10.1016/j.jmmm.2025.173578

Invited Lecture – 22

ADVANCED MAGNETIC STORAGE APPLICATION USING THE NITROSPINICS MATERIALS

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Abstract: Magnetic storage systems, such as hard-disk-drives (HDDs) and nonvolatile magnetic random access memories (MRAMs), are further expected to boost their areal density capability with low power consumption and high-speed operation, in particular for the data center and the edge-AI servers. We have developed the advanced recording systems hybridized by a well-known spintronics phenomenon of spin-transfer-torque so far, which is regarded as the thermal-spin-torque heat assisted magnetic recording (TST-HAMR) [1]. Not only that, MRAM devises based on the spin–orbit torque (SOT) with two-dimensional (2D) materials have been demonstrated for enhanced data-storage scalability and low power consumption [2]. To expand the potential of 2D materials in SOT devices, we investigated Cr_2N, an emerging 2D MXene. Epitaxial and polycrystalline 2D-Cr_2N were realized by reactive nitridation sputtering, and field-free perpendicular magnetization switching was achieved with a critical current density comparable to W/CoFeB systems [3]. Note that the 2D-Cr_2N exhibits isotropic SOT with respect to its in-plane mirror symmetry, overcoming the specific principle in conventional 2D materials such as transition-metal dichalcogenides [4]. X-ray magnetic circular dichroism revealed that this behavior originates from interfacial uncompensated Cr moments, antiparallel to the ferromagnet, which act as an efficient spin filter for z-polarized spins. These specific characteristics are originating from the efficient spintronic functionalities involved in the nitride-based materials, driven by strong *p–d* hybridization with interstitial nitrogen. These findings motivate the concept of "Nitrospinics," nitrogen-enabled efficient and stable spintronic properties. This talk will highlight Nitrospinics-driven advances and their implications for future advanced magnetic storage applications [5].

Keywords: Advanced magnetic recording, Two-dimensional material, Field-free magnetization switching, Nitrospinics

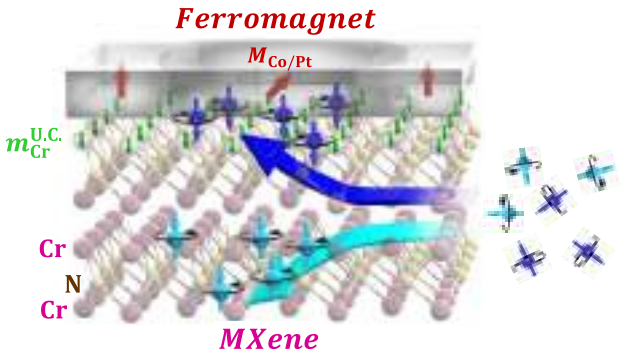


Fig. 1: Field-free current deiven magnetization switching by SOT originating from the orbital current in two-dimensional Cr_2N Mxene.

References:

[1] S. Isogami *et al*., Acta Materialia, 286, 120743 (2025).
[2] H. Yang *et al*., Nature 606, 663 (2022).
[3] [P. Kumar *et al*., Small 21, 2500626 (2025); P. Kumar *et al*., STAM 26, 2551484 (2025).
[4] Y. Liu *et al*., ACS Nano 14, 9389 (2020).
[5] S. Isogami *et al*., Adv. Electron. Mater. 9, 2200515 (2023).

Invited Lecture – 23

PHASE-BINARIZED SPIN-WAVE MODES IN SPIN HALL NANO-OSCILLATORS

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Abstract: Nano-constriction spin Hall nano-oscillators (SHNOs) are emerging spintronic devices for high-quality GHz signal generation and neuromorphic computing, thanks to their CMOS-compatible nanoscale footprint, wide frequency tunability, and robust synchronization in oscillator networks. A major challenge in magnetic nanoscale devices is understanding how device geometry governs spin-wave mode selection, phase stability, and nonlinear mode competition [1-4]. While narrow constrictions ($w \leq 200$ nm) typically host a single auto-oscillating spin-wave mode, the dynamical behavior of wider constrictions remains largely unexplored [5].

By combining micromagnetic simulations with analytical modeling, we demonstrate that wide nano-constriction SHNOs ($w > 200$ nm) host two coexisting edge-localized auto-oscillation modes: a low-frequency in-phase mode and a high-frequency out-of-phase mode with nearly 180° phase difference between opposite edges. These modes emerge from a strongly nonuniform internal-field landscape created by demagnetizing and antisymmetric Oersted fields, which creates an effective double-well potential across the constriction. Competing dynamic dipolar and exchange coupling between the edge states give rise to symmetric (in-phase) and antisymmetric (out-of-phase) hybridized modes. Subharmonic injection locking stabilizes these phase-binarized states, highlighting wide SHNOs as promising building blocks for neuromorphic computing and spin Hall Ising machines [4].

Keywords: Spin Hall nano-oscillators, Spin-wave modes, Wide nano-constrictions, Magnetization dynamics

References:

[1] V. E. Demidov, S. Urazhdin, A. Zholud, A. V. Sadovnikov, and S. O. Demokritov, Appl. Phys. Lett. 105, 172410 (2014).
[2] H. Fulara, M. Zahedinejad, R. Khymyn, A. A. Awad, S. Muralidhar, M. Dvornik, J. Åkerman, Science Advances 5, eaax8467 (2019).
[3] A. Kumar, H. Fulara, R. Khymyn, A. Litvinenko, et al., Nano Letters 23, 6720–6726 (2023).
[4] M. Zahedinejad, H. Fulara, R. Khymyn, A. Houshang, M. Dvornik, S. Fukami, S. Kanai, H. Ohno, and J. Åkerman, Nature Mater. 21, 81–87 (2022).
[5] Arunima TM and Himanshu Fulara*, Applied Physics Letters 127, 092403 (2025). [Editor's Pick and featured on the journal cover]

Invited Lecture – 24

AN INVESTIGATION ON MODULATING THE MULTIFERROIC PROPERTIES OF IN Y-TYPE HEXAFERRITE

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Abstract: In the last few decades, multiferroic (MF) materials have attracted interesting attention due to their mutual control of electric and magnetic properties termed as magnetoelectric (ME) effect. This area of research is important in terms of potential technological applications such as spintronic devices, electronic devices, medical drug delivery, and ME sensors. Most MF materials exhibit high field control ME coupling below liquid nitrogen temperature, which is not appropriate for effective devices based on the ME effect. To realize useful devices based on the ME effect, a low-field control of the ME effect at room temperature (RT) is required. Direct measurement of ME coupling is not an easy task, as most MF materials are poor insulators. Hence, an alternative route to investigate ME coupling is to measure the influence of dielectric properties with the application of a magnetic field, termed the magnetodielectric (MD) effect. Interestingly, Y-type hexaferrite possesses a significantly low field control ME effect at RT, which has an advantage over several other single-phase MF materials. The Y-type $Ba_2Mg_2Fe_{12}O_{22}$ (BMF) hexaferrite has drawn significant attention recently due to its tunable magnetic and ME properties upon suitable substitution at magnetic and non-magnetic sites. This work investigates different synthesis routes, electrical, magnetic, and magnetodielectric coupling of pure BMF, its substituted samples, and BMF-based composites.

Keywords: Hexaferrites, Antiferromagnetism, Ferrimagnetism, Magnetoelectric coupling, Multiferroics.

References:

[1] G. Palai, D.P. Sahu, A. Mohanty, C. Mahapatra, Md.F. Abdullah, **A. K. Singh**, *J. Magn. Magn. Mater.* 638, (2025) 173756.

[2] Md. F. Abdullah, S. Devi, P. Pal, K Chandrakanta, R. Jena, S. Mahapatra, C. S. Yadav, and **A. K. Singh**, *J. Magn. Magn. Mater.* 552, (2022) 169191.

[3] Md F. Abdullah, P. Pal, K. Chandrakanta, R. Jena, S. Devi, C. S. Yadav and **A. K. Singh**, *J. Phys. Condens. Matter. 32, (2020)* 135701.

[4] Md. F. Abdullah, P. Pal, K. Chandrakanta, R. Jena, M. R. Sahoo, P. N. Vishwakarma, **A. K. Singh**, *Physica B: Condensed Matter* 568, (2019) 70 .

[5] Md. F. Abdullah, P. Pal, S. Lal, S. R. Mohapatra, K. Chandrakant, S. D. Kaushik, C. S. Yadav, and **A. K. Singh,** *Mater. Res. Express* 5, (2018) 11.

Invited Lecture – 25

UNDERSTANDING THE MECHANISMS OF SELF-HEATING IN MAGNETIC NANOPARTICLES FOR MAGNETIC HYPERTHERMIA APPLICATIONS

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Abstract: Magnetic hyperthermia relies on the efficient conversion of electromagnetic energy into heat by magnetic nanoparticles under an alternating magnetic field. Achieving high heating efficiency, quantified by the Specific Absorption Rate (SAR), requires precise control over the intrinsic magnetic and structural properties of the nanoparticles. This invited talk focuses on spinel ferrite nanoparticles, particularly magnetite (Fe_3O_4) and doped ferrite systems, and examines how particle size, magnetic anisotropy, saturation magnetization, and interparticle interactions govern their self-heating behavior. The interplay between Néel and Brownian relaxation mechanisms, as well as the impact of dipolar interactions and aggregation, is discussed in the context of optimizing SAR. By establishing clear structure–property–performance correlations, this presentation provides insights into the rational design of ferrite-based magnetic nanoparticles for enhanced efficacy in magnetic hyperthermia applications.

Keywords: Magnetic Hyperthermia, Magnetic nanoparticles.

References:

[1] J. P. Borah. Krishna Priya Hazarika, *J. Magn. Magn. Mater.*, 2022, 560, 251–256.

[2] Krishna Priya Hazarika, R. Fopase, L. M. Pandey and J. P. Borah, *Phys. B Phys. Condens. Matter*, 2022, 645, 414237.

[3] R. D. Ralandinliu Kahmei, Papori Seal, J P borah, Tunable heat generation in nickel-substituted zinc ferrite nanoparticles for effective magnetic hyperthermia, Nanoscale Advances , 3 (2021) 5339

[4] R D Ralandinliu Kahmei and J P Borah, Clustering of MnFe2O4 nanoparticles and the effect of field intensity in the generation of heat for hyperthermia application, *Nanotechnology* 30 , 035706 (2019).

Invited Lecture – 26

COUPLED STRUCTURAL AND MAGNETIC RESPONSES OF La_2NiHfO_6 DOUBLE PEROVSKITE TO HIGH PRESSURE AND LOW TEMPERATURE

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Abstract:The exploration of novel double perovskite (DP) oxides with advanced and tunable properties continues to expand, owing to their potential to host distinctive electronic and magnetic ground states. This study demonstrates the first-ever synthesis of the theoretically predicted 3*d*-5*d* DP oxide La_2NiHfO_6 (LNHO), via sol-gel auto-combustion technique. At ambient conditions, LNHO crystallizes in the orthorhombic (*Pbnm*) structure. Thermomagnetic studies propose an antiferromagnetic ordering with uncompensated spins leading to ferrimagnetism below T_c~101 K. The presence of such uncompensated spin contributions from the multivalent Ni ions (Ni^{2+} and Ni^{3+}), as confirmed from XPS, further demonstrates a conventional exchange bias of 600 Oe at 5 K. Low temperature structural analysis indicates subtle changes in the cell parameters, octahedral tilting, and modulations in bond angle, suggesting a magneto-structural coupling below 100 K in LNHO [1]. Further, high pressure structural investigation reveals an anisotropic lattice compression and a reversible isostructural phase transition at 8.6 GPa. These findings propose LNHO could be a potential material for applications like spintronics and pressure sensing devices.

Keywords: Double perovskite, Ferrimagnetic, High pressure, Low temperature

References:

[1] Deepankar Das, Prince Kumar Rathour, K.A. Irshad, Boby Joseph, Chandana Rath, J. American Ceramic Society 2026 (accepted).

Invited Lecture – 27

MÖSSBAUER AND MOKE STUDY OF MAGNETIC COMPENSATION IN RARE-EARTH - TRANSITION METAL SYSTEMS

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Abstract: Rare-earth - transition metal (RE-TM) systems, either in the form of metallic thin films / multilayers or in the form of insulating oxides, form an interesting family from basic physics and various practical application point of view as well [1]. From a fundamental physics point of view, these systems exhibit rich H-T (field-temperature) phase diagram as an interplay of Zeeman energy, exchange energy and anisotropy energy. Because of antiferromagnetic coupling between RE and TM sublattices (layers) and their different temperature dependency of magnetization leads to a temperature known as magnetic compensation temperature (T_{Comp}), where the net magnetic moment vanishes. In the present talk, study of magnetic compensation and associated phenomena with in-field ^{57}Fe Mössbauer spectroscopy and magneto-optical Kerr effect (MOKE) would be discussed [2-5].

Keywords: Magnetic compensation, Mossbauer spectroscopy, MOKE.

References:

[1] J. A. Gonzalez, J. P. Andres, and R. Lopez Anton., Sensors 21, 5615 (2021)
[2] Smritiparna Ghosh, Rakhul Raj, Sourav Mukherjee, Chandana Mondal, Mukul Gupta, and V. Raghavendra Reddy., Phys. Rev. B. 112 (2025) 134406
[3] Manik Kuila, Jose Mardegan, Akhil Tayal, Carlo Meneghini, Sonia Francoual, and V Raghavendra Reddy., J. Phys.: Condens. Matter 35 (2023) 445801
[4] Manik Kuila and V. Raghavendra Reddy., Hyperfine Interactions 242 (2021) 36
[5] Manik Kuila, Zaineb Hussain, V. Raghavendra Reddy., Journal of Magnetism and Magnetic Materials 473 (2019) 458

Invited Lecture – 28

DEFECT DRIVEN d⁰ FERROMAGNETISM IN TRANSITION METAL-DOPED WIDE BAND-GAP OXIDE SEMICONDUCTORS NANOSTRUCTURES

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Abstract: The emergence of *d⁰ ferromagnetism* in oxide semiconductor nanostructures has attracted considerable attention due to its potential applications in next-generation spintronic and magneto-electronic devices. Wide band-gap oxide semiconductors such as TiO_2, ZnO, and SnO_2, when doped with transition metals, have been widely explored as dilute magnetic systems that exhibit weak but reproducible room-temperature ferromagnetism. However, the microscopic origin of magnetic ordering in these oxide semiconductor nanostructures remains a subject of ongoing debate. Increasing experimental and theoretical evidence suggests that intrinsic lattice defects play a crucial role in governing magnetic interactions in these materials [1–3].

In this work, we summarize our systematic investigations on transition-metal (Cr, Mn, Fe, Co, and Ni) doped MgO, TiO_2, ZnO, and SnO_2 oxide semiconductor nanostructures and correlate our findings with previously reported studies to clarify the origin of d⁰ ferromagnetism in these systems. Structural characterization using X-ray diffraction and high-resolution transmission electron microscopy confirms the successful incorporation of dopant ions into the host nanostructured lattices without detectable secondary magnetic phases in MgO, TiO_2, and SnO_2. However, in the case of ZnO, secondary phases evolve upon transition-metal substitution. Magnetic measurements and photoluminescence spectroscopy reveal intrinsic defects, such as oxygen vacancies and cation vacancies, which strongly influence the magnetic response [1–3]. The combined evidence indicates that the observed ferromagnetism is predominantly defect-mediated rather than purely intrinsic. Oxygen vacancies act as electron trapping centers that generate localized magnetic moments and induce spin polarization in the surrounding lattice. The overlap of defect-induced bound magnetic polarons or F-center exchange interactions facilitates long-range ferromagnetic ordering even at dilute dopant concentrations [1–4]. The enhanced surface-to-volume ratio in oxide semiconductor nanostructures further increases defect density, thereby stabilizing ferromagnetic interactions.

Keywords: d⁰ Ferromagnetism, Oxide Semiconductor Nanostructures, Transition Metal Doping, Defect-Induced Magnetism, Oxygen Vacancies and Dilute Magnetic Semiconductors.

References:

[2] Supin K K *et al.*, *Phys. Chem. Chem. Phys.*, 2023, **25**, 32234–32245.
[3] Supin K K *et al.*, *RSC Adv.*, 2022, **12**, 22741–22753.
[4] Akshay V R *et al.*, **J. Phys. Chem. C.**, 2018, 122, 26592−26604
[5] J. M. D. Coey, M. Venkatesan and C. B. Fitzgerald, **Nat. Mater.**, 2005, *4*, 173–179.

Invited Lecture – 29

HIGH-PRESSURE ROUTES TO FUNCTIONAL OXIDES: EXCHANGE-BIASED DOUBLE PEROVSKITES AND BEYOND

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Abstract: High-pressure synthesis provides access to metastable crystal structures and functional states that are difficult to obtain under ambient conditions, enabling the discovery of oxide materials with emergent magnetic and transport properties. In this talk, I focus on two representative outcomes. First, I present exchange-bias-like behavior in bulk double-perovskite oxides such as Cd_2FeOsO_6 and Lu_2NiIrO_6 [1,2]. Unlike conventional exchange bias in thin-film heterostructures that originates at ferromagnet–antiferromagnet interfaces, these bulk oxides exhibit intrinsic loop shifts characterized by prominent vertical magnetization shifts accompanied by smaller horizontal shifts. Magnetization measurements show reversal of the vertical shift with the sign of the cooling field and a modest training effect upon repeated cycling, supporting a bulk-pinning scenario. Complementary first-principles analysis indicates large magnetic anisotropy and pinned spin components as a microscopic origin of the intrinsic vertical exchange-bias-like response. Second, I discuss pressure-controlled polymorphism in Mn_3Sb and its impact on Hall transport [3]. Cubic Mn_3Sb synthesized at moderate pressure shows weak ferromagnetism and a sizable room-temperature anomalous Hall effect; conductivity scaling places it in the intrinsic (Berry-curvature) regime, suggesting that reduced disorder may further enhance the Hall signal. In contrast, the high-pressure hexagonal phase exhibits strongly suppressed anomalous Hall response. Together, these examples highlight high pressure as a practical route to interface-free exchange-bias materials and Berry-curvature-driven transport platforms for spintronic applications.

Keywords: igh-pressure synthesis, Exchange bias, Double perovskite, Anomalous Hall effect, Mn_3Sb.

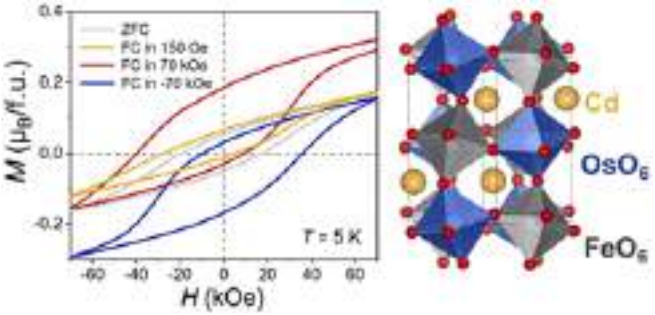


Fig. 1: Field-cooled hysteresis loops of Cd_2FeOsO_6 at 5 K showing intrinsic vertical and horizontal exchange-bias-like shifts; right panel illustrates the double-perovskite crystal structure with alternating FeO_6 and OsO_6 octahedra separated by Cd.

References:

[1] X. Kang, R. Ishikawa, A.A. Belik, Y. Tsujimoto, S. Kawata, K. Yamaura, *Promising approach to achieving a large exchange bias effect in bulk materials with small cooling fields*, Chem. Mater. 35 (2023).

[2] X. Kang, Z. Li, X. Liang, A.A. Belik, Y. Tsujimoto, M. Arai, S. Pan, K. Yamaura, *Ir-driven anisotropy and low-field vertical magnetization shifts in Ni-Ir double perovskites*, J. Alloys Compd. 1049 (2025).

[3] H. Hayashi, Y. Shirako, L. Xing, A.A. Belik, M. Arai, M. Kohno, T. Terashima, H. Kojitani, M. Akaogi, K. Yamaura, *Large anomalous Hall effect observed in the cubic-lattice antiferromagnet Mn3Sb with kagome lattice*, Phys. Rev. B 108 (7) (2023).

Invited Lecture – 30

STATIC AND DYNAMIC PROPERTIES OF RARE-EARTH (RE) TRANSITION METAL (TM) BASED FERRIMAGNETIC ALLOYS AND MULTILAYERS

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Abstract: Ferrimagnets, consisting of two different sublattices with unequal magnetic moments produce low net magnetization and less stray field as compared to ferromagnets. The small magnetization of ferrimagnets is responsible for their ultrafast dynamics[1] and low energy operation. The strong antiferromagnetic coupling between RE and TM ions provide wide flexibility in tuning the magnetic properties of the alloy. In this work, we show the effect of growth rate on the static and dynamic magnetic charaterstics of GdFeCo layers. We have observed ultra-low damping in GdFeCo alloy and demonstrated self-induced inverse spin Hall effect. We have prepared GdCo alloys with various compositions by tuning the deposition rates of Gd and Co. Near the magnetic compensation composition, the magnetization reversal is driven via nucleation of stripe domains. Moreover, orientation dependant sub-lattice switching is observed in this alloy as shown in Figure 1. Futher, we have prepared Co/Tb/Co multilayer stacks by varying stack reptetion and Tb thickness. By varying the stack repetions, skyrmions are observed at room temperature. The evolution of labyrinthine domains in 4 repetitions and transformation to skyrmions with diameters close to 120 nm was observed in 5 repetitions. Interestingly, Tb thickness is shown to effect the size and density of skymrion by engineering the anisotropy and Dzyaloshinskii-Moriya interactions (DMI). The results highlight the importance of rare-earth transition metal based ferromagnetic layers for future spintronic devices.

Keywords: Ferrimagnets, Rare-earth transition metal alloys, Skyrmions, Magnetic compenstaion point.

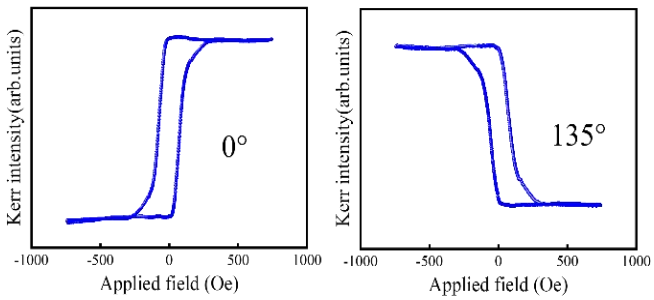


Fig. 1: Hysteresis loops observed from MOKE measurements at the angles of 0° and 135°of the applied magnetic field.

References:

[1] **J. Pradhan**, et al.,, Ultra-Low Gilbert Damping and Self-Induced Inverse Spin Hall Effect in GdFeCo Thin Films, J. Appl. Phys. 136, 203903 (2024).

Invited Lecture – 31

TAILORING MAGNONS USING SPIN ORBIT TORQUE AND NONLINEAR INTERACTIONS

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Abstract: Magnonics or magnon spintronics represents a burgeoning technological paradigm wherein magnons - the quanta of spin waves - process the information analogous to electronic charges in electronics. This presentation delineates the fundamental architecture of magnonic systems, specifically focusing on the magnetic micro-conduits that channels/guide the magnons in a nanomagnetic device. A critical research frontier in this field involves the efficient channeling of magnons and the excitation of higher-order harmonics driven by magnetic non-linearity. In this context, I will present recent advancements from our group regarding spin-orbit torque (SOT) enhanced magnon transport and the generation of harmonics within engineered micro-conduits. These phenomena are characterized using micro-Brillouin light scattering (micro-BLS) and spin-torque ferromagnetic resonance (ST-FMR) spectroscopy, providing insights into the design of next-generation wave-based logic technologies [1-4].

Keywords: Spintronics, Spin-orbitronics, Spin dynamics, Nanomagnetic devices

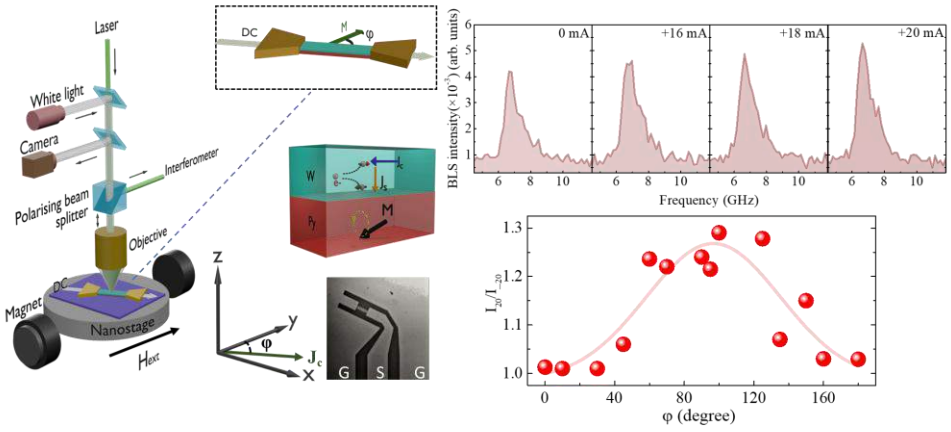


Fig. 1: Schematic of the micro-BLS technique and SOT-enhanced magnons [2].

References:

[1] M S Devapriya et al, Appl. Phys. Lett. 128, 092405 (2026)
[2] N S Adithya et al., ACS Appl. Electron. Mater. 8, 1643 (2026)
[3] J. Pradhan et al., J. Phys. D: Appl. Phys. 59, 035002 (2026)
[4] M S Devapriya et al., Phys. Rev. Appl. 24, 024018 (2025).

Invited Lecture – 32

CONTROLLING ANTIFERROMAGNETIC SKYRMIONS VIA SPIN-ORBIT TORQUES FOR NEXT-GENERATION COMPUTING

Sougata Mallick[1,*], Vijay R[1], Sudharsun G[1], Nicolas Reyren[2], Vincent Cros[2]

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Abstract: Magnetic skyrmions, spin swirling particle like entities, have been in the focal point of many research in condensed matter physics due to their solitonic nature combined with chiral and topological properties. The main challenge for their practical application is ensuring room temperature stability and high mobility without unwanted transverse deviation (skyrmion Hall effect: SkHE). Achieving thermal stability typically requires multi-layered structures, which introduce dipolar coupling and enlarge skyrmions. [1] Other challenges include energy dissipation, non-optimized spin torques, and domain wall pinning, which all hinder skyrmion mobility. A promising solution is using antiferromagnetically coupled sub-layers, such as synthetic antiferromagnets (SAFs) or synthetic ferrimagnets, which ensure reduction in skyrmion size and SkHE due to neutralized magnetization and angular momentum [2].
We investigate SAF and ferrimagnetic multilayers as tuneable platforms for achieving high skyrmion mobility without compromising the core rigidity. We demonstrate field free electrical stabilization and manipulation of skyrmions in ferromagnets as well as in SAFs, enabling simplified device architectures and scalable miniaturization [1, 3]. On the other hand, in synthetic ferrimagnets, we show that compact skyrmions operate in the viscous flow regime under spin orbit torques (SOTs), where concurrent optimization of antiferromagnetic exchange, interfacial Dzyaloshinskii Moriya interaction, SOTs, and pinning landscape yields straight line motion with velocities approaching 400 m/s for skyrmions of sub-100 nm [4, 5]. We further establish that skyrmion mobility, SkHE, and inertial dynamics originate from a strongly coupled dependence on micromagnetic parameters and skyrmion size, supported by quantitative agreement between analytical theory, micromagnetic simulations, and experiments over a 10–100 nm radius range. [6, 7] Beyond intrinsic dynamics, we demonstrate deterministic boundary mediated control of skyrmion motion, where geometry engineered nanotracks enable edge repulsion induced acceleration via a precise balance between SOT and confinement forces [7]. These results define unified design principles for maximizing mobility, suppressing the SkHE, and extending propagation length, and provide a foundation for exploiting topological textures in spintronic devices. The presentation will be concluded by outlining future research focused on leveraging these topological textures to bridge the gap between classical and quantum computing, highlighting their unique potential for simultaneous application in probabilistic, neuromorphic, and quantum computing paradigms.

Keywords: Skyrmion, Ferrimagnet, Spin-Orbit Torque.

References:

[1] S. Mallick *et al*, Physical Review Applied 18, 064072 (2022)
[2] S. Panigrahy, S. Mallick *et al*, Physical Review B 106, 144405 (2022)
[3] S. Mallick *et al*, Advanced Functional Materials 34, 2409528 (2024)
[4] S. Mallick *et al*, Nature Communications 15, 8472 (2024)
[5] S. Mallick *et al*, Physical Review B 112, 014437 (2025)
[6] G. Sudarshun, S. Mallick *et al*, (Unpublished)
[7] R. Vijay, S. Mallick *et al*, (Unpublished)

Invited Lecture – 33

MAGNETIC NANOPARTICLES AIDED MAGNETIC FLUID HYPEARTHERMIA AND ANTI-CANCER DRUG DELIVERY: INSIGHTS FROM EXPERIMENTAL AND NUMERICAL ANALYSES

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Abstract: Surface functionalized bio-compatible magnetic nanoparticles (MNPs) have found wide-spread applications in various bio-medical fields. Magnetic fluid hyperthermia (MFH) is one such emerging and powerful approach for cancer therapeutics. This technique utilizes magnetic nanofluids, which are stable colloidal suspensions of superparamagnetic MNPs in a suitable carrier fluid. When injected directly into the cancerous tissues, and exposed to a high-frequency alternating magnetic field, these superparamagnetic MNPs generate localized heating through Neel-Brown relaxation losses, raising the temperature to the therapeutically relevant levels. The current research activities are intensely focused on tuning the magneto-structural properties of the MNPs to maximize the heating performances. However, during practical applications, the heating efficiency is highly influenced by the physiological characteristics of the tumour tissues, such as porosity and thermo-physical properties, as well as the injection strategy. While experimental magneto-calorimetric studies offer valuable insights into the heating behaviour, repeated experiments are often cumbersome and restricted by practical difficulties. Under such a scenario, finite element modelling (FEM) offers a robust computation framework to simulate the spatio-temporal distributions of the thermal profiles during MFH. A few case studies highlighting the importance of the numerical schemes will be discussed in this talk. Further, for multi-modal therapy, anti-cancer drug loading onto the surface of the MNPs and subsequent targeted drug release is being studied. The difference between the doxorubicin loading efficienes for various surface functional moities and loading kinetics will be highlighted. The talk will also touch upon the future challenges in the field of magnetic fluid hyperthermia.

Keywords: Magnetic fluid hyperthermia, Neel-Brown relaxation, Superparamagnetic nanoparticles.

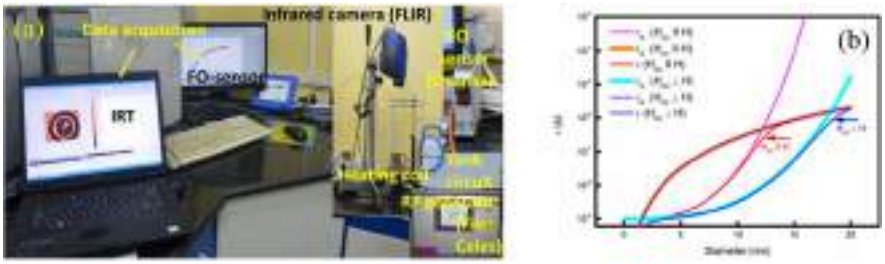


Fig.1: (a) Magnetic fluid hyperthermia experimental set-up at IGCAR. The set-up is equipped with contact and non-contact time-temperature probes. (b) Typical variations of the Neel, Brown and effective relaxations times for magnetic nanoemulsions under simultaneous DC and AC magnetic fields with parallel and perpendicular orientations.

References:

[1] Rosensweig, R.E., "Heating magnetic fluid with alternating magnetic field", 2002. *J. Magn. Magn. Mater., 252, pp 370-374.*

Invited Lecture – 34

MULTIPLE METAMAGNETIC TRANSITIONS AND UNUSUAL QUANTUM CRITICALITY PHASE BOUNDARY SCALING IN ANTIFERROMAGNETIC TbAsSe

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Abstract: Intrinsic magnetic topological materials offer a unique platform for exploring emergent quantum phenomena arising from the interplay between magnetism and topology, thereby establishing a paradigm for the design of novel functional devices. Here we report the synthesis of high-quality single crystals of antiferromagnetic TbAsSe (T_N=12.5 K), which crystallizes in the orthorhombic structure with the *Pnma* space group, in contrast to the previously proposed monoclinic structure (space group *P1121/n*). Through comprehensive measurements of magnetic susceptibility, heat capacity and transport properties, we map out a detailed magnetic phase diagram and identify a cascade of field-driven metamagnetic transitions. Notably, power-law fitting of the phase boundary reveals an unusual sharp quantum phase transition for $H \parallel a$ with the power law exponent ϕ =1/6, attributed to spin-orbit coupling and complex magnetic exchange interactions. This is in sharp contrast to the mean-field-like exponent ϕ = 1/2 observed for $H \perp a$. Our first-principles calculations elucidate the magnetic ground state, reproduce the field-induced metamagnetic transitions and further highlight the topological characteristics of its band structure. Our results establish a new playground for investigating the rich interplay between novel magnetic phenomena and topological behavior

Keywords: Magnetic Materials, Toplogical Magnetic System, Antiferromagnetic, Quantum Phase transition, Metamagnetism

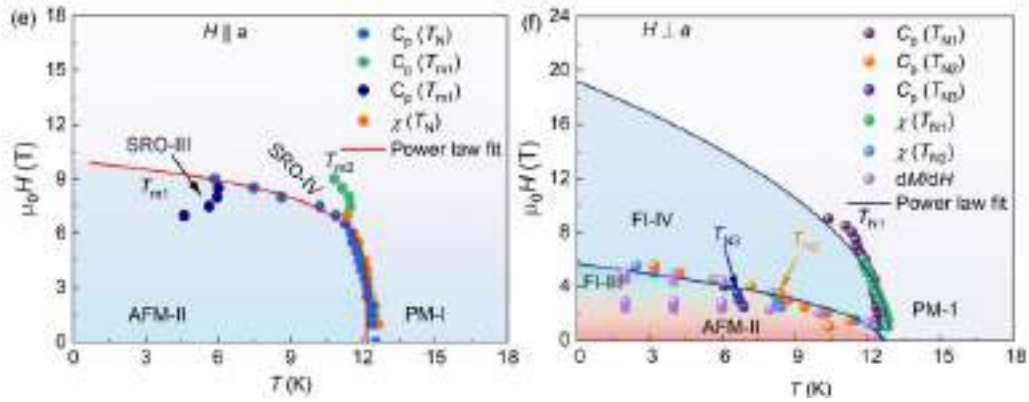


Fig. 1: $H \parallel a$ and (f) $H \perp a$, constructed from combined measurements of $\chi(T, H)$, $M(T, H)$ and $C_p(T, H)$. The solid lines represent the power-law fits to $H_c = H_0(1\text{-}T/T_N)^{\phi}$.

Invited Lecture – 35

MICROSTRUCTURE AND MAGNETIC PROPERTY CORRELATION IN ND-FE-B MAGNET

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Abstract: Rare earth permanent magnets, in particular Sm-Co and Nd-Fe-B magnets, have played a prominent role in the development of modern electrical and electronic devices. Nd-Fe-B magnets have played a key role in the miniaturization of modern electronic devices owing to its significantly higher energy product (BH_{max}). In addition to the commercial applications, NdFeB magnets also finds application in many strategic systems. The key requirement of permanent magnet in strategic systems is the higher operating temperature. The conventional Nd-Fe-B magnets exhibits lower Curie temperature thus limiting its applications wherein high field strength is needed at high operating temperatures. To develop high operating temperature Nd-Fe-B magnets, the intrinsic coercivity of magnets has to be enhanced. This is achieved either by alloy additions of heavy rare earths such as Tb, Dy or by microstructural modification involving decreasing the grain size.

In this talk, effect of microstructure on magnetic properties of Nd-Fe-B magnet will be presented.

Invited Lecture – 36

ELECTRIC-FIELD DEPENDENT SPIN-WAVE PROPAGATION IN $La_{0.63}Sr_{0.37}MnO_3$ /PMN-PT HETEROSTRUCTURE

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Abstract: The field of magnonics is currently of great interest due to its promising applications in the development of logic-based devices with low-power consumption. In view of this, the exploration of suitable ferromagnetic (FM) $La_{0.63}Sr_{0.37}MnO_3$ (LSMO) and ferroelectric (FE) $Pb(Mg_{0.3}Nb_{0.7})O_3$-$PbTiO_3$ (PMN-PT) heterostructures is of primary focus due to their promising magnetoelectric (ME) coupling at room temperature [1]. In the present work, an 80 nm thick epitaxial LSMO film was grown on a PMN-PT (011) single crystal substrate by pulsed laser deposition at a substrate temperature of 800°C. Structural characterisation was performed by X-ray diffraction in the out-of-plane geometry. In-plane static magnetisation measurements were performed using a vibrating sample magnetometer and magneto-dynamic measurements were done using a coplanar waveguide-based ferromagnetic resonance setup with a vector network analyser. A spin wave (SW) device was fabricated from the LSMO/PMN-PT heterostructure by electron beam lithography and electrodes were deposited to apply an out-of-plane electric (*E*-) field to the SW device. The SW measurements were performed by using SW device antennae with different inter-distances (2-9 µm). Interestingly, significant changes in the SW signals are observed upon application of the *E*-field, particularly when ferroelectric domains of the PMN-PT undergo polarization reversal. These observations can be interpreted on the basis of the coupling between the interfacial misfit strain and the net magnetisation of the LSMO. Overall, this particular work demonstrates the potential for *E*-field-controlled SW propagation in FM/FE systems.

Keywords: Multiferroic, Magnetoelectric, Spin waves, ferroelectric polarisation.

References:

[1] D. Pesquera, E. Khestanova, M. Ghidini, S. Zhang, A. P. Rooney, F. Maccherozzi, P. Riego, S. Farokhipoor, J. Kim, X. Moya, M. E. Vickers, N. A. Stelmashenko, S. J. Haigh. S. S. Dhesi, N. D. Mathur, Nat. Commun. 11 (2020) 3190(1)-3190(8).

Invited Lecture – 37

MAGNETIC ANISOTROPY: THE "SWISS ARMY KNIFE" FOR EMERGING SPINTRONICS DEVICES

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Abstract: Magnetic anisotropy, originating from symmetry breaking in magnetic materials, is a fundamental parameter governing the equilibrium and dynamic behavior of magnetization. It plays a decisive role in determining spin configurations and spin-transport phenomena, thereby directly impacting both fundamental magnetism and spintronic device functionality. Despite its central importance, exploiting magnetic anisotropy as an active control knob for spin-current generation and manipulation in realistic device architectures remains a significant challenge. In this talk, I will demonstrate how magnetic anisotropy can be deliberately engineered and utilized to control the generation, directionality, and propagation of spin currents. I will show that anisotropic spin–orbit torque-driven generation of pure spin currents enables highly directional and efficient spin transport. This anisotropic spin current results in controlled anisotropic magnon propagation, opening pathways toward reconfigurable and tunable magnonic devices, logic elements, and integrated magnonic circuits. Building on this concept, I will present our recent work on uniaxial anisotropy–based spin Hall nano-oscillators (SHNOs) that operate without the need for an external magnetic field. The absence of an applied field significantly enhances device scalability and energy efficiency. These field-free SHNOs exhibit distinctive current-driven auto-oscillation characteristics, with their frequency, threshold current, and mode profiles strongly dependent on device dimensions and the strength of uniaxial anisotropy. Furthermore, I will discuss the nonlinear magnetization dynamics of field-free SHNOs, revealing a robust bistable regime that gives rise to stochastic dynamics. Such behaviour enables these spintronic oscillators to be promising candidates for energy-efficient probabilistic computing, neuromorphic architectures, and hardware-based true random number generators.

Keywords: Magnetic anisotropy, spintronic, spin current, probabilistic computing.

Invited Lecture – 38

MAGNETO-STRUCTURAL ENGINEERING OF Fe-BASED SOFT MAGNETIC RIBBONS FOR GREEN POWER TECHNOLOGIES

Ravi Gautam[1]*, S. Hiramoto[2], N. Ono[2], T. Tanuguchi[2], S. Okamoto[1,2], T. Ohkubo[1], H. Sepehri-Amin[1]

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Abstract: Soft magnets are essential for improving the efficiency and miniaturization of modern power electronic systems operating at high frequencies. However, simultaneously achieving low core loss, high saturation magnetization, and mechanical flexibility remains a major challenge. In this work, we demonstrate a magneto-structural engineering strategy to tailor the nanostructure and magnetic domain configuration of Fe-based amorphous ribbons for green power technologies[1]. Amorphous ribbons were fabricated using melt-spinning technique and subsequently annealed near the crystallization onset temperature to induce controlled partial nanocrystallization. Detailed structural and magnetic investigations were carried out using synchrotron XRD, TEM, APT, and magneto-optical Kerr effect (MOKE) microscopy. The optimized ribbons exhibited the formation of nanoscale α-Fe crystallites embedded in a residual amorphous matrix along with refined stripe-like magnetic domains originating from stress-induced perpendicular magnetic anisotropy [1]. The synergistic interaction between nanostructure evolution, magnetostriction, and magnetic domain refinement significantly suppressed excess core loss under high-frequency excitation. Consequently, the core loss was reduced from ~165 W/kg in the fully amorphous state to ~75 W/kg in the partially nanocrystalline state at 1 T and 10 kHz [Fig. 1]. These findings provide fundamental insights into the process–microstructure–magnetic property correlation in Fe-based soft magnetic ribbons and establish a scalable pathway for the development of next-generation energy-efficient magnetic materials for sustainable power electronic applications.

Keywords: Soft magnetic ribbons, Nanostructure engineering, Magnetic domains, Perpendicular magnetic anisotropy, Magnetostriction, Core loss.

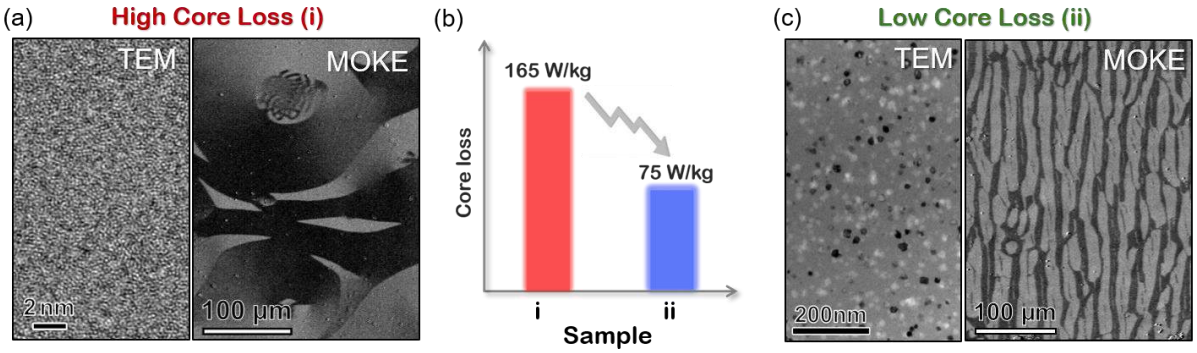


Fig. 1: Magneto-structural evolution from amorphous sample i to partial nanocrystalline sample ii, showing magnetic domain refinement and the resulting reduction in core loss.

References:

[1] R. Gautam, S. Hiramoto, N. Kulesh, H. Mamiya, S. Okamoto, N. Ono, T. Ogasawara, T. Ohkubo, H. Sepehri-Amin, Nat. Commun. 16 (2025) 8022.

Invited Lecture – 39

SPIN ORBIT TORQUE MAGNETIC TUNNEL JUNCTIONS FOR NEUROMORPHIC COMPUTING

Anuj Kumar, [1,2,*] Debasis Das, [3] Martin Z. X. Koh, [4] Hui Ru Tan, [4] Dennis J. X. Lin, [4] Lisen Huang, [4] Sherry L. K. Yap, [4] Hang Khume Tan, [4] Royston J. J. Lim, [4] Yeow Teck Toh, [4] Sze Ter Lim, [4] Xuanyao Fong, [5] Pin Ho [4,*]

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Abstract: Magnetic tunnel junctions (MTJs)-based spintronic devices are promising candidates for mimicking synapse characteristics for neuromorphic computing applications due to their non-volatility, high endurance, and fast switching. However, existing architectures for achieving multistate synaptic behavior in MTJs suffer from poor resistance-state separation, limited synaptic tolerance, scaling issues, and non-robust resistance states. Here, we investigate a compact, scalable array of MTJs on a shared heavy-metal channel to achieve multistate synaptic behavior. The compound MTJ with *N* identical cells shows *N*+1 well-distinguished states. The compound MTJ with different-shape anisotropy cells exhibits 2*N* resistance states, improved write tolerance, and selective switching of constituent MTJs, compared to its identical-cell counterpart. The experimental bimodal effect was explored by varying the number of constituent MTJs and tunnel magnetoresistance, leading to alteration in synaptic resolution and precision. Artificial neural network (ANN) simulations were performed by feeding the experimentally measured resistance values and the number of states. We observed that multistate-induced synaptic resolution plays a dominant role compared to synaptic tolerance in recognising MNIST handwritten digits. Further, the anisotropy engineered MTJs with 2*N* state show higher test accuracy than identical cell-based compound MTJs for recognizing MNIST handwritten digits and fashion objects. These results demonstrate that the compound MTJ with different-shape anisotropies exhibits robust multistate behavior, improved synaptic tolerance, and high selective switching of constituent MTJs for neuromorphic computing applications.

Keywords: Magnetic tunnel junction, Spin orbit torque, Artificial synapses, Artificial neural network, Neuromorphic computing.

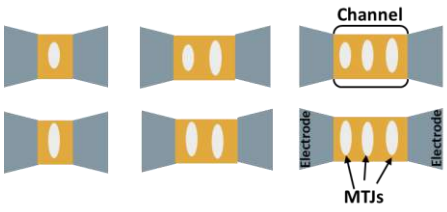


Figure 1: Compound MTJs with N:1-3 identical and anisotropy engineered cells on shared SOT channel

References:

[1] A. Kumar et al. Nanoscale Horiz. 9, 1522 (2024)
[2] A. Kumar et al. ACS Appl. Mater. Interfaces 16, 10335 (2024)
[3] A. Kumar et al. (under review 2026)

Contributed Abstracts

Abstract ID: 08

EFFICIENT MICROWAVE ABSORPTION THROUGH THE LENSES OF FERROMAGNETIC RESONANCE SPECTROSCOPY – an $MgFe_2O_4$ CASE STUDY

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Abstract: Microwave (MW) absorption in the targeted frequency bands can be an efficient solution to the ever-growing problem of electromagnetic pollution. This study reports efficient MW absorption response of Magnesium Ferrite ($MgFe_2O_4$) spherical nanoparticles (NP) within 1-20 GHz frequency and compares the results with its Bulk counterpart. Optimum impedance matching, increased interfacial polarization, higher attenuation constant along with enhanced dielectric and magnetic loss establish NP as a much superior absorber than Bulk. Natural resonance, experimentally probed by Ferromagnetic Resonance (FMR) spectroscopy in the same GHz frequency, is shown to play a crucial role in the absorption. Broader FMR linewidth in NP validates its better Reflection loss (RL) properties. NP exhibits maximum RL of about -70 dB at around ~18 GHz for 20 wt% filler content and 5.08 mm absorber thickness with an effective bandwidth of ~4.6 GHz [1]. Additionally, NP is shown to achieve efficient absorption in C-, X-, and Ku-bands also. This study underlines that one not only has to select the desired material but also the unique morphology in order to obtain optimal MW absorption. To the best of our knowledge, this is the first time that FMR spectra have been correlated with MW absorption to analyze experimental findings.

Keywords: Ferromagnetic Resonance, Nanoparticles, Microwave Absorption, Impedance matching.

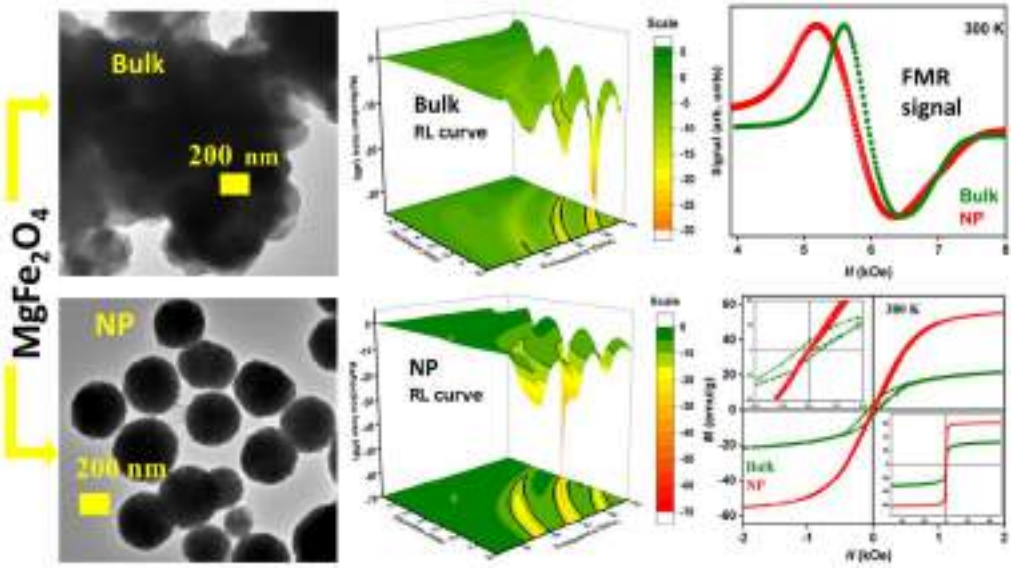


Fig. 1: Correlation between Reflection loss response and FMR spectroscopy in $MgFe_2O_4$ samples.

References:

[1] S. Sarkar, A. Gorai, K. Mandal, A Ferromagnetic Resonance Study of MgFe 2 O 4 Nanoparticles as Efficient Microwave Absorber for Different Frequency Bands, ACS Appl Nano Mater (2025). https://doi.org/10.1021/acsanm.5c05016.

Abstract ID: 09

MULTIFUNCTIONAL PROPERTIES OF V_2O_5 NANOPARTICLES: A STUDY ON STRUCTURE, DEFECTS, AND MAGNETISM

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Abstract: In this work, vanadium pentoxide (V_2O_5) nanoparticles were thoroughly characterized using a combination of techniques to understand their structural, optical, morphological, and magnetic properties. These nanoparticles exhibit a high degree of crystallinity with orthorhombic phase structure, as confirmed by sharp diffraction peaks with an average crystallite size of ~ 20–25 nm, affirming the formation of nanoscale structures. The prominent vibrational bands corresponding to V=O and V–O–V stretching modes confirm the chemical identity and purity of the V_2O_5 phase. The characteristic bands match the orthorhombic V_2O_5 phase and indicate well-defined lattice vibrations. UV-Vis transmittance spectra revealed a sharp absorption edge in the ultraviolet region, indicating a direct band gap of ~ 2.2 eV, which highlights the semiconducting behaviour of the material. PL spectra, recorded at room temperature (RT), showed broad emission peaks in visible range, attributed to oxygen vacancies and structural defects, which may influence optoelectronic properties. The surface morphology reveals uniformly distributed nanoparticles of size 111 nm with slight agglomeration. The Vibrating Sample Magnetometer (VSM) results exhibit weak ferromagnetism at room temperature, arising from surface disorder and oxygen-related defects. The above results demonstrate that V_2O_5 nanoparticles possess promising multifunctional properties, making them suitable candidates for applications, including optoelectronics, heterogeneous catalysis, environmental remediation, energy storage systems, and next-generation spintronic devices.

Keywords: Vanadium Pentoxide, Spintronics, Oxygen Vacancies, ferromagnetism, photoluminance.

Abstract ID: 14

ENHANCED DIELECTRIC AND ELECTROCHEMICAL PROPERTIES OF COBALT–COPPER FERRITE/CNT NANOCOMPOSITES

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Abstract: Spinel ferrite–carbon nanocomposites have attracted significant attention as electrode materials for energy storage due to their tunable magnetic, dielectric, and electrochemical properties. In this work, cobalt–copper spinel ferrite ($Co_{0.5}Cu_{0.5}Fe_2O_4$) nanoparticles were synthesized via a chemical co-precipitation route [1]. Nanocomposites containing 5–15 wt% multi-walled carbon nanotubes (MWCNTs) were obtained using an ultrasonication process. X-ray diffraction confirmed the formation of a single-phase cubic spinel structure for all samples, with no impurity phases after CNT addition. The crystallite size decreased from 16.88 nm to 14.89 nm with MWCNTs addition. HRTEM images showed nearly spherical ferrite nanoparticles uniformly distributed on the CNT surface, while CNT incorporation reduced particle agglomeration and improved connectivity between nanoparticles. Magnetic measurements indicated soft ferrimagnetic behavior. Dielectric studies showed an enhanced dielectric constant with CNT incorporation, particularly at low frequencies, attributed to Maxwell–Wagner interfacial polarization and improved charge transport across ferrite/CNT interfaces, while dielectric loss decreased with increasing frequency [2]. Electrochemical performance evaluated through cyclic voltammetry exhibited quasi-rectangular CV profiles with distinct redox features, confirming the coexistence of electric double-layer capacitance and pseudocapacitive behavior. CNT incorporation markedly increased the enclosed CV area and improved rate capability, highlighting enhanced electrical conductivity and accessible electroactive sites. A maximum of 437.4F/g specific capacitance was recorded for MWCNTs incorporated sample. the synergistic integration of CCF nanoparticles with CNTs leads to improved dielectric and electrochemical performance, establishing CCF–CNT nanocomposites as promising electrode materials for high-performance supercapacitor applications.

Keywords: Cobalt copper ferrite; Magnetism, HRTEM, Cyclic Voltammetry; Dielectric constant.

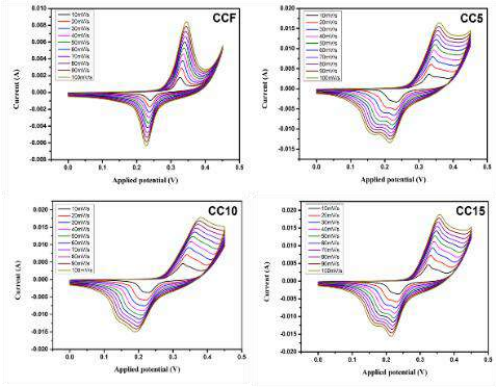


Fig. 1: Cyclic voltammogram for CCF, CC5,CC10 and CC15 samples at different scan rates

References:

[1] I. Chihi, M. Baazaoui, N. Hamdaoui, et al., J. Mater Sci Mater Electron 32 (2021) 16634-16647.
[2] H. Riaz, S. Anjum, S. R. Ejaz, M. I. Khan, A. Shanableh, R. Luque, Results Engg. 25 (2025) 104209.

Abstract ID: 15

FIRST-PRINCIPLES INVESTIGATION OF ELECTRONIC, MECHANICAL, MAGNETIC, AND THERMOELECTRIC PROPERTIES OF FeVTe HALF-HEUSLER ALLOY

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Abstract: The present study examines the structural, electronic, mechanical, magnetic, and thermoelectric properties of the Half-Heusler Alloy of FeVTe using first-principles calculations. FeVTe crystallizes in the cubic F-43m space group (No. 216) and is structurally stable in the FM phase. The equilibrium structural parameters were obtained by fitting the total energy versus volume data to the Birch–Murnaghan equation of state. The optimized lattice constant was found to be 5.8403 Å. Electronic structure analysis shows Half metallic behaviour the spin-up channel acts like a metal and the spin-down channel acts like a semiconductor [1]. We computed at the mechanical properties of the compound, such as Young's modulus, Poisson's ratio, compressibility, and shear modulus, and found that they are mechanically stable. The calculated magnetic moment of 1 μ_B is satisfied with the Slater-Pauling rule of 18. We used Slack's equation, the thermodynamic properties like Heat capacity, Gibbs free energy and entropy have been calculated using Gibbs2 Package. The BoltzTraP2 code was used to predict the transport properties including Seebeck coefficient, electrical conductivity, and electronic thermal conductivity [2]. This work provides the theoretical insights of FeVTe for high temperature thermoelectrics.

Keywords: Half Heusler Alloy; DFT; Structural Stability; Electronic Structure; Thermoelectrics.

References:

[1] Alsobhi, B. O. First-principles calculations to investigate optoelectronic of transition-metal half-Heusler alloys MTiSn (M= Pd and Pt) for optoelectronics applications. *Chem. Phys.* **588**, 112469 (2025).

[2] Gurunani, B. & Gupta, D. C. Probing the thermoelectric and optical performance of half-Heusler PtZrX (X= Si, Ge) semiconductors: a first principles investigation. *Mater. Adv.* **5**, 9340–9358 (2024).

Abstract ID: 16

CRITICAL BEHAVIOR AND MAGNETIC PHASES IN SINGLE CRYSTALLINE MN INTERCALATED TaS_2

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Abstract: We have investigated the critical behavior and underlying magnetic interactions in Mn-intercalated TaS_2 through a critical scaling analysis of isothermal magnetization across the ferromagnetic–paramagnetic transition. This compound shows a ferromagnetic (FM) order below T ~ 30 K and exhibits magnetic anisotropy with a large ab-plane moment and a small moment along the c-axis. The critical scaling analysis of isothermal magnetization yields the critical exponents = 0.377 ± 0.002, = 1.345 ± 0.003, = 4.682 ± 0.003. The exponent is close to the 3D Heisenberg model but lies between the 3D Heisenberg and 3D XY models, suggesting the presence of complex magnetic interactions arising from the competition between Heisenberg exchange and Dzyaloshinskii–Moriya (DM) interactions.

Keywords: Intercalated TaS_2 single crystal, Critical scaling analysis, Van der Waals magnets, Topological spin textures, Transition metal dichalcogenides.

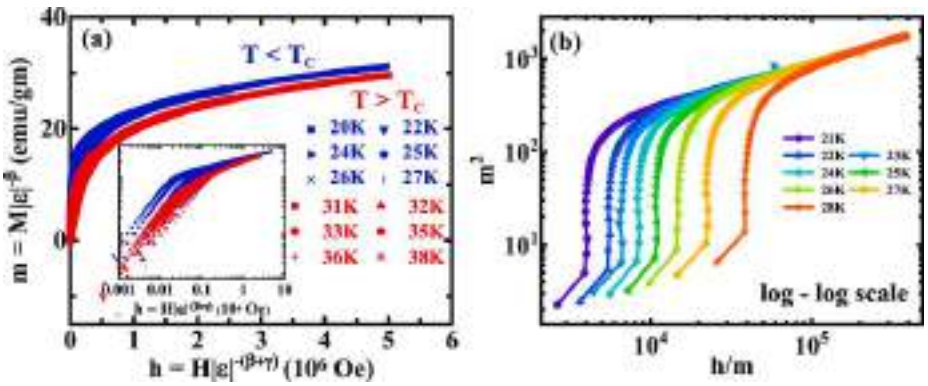


Fig. 1: (a). Scaled plot of m versus h around T at few selected temperatures. (Inset is on log–log scale). (b). Mean field plot of renormalized m2 vs h/m at low field region below T.

References:

[1] T.Debnath et al. Journal of Magnetism and Magnetic Materials 631 (2025) 173440.

Abstract ID: 17

STRUCTURAL AND TEMPERATURE DEPENDENT MAGNETIC PROPERTIES OF B_2CoMnO_6 (B = Nd and La) DOUBLE PEROVSKITES

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Abstract: The B_2CoMnO_6 (B = Nd & La) double perovskites were synthesized using conventional solid-state reaction method. Rietveld refinement of the powder X-ray diffraction confirmed the crystal structure of the double perovskite for the two samples to be monoclinic ($P2_1/n$). XRD results were further supported by Raman spectroscopic modes. Raman analysis revealed characteristic vibrational modes associated with the BO_6 octahedra, further confirming the monoclinic symmetry and structural ordering of the samples. Nd_2CoMnO_6 and La_2CoMnO_6 powders showed paramagnetic behavior at room temperature. The zero field cooled (ZFC) and field cooled (FC) curves diverged below 220 K for La based sample and near 150 K for Nd based sample. Both the samples exhibited ferromagnetic behavior with significant amount of remanent magnetization at 3 K. We found that value of effective magnetic moment from the Curie-Weiss fitting of Nd_2CoMnO_6 is higher than that of La_2CoMnO_6. We observed a transitional magnetic phase between the paramagnetic and ferromagnetic phases from the downward deviation from the Curie-Weiss fitting of Nd based sample [1]. A downward deviation from the Law of Approach to Saturation (LAS) [2] fitting of M – H hysteresis loops indicates that the saturation magnetization (M_S) of Nd_2CoMnO_6 sample is nearly double that of La_2CoMnO_6. This enhancement arises from replacing the non-magnetic $La^{3+}(4f^0)$ ion with magnetic $Nd^{3+}(4f^3)$ ion, thereby increasing the overall magnetic contribution.

Keywords: Double perovskite, Solid-state reaction, Rietveld analysis, Raman analysis, Ferromagnetic.

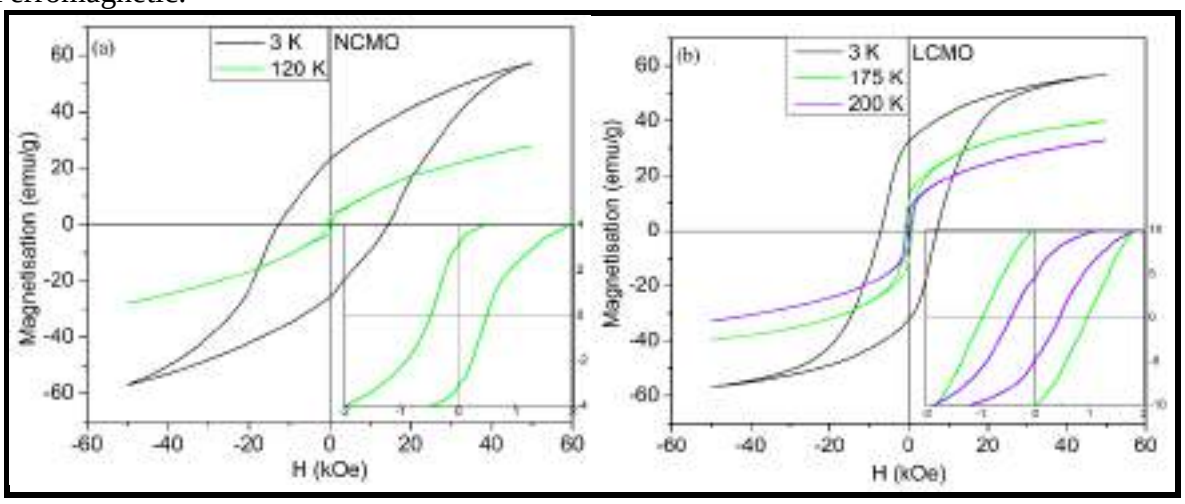


Fig. 1: M – H hysteresis loops of (a) NCMO and (b) LCMO double perovskites at different temperatures under an applied magnetic field of up to ± 50 kOe . Inset show their enlarge view.

References:

[1] S. Banik, N. Banu, I. Das, J Alloys Compd 745 (2018) 753–760.

[2] **S.** Chikazumi, Sōshin, and C D Graham, Jr, Physics of Ferromagnetism (Oxford, 1997; online edn, Oxford Academic, 31 Oct. 2023.

Abstract ID: 20

EXPLORATION OF EXOTIC GROUND STATES IN MAGNETICALLY FRUSTRATED PYROCHLORE VIA COMPOSITIONAL DISORDER

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Abstract: The interplay between magnetic frustration and crystal field in Ln2Ti2O7-based (Ln = lanthanides) pyrochlores is known to establish various exotic magnetic states, including spin ice, spin liquid, and spin glass, at low temperatures [1]. The introduction of disorder in the pyrochlore structure can modify the magnetic spin arrangement and alter the low-temperature magnetic states [2]. Herein, the effect of disorder in high entropy oxides (HEOs) pyrochlores of (Gd0.4Sm0.4Eu0.4Dy0.4Ho0.4)Ti2O7 and (Gd0.4Sm0.2Eu0.2Dy0.6Ho0.6)Ti2O7 has been investigated. We present the XRD data confirming the formation of pure pyrochlore oxide with the space group $Fd\bar{3}m$ [Fig. 1(a)]. We show a close match in nominal composition with the EDX data analyzed composition. Raman spectra [Fig. 1(b)] were recorded at room temperature, and phonon modes of HEO display Raman shifts similar to those of pure Gd2Ti2O7, confirming the successful substitution of the Gd3+ ion by Sm3+, Dy3+, Eu3+, and Ho3+ ions. The temperature-dependent magnetic susceptibility (χ_M) of HEOs indicates the absence of magnetic ordering till 2 K [Fig. 1(c)]. The effective magnetic moment (μ_eff) ~ 8.0μ_B and Curie-Weiss temperature (θ_CW) ~-13 K was determined. The M-H curve, measured at 2 K, [Fig. 1(d)] reveals a ferromagnetic saturation at higher fields. Any hysteresis and remnant magnetization are not observed near H=0 T, but a Wasp-Waisted type-loop is observed in the M-H curve of HEOs.

Keywords: magnetic frustration, pyrochlore, high entropy oxides, Rare-earth titanate.

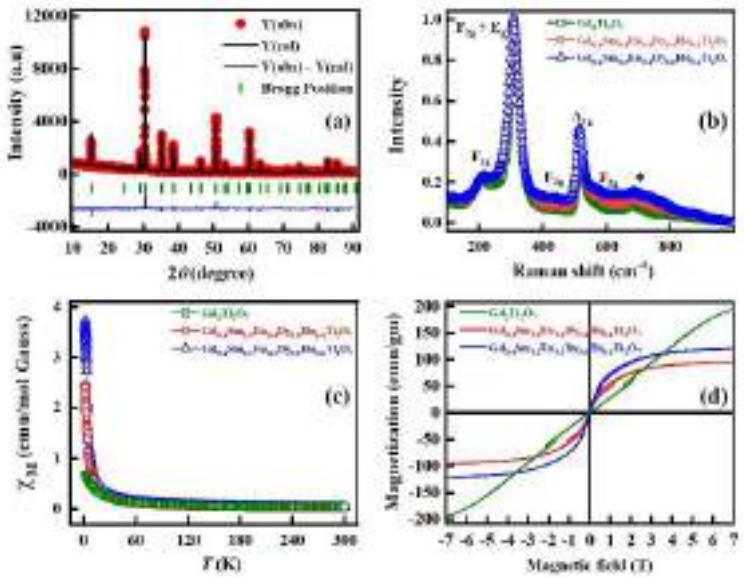


Fig. 1: (a) XRD data, (b) Raman Spectra, (c) χ-T plot, and (d) M-H plot of HEO samples.

References:

[1] Jason S. Gardner et al., *Rev. Mod. Phys.* **82** (2010) 53-107.

[2] Solveig S. Aamlid et al., *J. Am. Chem. Soc.* **145** (2023) 5991−6006.

Abstract ID: 21

TERAHERTZ SPINTRONICS FOR ON-CHIP APPLICATIONS

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[2]*Division of Physics and Applied Physics, School of Physical and Mathematical Sciences, Nanyang Technological University, 21 Nanyang Link, Singapore 637371, Singapore*

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Abstract: Terahertz spintronic emitters are widely recognized as versatile broadband sources for generating ultrafast spin and charge currents, offering strong potential for next-generation opto-spintronic technologies. Despite their advantages, most existing terahertz spintronic emitters rely on relatively strong external magnetic fields to stabilize magnetization and control the amplitude and polarization of the emitted radiation. This requirement significantly limits their applicability in compact, low-power, and chip-integrated platforms. In this study, we demonstrate a compact terahertz spintronic emitter that operates robustly under weak magnetic bias by leveraging uniaxial magnetic anisotropy. The engineered anisotropy provides intrinsic stabilization of the magnetization, enabling reliable control of ultrafast spin current dynamics without the need for high-field magnetic biasing. Terahertz emission measurements were systematically performed under repeated femtosecond laser excitation while applying external magnetic fields far below the anisotropy field, extending into the sub-Oersted regime. Under these conditions, we observe strong amplitude modulation as well as deterministic polarization switching of the emitted terahertz pulses at magnetic fields below 1 Oe. Importantly, the emitter exhibits excellent stability during repeated measurements, with no observable magnetization drift, in contrast to conventional spintronic emitters that require strong magnetic fields to maintain reproducible operation. These results underline the crucial role of uniaxial magnetic anisotropy in enhancing the robustness, sensitivity, and tunability of terahertz spintronic emission at ultralow magnetic fields. The demonstrated approach provides a promising pathway toward energy-efficient, ultrafast, and miniaturized terahertz spintronic devices, enabling practical on-chip opto-spintronic systems capable of operating at weak or near-zero magnetic bias.

Keywords: Terahertz spintronics; Uniaxial magnetic anisotropy; Ultralow magnetic field; Spin current; On-chip opto-spintronic devices

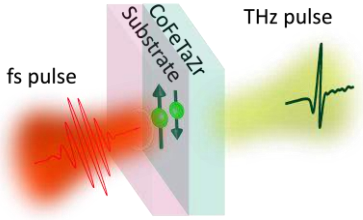


Fig. 1: Schematic of femtosecond pulse pumped terahertz emitter.

References:
[1]. Chaurasiya, A., et al, Advanced Optical Materials, 2022. **10**(24): p. 2201929.
[2]. Bigot, J.Y., et al, Chemical Physics, 2005. **318**(1-2): p. 137-146.
[3]. Battiato, M., et al, Phys Rev Lett, 2010. **105**(2): p. 027203.

Abstract ID: 22

MAG ONBOARD ADITYA-L1 SPACECRAFT: FIRST INDIAN MAGNETIC FIELD EXPERIMENT IN INTERPLANETARY SPACE

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Abstract: Aditya-L1 is the first observatory class spacecraft place in a halo-orbit around the first Lagrangian (L1) point to continuously observe the Sun and study the inner heliosphere. There are seven payloads onboard to study the coronal and chromospheric dynamics; soft and hard X-ray emission from Sun, and solar wind composition and dynamics. A triaxial fluxgate magnetometer (MAG) is one of the payloads onboard Aditya-L1 spacecraft to measure the local interplanetary magnetic field (IMF) reaching at the L1 point from the Sun [1]. This IMF measurement is mandatory in detecting the solar coronal mass ejections (CMEs), and for the near-Earth space weather studies. The MAG payload is comprised of twin-sets of fluxgate magnetic sensors mounted on a 6-m long non-conducting boom with one set at the tip of the boom and the other at the centre of the boom around 3 m away from the spacecraft towards the boom tip [1]. The MAG payload is mounted on the Sun-viewing panel deck and the boom is configured in such a way that it can deploy along the downward direction of the spacecraft [1]. A common power supply and the processing electronics is designed and realized for the MAG payload which is enclosed in a box and placed inside the spacecraft frame [2]. Each of the two triaxial fluxgate sensors measures the IMF vectors at L1 in the default range of ± 256 nT per axis once every 125 ms. The observed magnetic field data is time stamped at the spacecraft with the on board clock and transmitted to ground once every day. Post launch, the MAG boom was deployed on January 11, 2024 and since then the MAG payload is working as per the designed parameters measuring the IMF and has so far observed a number of extreme solar transient events. In this paper all these MAG details shall be presented.

Keywords: L1 Point, Interplanetary Magnetic Field (IMF), Aditya-L1, MAG, Fluxgate Magnetometer, ISRO



Fig. 1: The flight model (FM) of MAG payload onboard Aditya-L1 spacecraft

References:

[1] Vipin K. Yadav, Y. Vijaya, et al., Solar Physics, 300 (3), (2025), 33. Doi: 10.1007/s11207-025-02440-0
[2] Monika Mahajan, Vipin K. Yadav, Y. Vijaya, et al., Review of Scientific Instruments, 96 (11), (2025), 114704.

Abstract ID: 24

INTERFACE-INDUCED BERRY-CURVATURE DIPOLE AND SECOND-ORDER NONLINEAR HALL EFFECT IN POLLYCRYSTTALINE HETEROSTRUCTURES

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Abstract: Ferromagnetic heterostructures offer a highly tunable platform for generating emergent quantum phenomena through interface symmetry breaking [1-4]. Stacking-induced symmetry breaking at heavy metal/ferromagnet interfaces provides an effective method to modulate their electronic properties for spintronic devices. Here experimentally, we engineer interfacial DMI and spin-orbit coupling to break symmetries and induce the nonlinear Hall effect (NLHE) that persists robustly from 2 K to 300 K. Pronounced non-linear V2ω signals emerge as in ***Figure. 1***. The NLHE shows no sign reversal across this temperature range, with antisymmetric second-harmonic signals persisting under fixed current density. Scaling analysis of $\frac{E_{XY}^{2W}}{E_X^2} = \boldsymbol{a} + \boldsymbol{b\sigma_x} + \boldsymbol{c\sigma_x^2}$ confirms dominant Berry curvature dipole (BCD) contribution over extrinsic scattering mechanisms. The temperature-dependent BCD indicates asymmetric Berry curvature distributions across Fermi surface pockets in the interfacial ferromagnet. Our findings demonstrate that interface symmetry engineering enables robust, temperature-stable NLHE for room-temperature nonlinear quantum spintronic devices such as rectifiers and energy-efficient logic.

Keywords: Berry curvature, Magnetism, Second harmonics, Thin film, Temperature

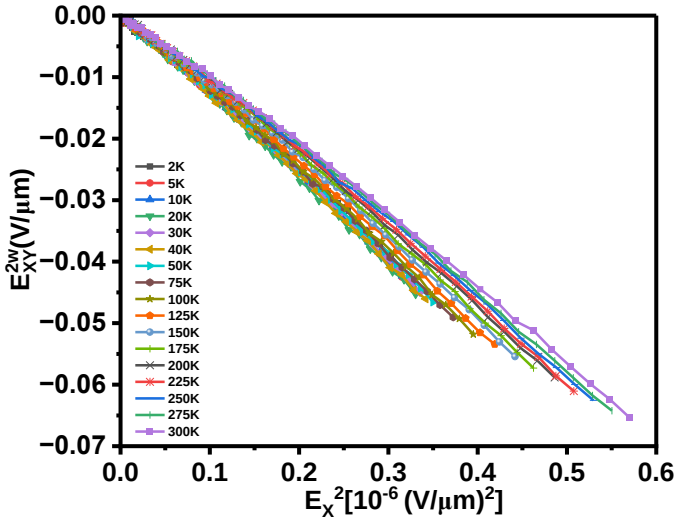


Fig. 1: $\boldsymbol{E_{XY}^{2W}}$ *as a function of* $\boldsymbol{E_X^2}$ *at temperature range from 2K-300K.*

References:

[1] J. Zhong, X. Wang, Q. Feng, G. Li, Phys. Rev. Applied 21 (2024) 024044.
[2] Y. Liu, et al., Natl. Sci. Rev. 10 (2023) nwac232.
[3] S. Wang, X. Li, S. Zhang, Appl. Phys. Lett. 124 (2024) 153102.
[4] R. Chen, Z.Z. Du, H.-P. Sun, H.-Z. Lu, X.C. Xie, Phys. Rev. B 110 (2024) L081301.

Abstract ID: 25

ATOMISTIC SPIN DYNAMICS MODELLING OF RARE-EARTH BASED FERRIMAGNETS FOR FERRIMAGNETIC SPINTRONICS

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[2]*Department of Physics, Indian Institute of Technology Guwahati, Guwahati, India.*
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Abstract: Rare-earth (RE) based ferrimagnetic materials substantiate the emerging technologies, including racetrack and skyrmion-based memory and logic devices [1]. Here, we have investigated a systematic study on TbCo, GdCo, and TbGdCo alloys as a function of RE composition using atomistic spin-dynamics modelling within the Vampire framework. We have extracted key material-dependent parameters like net magnetization, magnetization compensation temperature, Curie temperature, uniaxial magnetic anisotropy, domain wall width, and exchange stiffness. The temperature-dependent net magnetization demonstrates the sublattices' contributions, where RE dominates at low temperature. The increasing magnetization compensation and decreasing Curie temperature with increasing RE indicate strong RE contributions and weakened Co-Co interactions, as supported by the mean-field approximation. The studied anisotropy scales directly with RE magnetization, thereby displaying unusual scaling. The domain wall modelled at 0K, influenced by the shape anisotropy via the demagnetizing field, and the corresponding exchange stiffness follow identical trends. Our findings demonstrate a direct pathway towards next-generation spintronic devices, for example, skyrmion-based memory and logic devices.

Keywords: Atomistic spin dynamics, Rare-earth, Monte Carlo, Compensation temperature, Curie temperature, domain wall width, exchange stiffness.

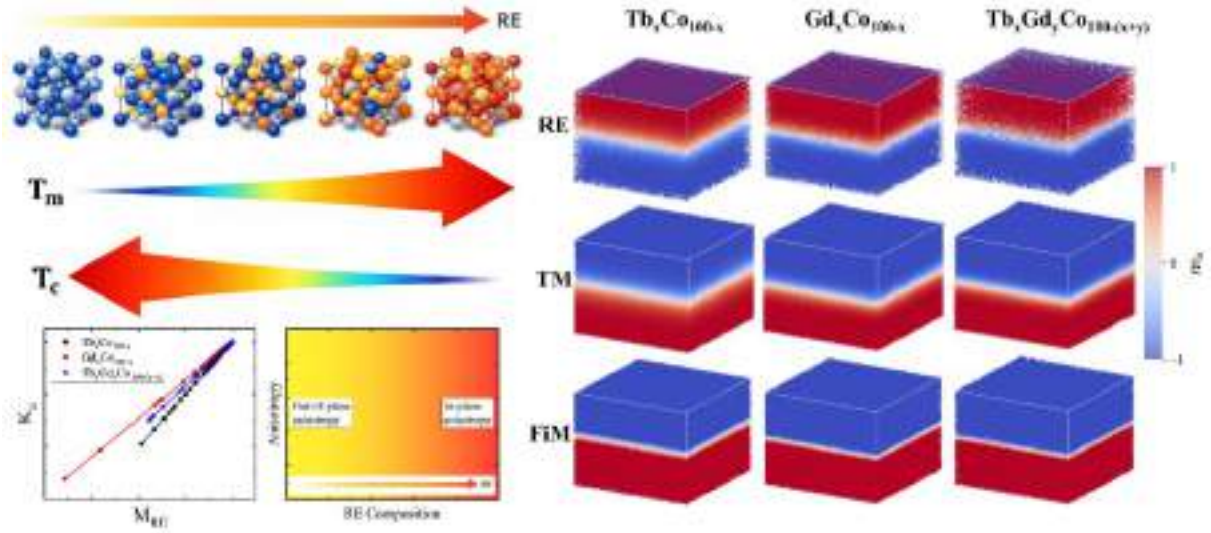


Fig. 1: Extracted parameters as a function of rare-earth composition, like Compensation temperature, Curie temperature, unusual scaling behaviour between the anisotropy and RE magnetization, anisotropic transition from out-of-plane to in-plane, and sublattices resolved domain wall width.

References:

[1] S.K. Kim, G.S.D. Beach, K.-J. Lee, T. Ono, T. Rasing, et al., Ferrimagnetic spintronics, Nat. Mater. 21 (2022) 24–34.

Abstract ID: 26

INTERFACE TUNED AMPLIFICATION AND LOW-TEMPERATURE QUENCHING OF ORBITAL HALL CURRENTS IN LIGHT METAL/NICKEL BILAYERS

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Abstract: The orbital Hall effect (OHE) has recently emerged as a new frontier in spin–orbitronics, enabling the generation of a transverse orbital angular momentum (OAM) current even in nonmagnetic conductors with weak spin–orbit coupling, referred to as Light Metals (LM). Such orbital currents can subsequently be reliably converted into a spin current with suitably designed heterostructures, giving rise to the familiar spin-orbit torque. Understanding and controlling the OHE and its interplay with spin and charge degrees of freedom is essential for the development of next-generation spin–orbitronic materials and devices. We present a systematic study of the OHE in thin films of light metals (Ti, Nb, Cu, and Mo) interfaced with ferromagnetic Ni. Using second-harmonic longitudinal and transverse voltage measurements under an a.c. excitation, we quantify the orbital Hall torque efficiency and in addition the unidirectional orbital magnetoresistance (UOMR) per unit current density. Control experiments on light-metal/NiFe bilayers and single-layer Ni films show the absence of torque and suppression of UOMR, confirming the key role of Ni as an efficient orbital-to-spin converter and of light metals as sources of orbital currents. We find a linear correlation between orbital Hall torque and UOMR efficiencies across different light-metal bilayers with Ni, indicating a common origin in the orbital current. Both effects increase with light-metal thickness, reflecting the long diffusion length of orbital currents compared to spin currents. Furthermore, we observe that combining two light-metal layers leads to a giant enhancement of these effects, emphasizing the importance of interface engineering. Finally, both efficiencies are strongly suppressed at low temperatures, raising important questions about the microscopic mechanism responsible for the generation or the OAM current or the conversion process of OAM into spin current.

Keywords: Orbital Hall Effect, Unidirectional Magnetoresistance, Orbital Torque, Spin-orbit torque, Orbital angular momentum current

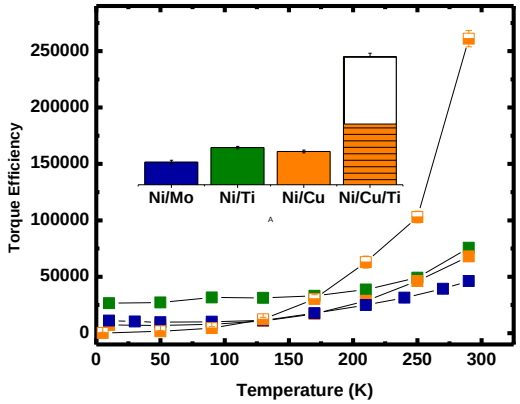


Fig. 1: Graph showing gaint enhancement of torque efficiency with Cu spacer at room temperature (inset histogram) and drastic supression at low temperatue.

References:

[1] D. Mahapatra, H. Bhunia, A. B. Miah, S. Aon, P. Mitra, Applied Physics Letters 126 (24), (2025) 242406
[2] D. Mahapatra, H. Bhunia, M. S. Pattelath , P. Mitra, arXiv2511.09349

Abstract ID: 27

TUNING ELECTROCHEMICAL & MAGNETIC PERFORMANCE OF Ni- MOF@MXENE-CONDUCTING POLYMER TERNARY NANOCOMPOSITE

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Abstract: Nickel-based metal–organic frameworks (Ni-MOFs) intercalated into MXene matrices have attracted significant attention due to their ability to suppress MXene restacking and oxidation while introducing redox-active and magnetic centers. Despite extensive studies on their electrochemical behavior, the combined influence of conducting polymer matrices on both the magnetic and supercapacitor properties of Ni-MOF@MXene ternary nanocomposites remains largely unexplored. This study addresses the research question of how different conducting polymers modulate the electrochemical and magnetic responses of Ni-MOF@MXene-based systems. The purpose of this work is to comparatively investigate ternary nanocomposites incorporating Ni-MOF@MXene with polyaniline (PANI), polypyrrole (PPy), and polyindole for multifunctional electrode applications. The composites were synthesized via a facile hydrothermal method followed by in situ polymerization. Structural and morphological characteristics were analyzed using X-ray diffraction and electron microscopy, while electrochemical performance was evaluated through cyclic voltammetry, galvanostatic charge–discharge, and cycling stability tests. Magnetic properties were examined using vibrating sample magnetometry. The results reveal that the Ni-MOF@MXene/PANI composite delivers the highest specific capacitance and excellent cycling stability due to enhanced conductivity and efficient ion transport. In contrast, the polyindole-based composite exhibits superior magnetic response with higher saturation magnetization, attributed to reduced magnetic dilution and preserved Ni^{2+} exchange interactions, while PPy-based composites demonstrate balanced multifunctional performance. In conclusion, the study highlights the critical role of polymer selection in tuning the electrochemical–magnetic synergy of Ni-MOF@MXene ternary nanocomposites for advanced energy storage and multifunctional applications [1].

Keywords: Cps, Nanostructure, Supercapacitors, Nanofillers, Magnetic Propeerties



Fig. 1: Schematic representation of Electrochemical & Magnetic behaviour.

References:

[1] Ji, Y.; Li, W.; You, Y.; Xu, G., *Chemical Engineering Journal*, 2024, 496, 154009.

Abstract ID: 30

LONG-RANGE MODULATION OF SKYRMION POPULATION BY LOCAL CURRENT INJECTION

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Abstract: Magnetic skyrmion [1] is one of the swirling spin textures observed in non-centrosymmetric crystals that lack inversion symmetry and/or magnetic heterostructures under the finite Dzyaloshinskii Moriya interaction (DMI). Such skyrmion textures, characterized by high stability under the topological protection, have emerged as promising candidates for the next-generation spintronic devices attributed to their robust manipulation via small electric current density. Recent researches have focused on the single skyrmion dynamics in multilayer thin films and clarified various new functionalities, including the skyrmion Hall effect [2], Brownian motions, etc. While most of these studies focus on the linear responses of a single skyrmion so far, the nonlinear responses of the collective skyrmions offer other new classes of opportunities, including the base of neuromorphic computing [3]. The thin-film magnetic skyrmion is designed to interact with each other as nonlinear response, enabling collective magnetic morphology at the nonequilibrium state. We here explore the alternative nonlinear morphology of multiple skyrmions induced by the orthogonal two-current injections for the Pt/Co/Ir multilayer platforms. The global currents induce polarity-dependent driving and accumulation of skyrmions across the whole area of a Hall bar device. Once another local current is injected from a mm width ports, dozens of skyrmions follow their polarity manners of the local injection, resulting in total modulations of skyrmion population governed by a pair of two-current polarities. Such massive morphology tuning at the nonlinear region indicates resemblances with a skyrmion Hall effect, where current-induced accumulation and depletion create the nonequilibrium distributions of skyrmions toward Hall deflections. Our findings propose an alternative controlling method of skyrmion population, threshold-like responses, providing analogies with neuromorphic architectures and other advanced information-processing technologies.

Keywords: Skyrmions, Non-linear physics, Optical measurement

References:

[1] Fert A, et al. “Magnetic skyrmions: Advances in physics and potential applications,” *Nat. Rev. Mater*. 2 (2024): 17031.
[2] Tolley, R, et el. “Room-temperature observation and current control of skyrmions in Pt/Co/Os/Pt thin films,” Phys. Rev. Mater. 2 (2018): 044404
[3] Huang, Y., et al. “Magnetic skyrmion-based synaptic devices,” Nanotechnology 28 (2017): 08LT02.

Abstract ID: 31

MULTIFUNCTIONAL MXENE QUANTUM DOTS/NFS CARBON QUANTUM DOTS HYBRID NANOFILLERS BASED CONDUCTING POLYMER TERNARY NANOCOMPOSITES EXHIBITING MAGNETIC AND SENSING PROPERTIES

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Abstract: The rational development of multifunctional nanocomposites with integrated electrical and magnetic functionalities is essential for next-generation sensing and smart material applications. In this study, multifunctional conducting polymer ternary nanocomposites were engineered using hybrid nanofillers composed of MXene quantum dots (MQDs) and NFS-derived carbon quantum dots (CQDs). The central objective is to elucidate how the synergistic interaction between conductive MQDs and surface-functionalized CQDs can simultaneously enhance charge transport, magnetic responsiveness, and sensing performance within a polymer matrix. A controlled synthesis strategy enabled uniform dispersion of the hybrid quantum dots and strong interfacial coupling with the polymer backbone. Comprehensive structural, optical, magnetic, and electrochemical characterizations confirm the formation of interconnected conductive pathways, abundant electroactive sites, and stable magnetic domains within the composite framework. The resulting ternary nanocomposites exhibit significantly improved electrical conductivity, enhanced magnetic behavior, and high sensitivity with rapid response toward target analytes. These multifunctional characteristics demonstrate the potential of MQD/CQD hybrid nanofillers as an effective platform for developing advanced magnetic sensing materials. The findings provide a versatile design strategy for tailoring multifunctional conducting polymer nanocomposites for future sensing and smart device applications [1].

Keywords: Carbon Quantum Dots; MXene Quantum Dots; Hybrid Nanofillers; Ternary Nanocomposites; Energy Storage; Sensing Applications

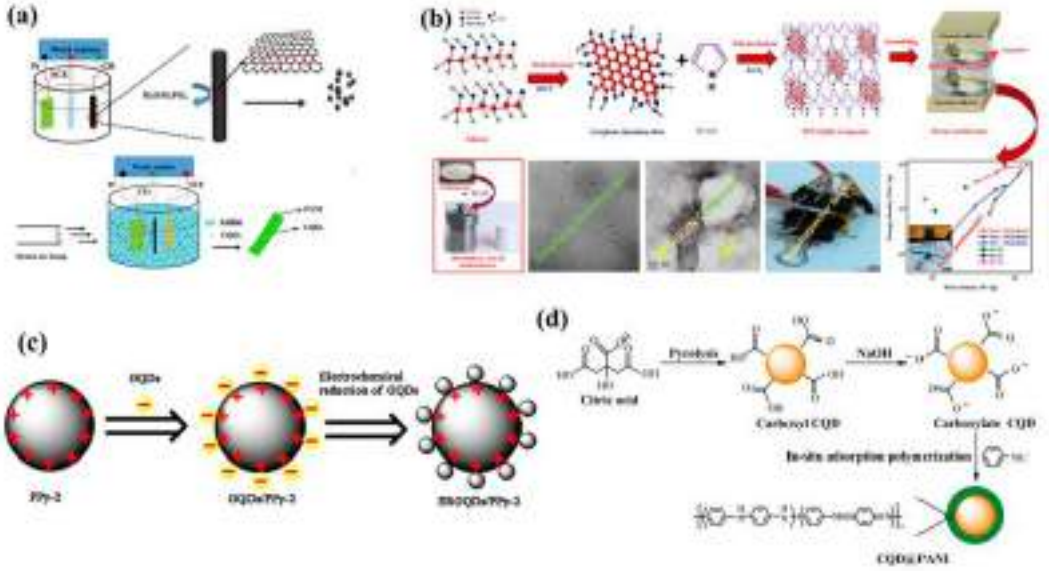


Fig. 1: Schematic illustrations of electrochemical fabrications of QD

References:

[1] H.T. Das, P. Barai, S. Dutta, N. Das, P. Das, M. Roy, M. Alauddin, et al., Polymers 14, 5 (2022) 1053.

Abstract ID: 32

JAHN-TELLER INDUCED COUPLING OF STRUCTURAL DISORDER AND SPIN DYNAMICS OF Cu^{2+} DOPED COBALT CHROMITE NANOPARTICLES

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Abstract: This study focuses on the synthesis, structural and magnetic behaviour of cobalt chromite nanoparticles substituted with copper ions. Both the nano-chromite samples with generic formula of $(Co_{1-x}Cu_xCr_2O_4: x = 0.30 \text{ and } 0.50)$ have been prepared using standard wet chemical co-precipitation route. X-ray diffraction (XRD) analysis confirmed that both the samples crystallize in a pure spinel phase. The crystallite sizes, determined using the Williamson-Hall (W-H) method, were found to be in the range of 9-11 nm, accompanied by tensile microstrain. Raman spectroscopy revealed all five characteristic Raman-active modes, indicating high phase purity. Magnetic measurements demonstrated a transition from paramagnetic (PM) to ferrimagnetic ordering (FiM) near 95 K, along with magnetization reversal for both compositions. An increment in magnetization was observed in the samples upon increasing doping concentration, as confirmed from both temperature (ϕ-T) and field dependent (ϕ-H) magnetization measurements. AC susceptibility measurements indicate a spin-glass transition slightly below the Curie temperature in both the samples. The characteristic spin relaxation time, determined using both the power law model and Vogel-Fulcher model, along with the observation of a finite Vogel-Fulcher temperature, provides strong evidence for the existence of cluster spin-glass behaviour for temperatures less than the ordering temperature. Enhanced lattice strain and anisotropy caused by Cu substitution strengthen the coupling between magnetic clusters, resulting in improved control over the system's magnetic relaxation and anisotropic behaviour.

Keywords: chromite nanoparticles, W-H plot, magnetic moment, Curie temperature, AC susceptibility, spin-glass phase.

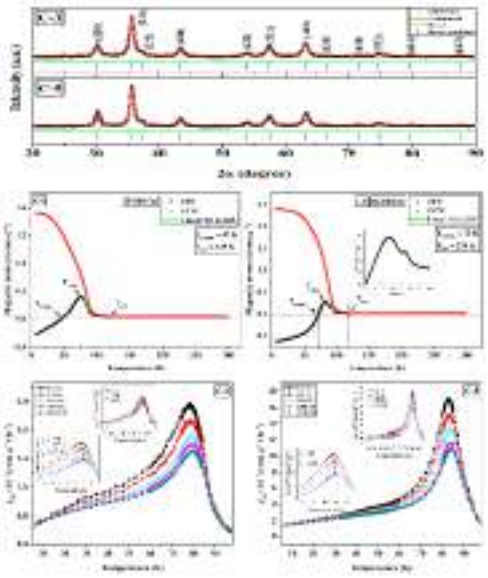


Fig. 1: Reitveld refined XRD plot, ZFC-FC magnetic data plot and AC susceptibitlity plot of both samples

Abstract ID: 33

CARBON DEFICIENCY AS A CONTROL PARAMETER FOR MAGNETISM IN Mn_3SnC_x (x = 0.2,0.5, 0.8 and 1) ANTIPEROVSKITES

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Abstract: Mn-based antiperovskite compounds Mn_3AX (A = Zn, Sn, Ga, Cu; X = C, N) form an important class of multifunctional materials owing to the strong coupling between their magnetic, structural, and electronic degrees of freedom [1]. These materials exhibit a wide range of intriguing physical phenomena, including negative thermal expansion, magnetostriction, and large magnetocaloric effects, making them promising for both fundamental research and technological applications. Among them, Mn_3SnC is particularly notable for its complex magnetostructural transition near ~265 K, arising from competing ferromagnetic (FM) and antiferromagnetic (AFM) interactions and non-collinear magnetic ordering. While the influence of Mn:Sn ratio and slight carbon non-stoichiometry has been explored, the effects of strong carbon deficiency remain largely unexplored. In this work, we systematically investigate the structural, magnetic, thermal, and electronic transport properties of Mn_3SnC_x compounds over a wide range of carbon deficiency ($0.2 \leq x \leq 1$). Rietveld refinement of X-ray diffraction patterns (Fig. 1a) confirms the cubic antiperovskite structure is retained for all compositions. Temperature-dependent electrical resistivity measurements (Fig. 1b) show overall metallic behavior with distinct anomalies near the magnetic transition, indicating strong magneto-transport coupling. Magnetization measurements (Fig. 1c and Fig. 1e) reveal gradual evolution of magnetic ground state from FM-dominated to AFM-dominated ordering with increasing carbon deficiency, accompanied by enhanced magnetic irreversibility. Differential scanning calorimetry results (Fig. 1d) confirm the first-order nature of the magnetostructural transition, with both the transition temperature. These results emphasize the critical role of carbon in stabilizing magnetic order and magnetostructural interactions in Mn_3SnC_x antiperovskites.

Keywords: Non-collinear antiferromagnetism, Magnetostructural transition, Carbon deficiency, Antiperovskite.

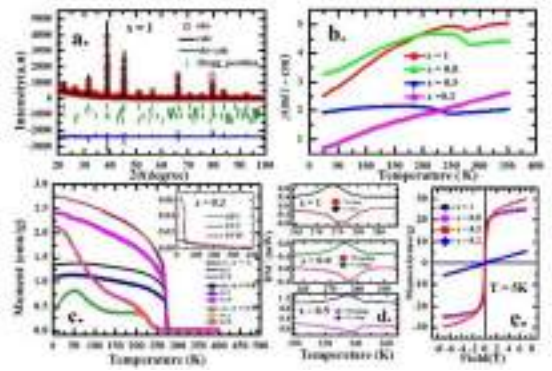


Fig. 1: a) X-ray diffraction pattern, Temperature dependence of the b) electrical resistivity and c) magnetization, d) DSC and e) Isothermal magnetization measurement at 5K of Mn_3SnC_x.

References:

[1] D Huang et al. J. Phys. Condens. Matter 35 (2023) 02570.

Abstract ID: 35

Anomalous Hall Transport in Fe-substituted off-stoichiometric Ni-Mn-Ga Heusler Alloy: Implications for Spintronics Functionality

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Abstract: The growing interest in anomalous transport phenomena in Heusler alloys stems from their nontrivial electronic structures, which give rise to large Berry curvature effects and make them highly attractive for spintronic applications. The anomalous Hall effect is characterized by a pronounced transverse voltage generated in ferromagnetic materials, arising from spin-orbit coupling and intrinsic magnetic order, in addition to the ordinary Hall response. In the present work, we have experimentally investigated the anomalous Hall effect in the polycrystalline Heusler alloy $Ni_{45}Fe_{10}Mn_{29}Ga_{16}$ to elucidate the underlying mechanisms governing its spin-dependent transport behavior. Moreover, the contributing mechanism to the electrical resistivity in different temperature regions of martensite and austenite phases are described thoroughly along with the magnetoresistance variation with the applied magnetic field. This analysis provides greater insight to the magneto-transport behavior of the Ni-Fe-Mn-Ga off-stoichiometric alloy for the spintronics applications.

Keywords: Heusler alloy, Electrical resistivity, Magnetoresistance, Anomalous Hall effect.

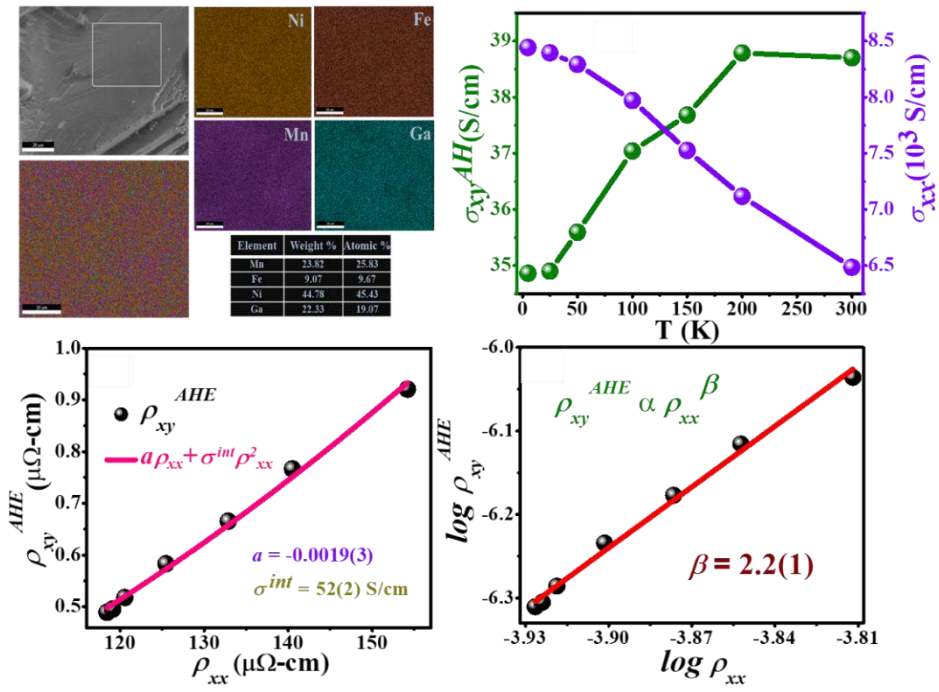


Fig. 1: Compositional and anomalous Hall effect analysis.

Abstract ID: 36

ENERGY-EFFICIENT EDGE DETECTION FRAMEWORK UTILIZING SOT-MTJ BIT-CELL ARRAYS

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Abstract: Edge detection is a first-stage operation in computer vision [1], but methods such as the Canny operator involve sequential filtering and hysteresis thresholding, increasing compute and memory traffic on Von Neumann CMOS platforms. This paper presents an MTJ-based edge detection framework using spin-orbit torque magnetic tunnel junctions (SOT-MTJs) to execute the key decision operation inside an MTJ bit-cell array. Magnetization dynamics are verified by numerically solving the Landau-Lifshitz-Gilbert-Slonczewski (LLGS) equation [2], and a write-read-reset cycle is demonstrated within ~6 ns with femtojoule-scale energy per operation. For image processing, an RGB image is converted to grayscale, split into bit-planes, and the MSB plane is processed using a 3×3 window mapped onto SOT-MTJ cells. During readout, the summed current distinguishes uniform neighborhoods (no edge) from mixed neighborhoods (edge), followed by thresholding to form a binary edge map. For a 1024×679 image, simulated energy and latency are 0.16 µJ and 4 ms, respectively. Qualitative comparison with Canny on image shows that the proposed method highlights prominent high-contrast contours while suppressing minor background details, with much lower computation overhead in the simulated system.

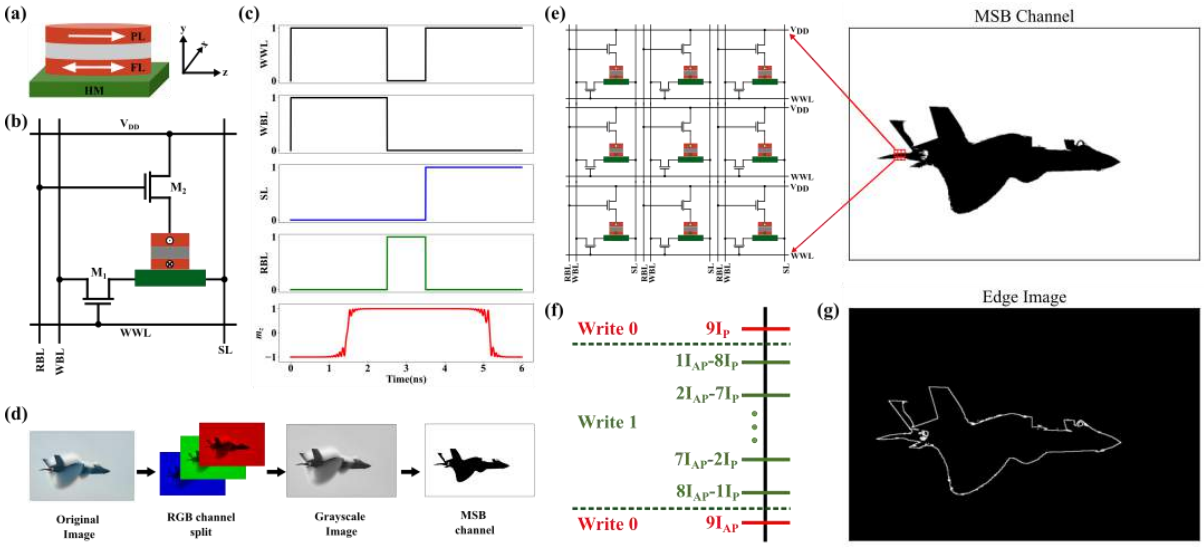


Fig. 1: (a) Schematic of the SOT-MTJ device, on top of the HM layer. (b) Schematic of the bit-cell of SOT-MTJ with the access transistors. (c) Variation of different signals across the bit-cell and the m_z with time. (d) Steps for obtaining the MSB channel from the original image. (e) A 3×3 kernel (red squares) is convolved over the MSB channel of the image. Each pixel of the kernel is implemented using a SOT-MTJ bit cell along with two access transistors, shown in enlarged scale. (f) Current levels for detecting edges. (g) Resulting edge detected image.

References:

[1] J. Canny, vol. PAMI-8, no. 6, pp. 679-698, 1986.

[2] D. C. Ralph, M. D. Stiles, Journal of Magnetism and Magnetic Materials, vol. 320, no. 7, pp. 1190–1216, 2008.

Abstract ID: 37

INFLUENCE OF BISMUTH SUBSTITUTION ON THE CRYSTAL STRUCTURE AND FUNCTIONAL PROPERTIES OF TERBIUM IRON GARNET

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Abstract: Polycrystalline $Tb_{3-x}Bi_xFe_5O_{12}$ (x = 0.00, 0.10, 0.20, 0.30 and 0.40) samples are synthesized using the solid-state reaction method. Rietveld analysis of XRD patterns verifies that every composition adopts the garnet structure without secondary phases, confirming phase purity of the samples. Additional structural confirmation comes from FTIR and Raman spectra, which align with the garnet lattice [1]. Deconvoluted XPS spectra reveals the mixed oxidation states of the ions, with Fe in both +2 and +3 states, Tb in +3 and +4 states, while Bi solely in +3 state. With rise in Bi concentration, a systematic increment in grain size is noticed from SEM images. Magnetization measurements show a marked rise in saturation magnetization (M_S), ascribed to replacement of magnetic Tb^{3+} ions by nonmagnetic Bi^{3+}, which weakens antiferromagnetic interactions and enhances the net magnetic moment of the system. Coercivity (H_C), on the other hand, declines from 102 Oe to 53 Oe with Bi addition, indicating a shift toward soft-magnetic character [2]. Impedance spectroscopy recorded over a wide range of temperatures reveals the presence of two relaxation peaks, associated to grain-boundary and electrode-interface effects, as supported by electric modulus plots. Room-temperature dielectric constant increases progressively with Bi substitution, indicating greater polarizability of the synthesized compounds. Nyquist plots are modelled with suitable equivalent circuits, which shows grain-boundary resistance to be the primary contributor to total impedance. AC conductivity data are fitted using Jonscher's power law and the double-power-law model, identifying correlated barrier hopping and small polaron hopping as the prevailing conduction mechanisms.

Keywords: Rare earth iron garnets, Coercivity, Impedance spectroscopy, AC conductivity

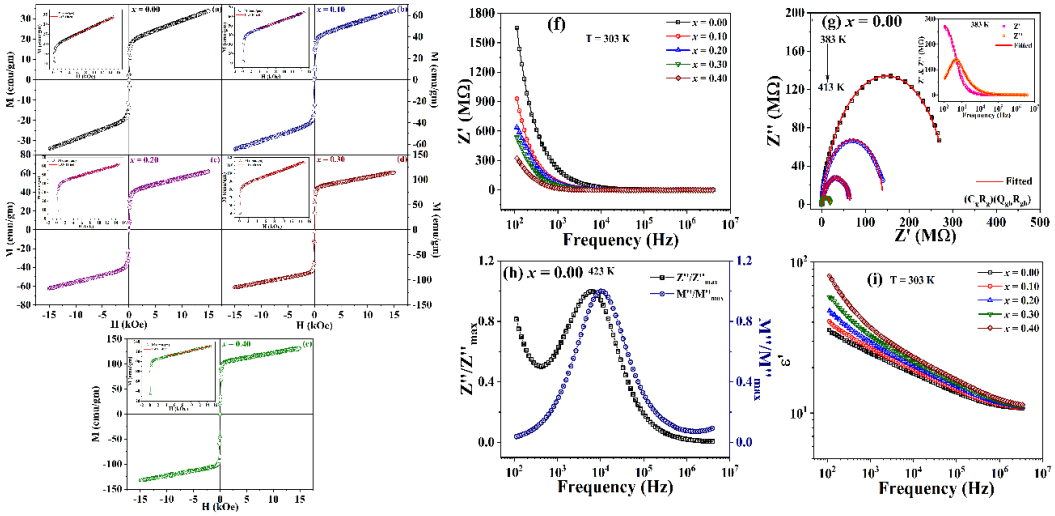


Fig. 1 (a-e) MH loops along with LAS fitted plots, **(f)** $Z'vs.$ Freq, **(g)** Nyquist plots with fitted data for x = 0.00, **(h)** Z''/Z''_{max} & M''/M''_{max} $vs.$ Freq, **(i)** σ_{ac} $vs.$ Freq. at 303 K

References:

[1] K. Rohith Vinod, N.K. Mathew, G. Theertharaman, et al., Mater. Sci. Eng. B 276 (2022) 115521.
[2] H. Shen, H. Wang, J. Ma, Y. Ma, Y. Fang, J. Xu, J. Sol-gel Sci. Technol. 103 (2022) 539–548.

Abstract ID: 39

DYNAMIC MODE DECOMPOSITION OF SPIN DYNAMICS

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Abstract: The design of fast and accurate algorithms for the numerical integration of nonlinear magnetization dynamics in confined devices is a significant challenge in computational micro magnetics. Conventional algorithms of discretization of the Landau-Lifshitz-Gilbert (LLG) equations are based on finite differences or finite elements methods [1]. Very recently, a new approach based on micromagnetic normal modes (NMs) has been proposed [2]. The magnetization dynamics is integrated by means of a system of ordinary differential equations where the NMs amplitudes are the unknows. The nonlinear nature of the dynamics results in the presence of a series of terms in the NMs equations, involving the product of increasing number of modes amplitudes. For many cases of practical interest, this approach has proven effective in reducing the number of degrees of freedom and consequently the computational cost of the integration process [3]. However, as the magnetization significantly deviates from the equilibrium direction, the number of nonlinear terms to be considered increases considerably. This leads to an excessive demand for memory and computational resources, making the application of NMs approach less practical. In the present work, we explore the comparison of NMs approach with an alternative modal approach known as dynamic mode decomposition (DMD-modes) [4]. The DMD modes are computed for a specific dynamic regardless of the micromagnetic equilibrium, and can be used as a basis to study nonlinear magnetization under diverse excitation conditions such as parallel and transversal external field pumping. As an illustrative example, the figures show the DMD-modes eigenfrequencies from small angles and large angles dynamics. The eigenfrequencies computed for small angles almost coincide with the eigenfrequencies of NMs (also shown in figure), but they differ from eigenfrequencies computed from large angles dynamics.

Keywords: Dynamic Mode Decomposition; LLG equations; Spintronics; Computer Simulations

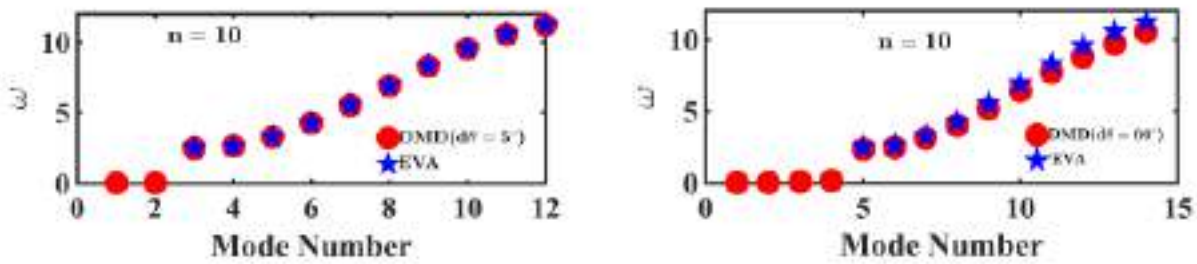


Fig. 1: DMD-modes eigenfrequencies vs Mode Number plot.

References

[1] J. Fidler, T. Schrefl, Journal of Physics D: Applied Physics, 33 (2000).
[2] S. Perna et al, J. Magn. Magn. Matter, vol. 546 (2022).
[3] S. Perna, F. Bruckner, C. Serpico, D. Suess, M. d'Aquino, *AIP Advances* 1 March 2022; 12 (3): 035244.
[4] Tu, J. H., Rowley, C. W., et al., Journal of Computational Dynamics, 1(2), 391-421 (2014).

Abstract ID: 40

TEXTURE AND MAGNETIC STATES OF MN ATOMS IN POLYCRYSTALLINE MNSI THIN FILMS FACING A C-SAPPHIRE SUBSTRATE STUDIED BY SOFT X-RAY MAGNETIC CIRCULAR DICHROISM

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Abstract: Polycrystalline MnSi is a highly efficient magnetic skyrmionic material and information carriers for future spintronic devices, deposited on a c-cut sapphire substrate by magnetron sputtering with a low base pressure. Due to their fascinating crystal structures and spin textures these Mn-based silicides are most extensively studied now a days. In order to study the appearance of any impure phases like Mn_xSi_y, hysteresis behaviour and the inception of ferromagnetic/superparamagnetic domains present in the MnSi film, we have performed X-ray diffraction (XRD), XRD pole figures in stereographic projection, vibrating sample magnetometry and powerful element specific X-ray absorption spectroscopy (XAS) and X-ray magnetic circular dichroism techniques. The room temperature hysteresis curve points towards the phenomenon of long-range ferromagnetic ordering. The Mn $L_{2,3}$ edge XAS spectra did not show a Mn^{2+}-like multiplet structure. The overall magnetization increases with the increase in applied magnetic field from 0.1 T to 2 T on MnSi thin film. The observed spin and orbital magnetic moments are ~ 0.03 to 0.1 μ_B and 0.01 to 0.04 μ_B, respectively.

Keywords: Thin films, Manganese silicide, X-ray absorption spectroscopy, X-ray magnetic dichroism and X-ray diffraction.

Abstract ID: 41

GATE-TUNABLE SOT-FET BASED ON PARAMETER VARIATIONS AND DOPING OF WSe_2 THIN FILMS FOR NEUROMORPHIC HARDWARE APPLICATIONS

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Abstract: Current CMOS devices are on the path towards reaching their physical and economic limitations. Spin-based devices can overcome this problem due to their non-volatility, high speed, retentivity, and endurance. The SOT devices lack dynamic switching capabilities; they are static in terms of SOT efficiency, limited by the materials. The gate-tunability is a transformative aspect of our work. It removes the static components with fixed properties with a more dynamic, programmable element. It transforms the device from purely digital to analog. Our goal is to create a "SOT-FET" structure where the spin-torque efficiency can be tuned electrically with a gate, using a 2D spin source layer WSe_2 with a conventional ferromagnet like $Ni_{80}Fe_{20}$ (Permalloy/Py) or CoFeB (Cobalt-Iron- Boron) and study the impact on SOT efficiency and gate-tunability due to variation of process parameters like sputtering gas pressure, deposition temperature and the tunability with n-type behavior, by engineering defects. The primary motivation is to continuously vary the SOT efficiency and FET channel conductance via the gate voltage, a similar physical property needed to create an artificial synapse whose synaptic weight can be modulated, unifying the logic and memory capabilities, and as an analog memristor (Neuromorphic computing). This adaptability is enabled by 2D materials, since these advanced architectures require large arrays of densely packed devices.

Keywords: Dynamic Switching, Gate-Tunability, Spin-Torque Efficiency, Channel Conductance, Artifical Synapse, Neuromorphic Hardware.

Sample	Avg. Se atomic %	Avg. W atomic %	Se/W Ratio
S1	66.5 %	33.5 %	~1.98
S2	62.9 %	37.1 %	~1.69
S3	59.4 %	40.6 %	~1.46

Fig. 1: EDX of WSe_2 thin film

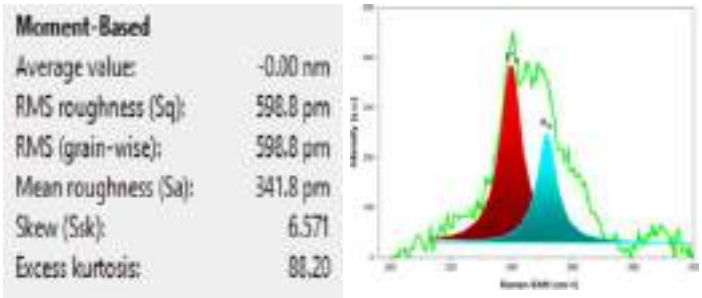


Fig. 2: Roughness & Raman of WSe_2 film

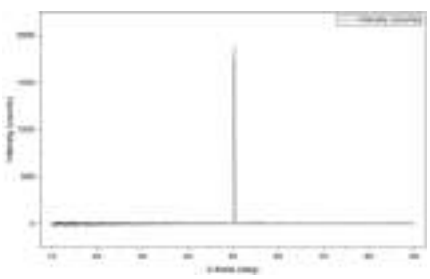


Fig. 3: XRD of $Ni_{80}Fe_{20}$

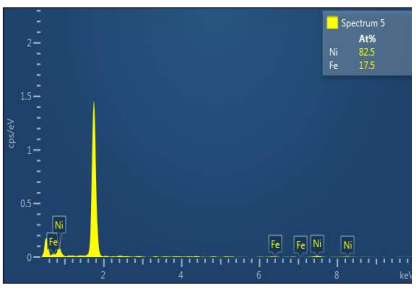


Fig. 4: EDX of $Ni_{80}Fe_{20}$



Fig. 5: Liftoff Device

Abstract ID 42

POROSITY TUNING IN FE-DOPED CO-AL SPINEL OXIDES FOR ENHANCED HYDROELECTRIC CELL PERFORMANCE: A MULTI-TECHNIQUE STUDY

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Abstract: Aluminum oxide (α-Al_2O_3) is valued for its thermal stability, mechanical strength, and applications in catalysis, filtration, and hydroelectric cells (HECs), where porosity critically governs performance. This study investigates porosity in $Co_{0.1}Fe_xAl_{1.9-x}O_4$ (x=0.00, 0.01, 0.05) spinel nanoparticles using XRD, photoluminescence (PL), FTIR, BET analysis, and I-V polarization XRD patterns revealed sharp, crystalline peaks with crystallite sizes increasing from 15.83 nm (x=0.00) to 16.74 nm (x=0.05). Fe^{3+} substitution induced peak shifts due to lattice distortion from ionic radius mismatch between Fe^{3+} and Al^{3+}, enhancing defect density and ionic conductivity. FTIR confirmed O–H stretching, H–O–H bending (adsorbed water), and metal–oxygen bonds (400–700 cm^{-1}), validating spinel structure and electrochemical readiness for water splitting. PL spectra exhibited broad blue emissions (450–503 nm) from oxygen vacancies and Co^{2+} d–d transitions, indicating defect-rich surfaces that trap electrons and promote water molecule interactions for HEC efficiency. BET analysis quantified specific surface area and pore volume, directly correlating porosity to catalytic activity. I-V curves of HECs displayed nonlinear voltage drops with rising current, characteristic of Grotthuss-like proton conduction enabled by defects and hydroxyl groups. These finding demonstrate that controlled Fe-doping strategically tunes porosity, defects, and conductivity in Co-Fe-Al spinels, optimizing them for advanced catalysis, filtration, and hydroelectric energy conversion applications.

Keywords: BET, PL, FTIR, XRD.

References:

[1] V. Jakhar, M. Dhall, A. Lathwal, P. Vashistha, M. Malik, S. Khasa, A. Hooda, J. Shah, R.K. Kotnala, , Journal of Electronic Materials. (2025). https://doi.org/10.1007/s11664-025-12596-x

Abstract ID: 43

ENGINEERING OXYGEN VACANCY CHANNELS IN BM-SCO FILM VIA STRAIN

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Abstract- Oxygen vacancies are not merely defects in materials but play a crucial role in determining their mechanical, optical, electrical, and catalytic properties.[1] Understanding and controlling these vacancies is essential for the development of advanced energy conversion and storage technologies.[2] $SrCoO_{2.5}$ exhibits a brownmillerite structure with alternating layers of metal–oxygen octahedra and tetrahedra. When grown on $SrTiO_3$ (STO) substrates, the oxygen vacancy channels (OVCs) are typically aligned horizontally.[2] Tuning these OVCs strongly influences magnetic anisotropy and resistive switching behavior, which is important for memristor applications. In this work, BM-SCO thin films were deposited on $Pb(Mg_{1/3}Nb_{2/3})O_3$–$PbTiO_3$ (PMN-PT) and $BaTiO_3$ (BTO) substrates using pulsed laser deposition. The lattice parameters of PMN-PT (4.0 Å) and BTO (3.994 Å) induce sufficient strain to transform horizontal OVCs into vertical ones without ionic liquid gating. The structural and magnetic properties of films grown on STO, PMN-PT, and BTO were systematically compared. Additionally in SRO/SCO/Nb-STO heterostructures, XRD measurements reveal a bias-induced topotactic phase transition from brownmillerite $SrCoO_{2.5}$ to perovskite $SrCoO_3$ (Figure 2), driven by electric-field-controlled oxygen migration. XRD and magnetization (M–T and M–H) measurements confirm the orientation and evolution of OVCs. These tunable vacancy channels enable fast ionic transport, offering promising opportunities for energy storage, neuromorphic devices, and oxide electronics [3].

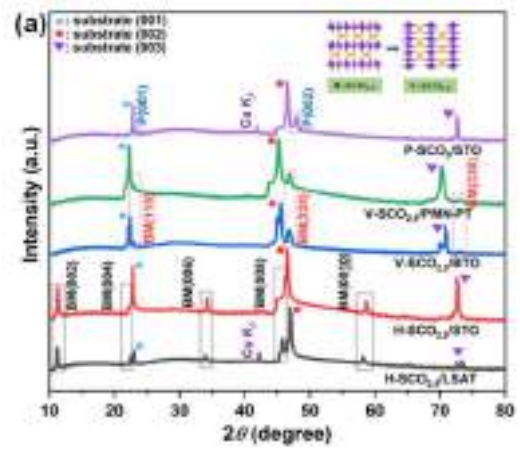


Fig 1. XRD data,reveals H-$SCO_{2.5}$ converted into V-$SCO_{2.5}$ when PNMPT or BTO substrates are

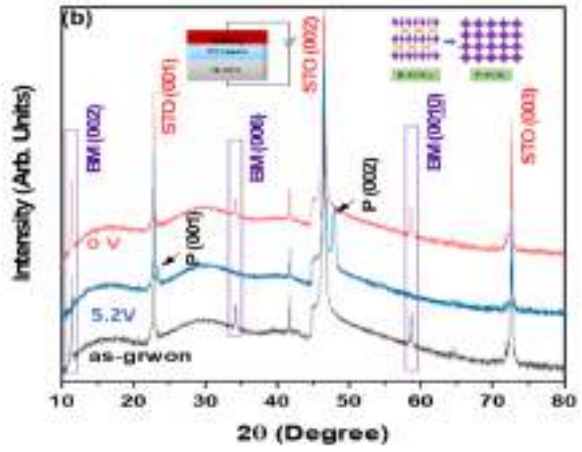


Fig 2. XRD shows Topotactic Phase transition from $SrCoO_{2.5}$ to $SrCoO_3$ using small bias of 5.2 volt.

References

[1] Hyeon Han and Stuart S. P. Parkin *ACS Nano* **2022** *16* (4), 6206-6214
[2] Chowdhury, S.. *ACS Appl. Electron. Mater.* **2021**, *3*, 3060– 3071
[3] Acharya, S. K.; Nallagatla ACS Appl. Mater. Interfaces 2016, 8 (12), 7902−7911

Abstract ID: 45

STRUCTURAL, MAGNETIC AND MAGNETOTRANSPORT PROPERTIES OF Sb DOPED MnTe

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Abstract: MnTe has recently attracted significant attention as a promising antiferromagnetic semiconductor due to its high Néel temperature, strong spin–lattice coupling, and potential applications in spintronic devices. In this work, we report a systematic investigation of the structural, magnetic, and transport properties of Sb doped MnTe, aiming to tune its electronic and magnetic behavior through controlled chemical substitution [1]. Single crystal $Mn0.5_{-x}Sb_xTe0.5$ (x=0.06) samples were synthesized using a Modified Bridgman under optimized growth conditions. X-ray diffraction of single crystal flake confirms the single phase formation. Energy dispersion X-ray spectroscopy confirms the right stoichiometry. Magnetic measurements reveal that Sb doping significantly influences the antiferromagnetic ordering of MnTe, leading to a modification of the Néel temperature and magnetic moment. A weak ferromagnetic component is observed at low temperatures [2], which may arise from spin canting or defect-induced magnetic interactions. Electrical transport studies demonstrate that Sb doping transforms MnTe from a semiconducting state to metallic conduction, Our results demonstrate that Sb doping provides an effective route to tailor the structural, magnetic, and electronic properties of MnTe. These findings highlight Sb-doped MnTe as a potential platform for exploring tunable antiferromagnetic semiconductors and for future spintronic applications.

Keywords: Magnetic phase transition, Electronic phase Transition, Magneto-elastic coupling, spin canting.

References:

[1] P.R. Sreeram, V. Ganesan, Senoy Thomas, M.R. Anantharaman, “Enhanced thermoelectric performance of nanostructured manganese telluride via antimony doping”. Journal of Alloys and Compounds **836**, (2020) 155374.

[2] J.B.C. Efrem D’Sa, P.A. Bhobe, K.R. Priolkar, A. Das, S.K. Paranjpe,1, R.B. Prabhu, P.R. Sarode, “Low-temperature neutron diffraction study of MnTe” Journal of Magnetism and Magnetic Materials **285**, (2005) 267–271

Abstract ID: 46

EFFECT OF Cr SUBSTITUTION ON THE STRUCTURAL AND MAGNETIC PROPERTIES OF NANO-SIZED $CoCr_{\varepsilon}Fe_{2-\varepsilon}O_4$ ($0.0 \leq \varepsilon \leq 0.9$) MATERIALS

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Abstract: We have synthesized $CoCr_{\varepsilon}Fe_{2-\varepsilon}O_4$ ($0.0 \leq \varepsilon \leq 0.9$) nanomaterials using citric acid assisted modified sol-gel autocombustion method [1]. XRD patterns of the annealed materials (650 °C) confirmed the cubic spinel phase of the products and the estimated crystallite sizes vary from 39.8 nm to 27.1 nm for Cr content, $\varepsilon = 0.0$ to 0.9, respectively. The lattice parameters decreases from 8.3533 Å to 8.3473 Å for $\varepsilon = 0.0$ to 0.9, respectively. FTIR spectroscopic analysis (i.e. M–O bonding frequencies) showed variation of ν2 (octahedral site occupancy) frequency from 455 cm^{-1} to 495 cm^{-1} whereas ν1 (tetrahedral site occupancy) frequency changes from 615 cm^{-1} to 607 cm^{-1}, for $\varepsilon = 0.0$ to 0.9, respectively. These results can be correlated to efficient cation redistribution occurring in the lattice with progressive increase of Cr content in $CoCr_{\varepsilon}Fe_{2-\varepsilon}O_4$ nanomaterials [2]. The morphology of particles was mainly spherical with some pseudocubes present and FESEM particle size changes from 44 nm ($\varepsilon = 0.0$) to 34 nm ($\varepsilon = 0.9$). The significant variation in saturation magnetization (M_s) values, decreasing from 74.3 emu/g to 23.8 emu/g were estimated using magnetization (M) *vs.* applied magnetic field (H) (i.e. M-H) curves (measured at 300 K) whereas the observed values of coercivity (H_c) decreases from 780 Oe to 440 Oe, for $\varepsilon = 0.0$ to 0.9, respectively. These variations in structural and magnetic parameters can be correlated to several factors; such as: varying Cr content in the spinel lattice, cation redistribution, nano-size, surface effects, lattice strain etc. [1-2].

Keywords: Cr-substituted $CoFe_2O_4$ Nanomaterials, Sol-gel autocombustion, X-ray diffraction, Magnetic properties, Cation redistribution, Nano-size and surface effects

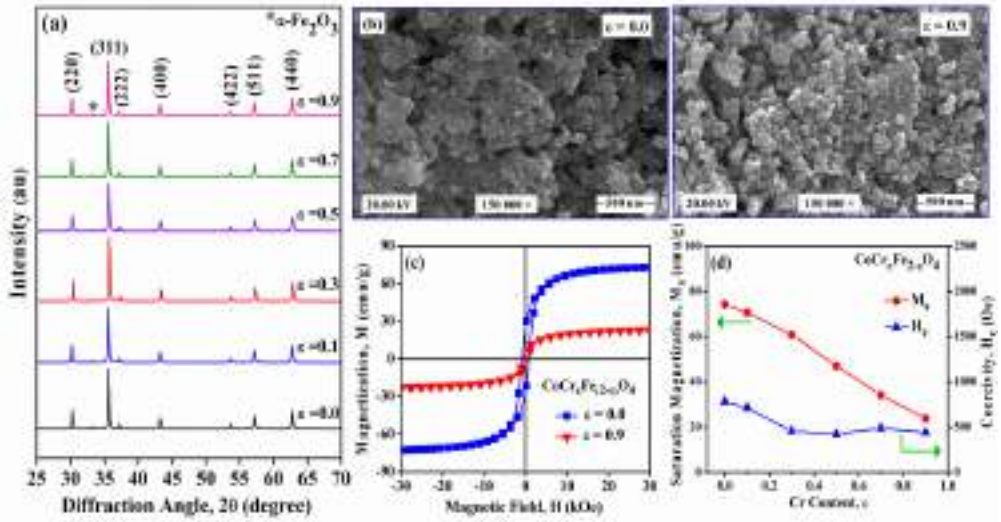


Fig. 1: (a) XRD patterns (b) FESEM micrographs (c) MH curves and (d) Variation of M_s and H_c with Cr content (ε), for vaious $CoCr_{\varepsilon}Fe_{2-\varepsilon}O_4$ nanomaterials

References:

[1] A.B. Patil, R.N. Panda, Mater. Chem. Phys. 307 (2023) 128215.
[2] A.B. Patil, R.N. Panda, New J. Chem. 49 (2025) 109-123

Abstract ID: 47

INTERPLAY OF MAGNETISM AND TOPOLOGY IN VDW TOPOLOGICAL INSULATOR

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Abstract: We investigate the magneto-transport properties of intrinsic magnetic topological insulator $MnBi_2Te_4$ (MBT) devices with systematically varied thicknesses to elucidate the interplay between magnetic ordering and anisotropic magnetoresistance (AMR). Temperature and angle-dependent magnetoresistance (MR) measurements, performed over a wide magnetic field range, reveal pronounced hysteretic behaviour at low temperatures, signifying magnetization switching and domain reorientation within the layered antiferromagnetic structure. The magnitude of hysteresis and the corresponding coercive field exhibit a strong dependence on film thickness, disappearing in both the ultrathin and bulk-like regimes. This observation suggests that the hysteresis originates from interlayer magnetic coupling and domain-wall pinning, which are most prominent at intermediate thicknesses where surface and bulk magnetic interactions coexist. Angle-dependent MR measurements further display a distinct evolution from a conventional twofold symmetry at low fields to an emergent fourfold symmetry at higher magnetic fields. This crossover behaviour reflects the competition between bulk spin–orbit-driven AMR and topological surface-state contributions to electronic transport. Additionally, the temperature dependence of the AMR amplitude closely follows the Néel temperature (~24 K), confirming the coupling between antiferromagnetic order and charge carrier scattering mechanisms. These results collectively highlight the tunability of magnetic and electronic responses in $MnBi_2Te_4$ through precise control of film thickness and magnetic field orientation. The observed field-driven symmetry transition and thickness-dependent hysteresis provide crucial insight into the coexistence and competition between bulk and surface magnetism in intrinsic magnetic topological insulators. Such understanding advances the design of spintronic and topological devices where magnetic anisotropy and transport symmetry can be engineered via dimensional control.

Keywords: Antiferromagnet, Topology, Surface states, Thickness, Devices.

Abstract ID: 48

CHIRAL ORBITAL CURRENT DRIVEN TOPOLOGICAL HALL EFFECT IN FERRIMAGNETIC NODAL-LINE SEMICONDUCTOR

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Abstract: Chiral orbital current (COC) plays a crucial role in governing the magnetization and transport behaviour in the layered ferrimagnetic nodal-line semiconductor Mn3Si2Te6. Here, we observe that the topological Hall effect (THE), typically attributed to Berry curvature from chiral spin textures, originates from COC, which produces an emergent magnetic field for conduction electrons due to its real-space orbital textures. We find that the THE signal strengthens as we move down from bulk to nanoflakes, but tends to disappear with increasing current, along with the disappearance of the COC state. We also demonstrate a strong correlation between the colossal magnetoresistance (CMR) and the observed THE, suggesting that large Berry curvature and topological transport can arise purely from orbital degrees of freedom, providing a new platform for engineering dissipationless transport in 2D magnets [1].

Keywords: Topological Hall effect, Chiral orbital current, nodal-line semiconductor, colossal magnetoresistance

References:

[1] A Das, S Mukhopadhyay, arXiv preprint arXiv:2512.14298.

Abstract ID: 52

ELEMENT-RESOLVED SPIN–ORBITAL COUPLING AND ANISOTROPIC FERRIMAGNETISM IN $NiFe_2O_4$ THIN FILMS PROBED BY XAS AND XMCD

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Abstract: NiFe2O4 thin films are synthesized by spray pyrolysis techniques, and structural, morphological, vibrational, optical, magnetic, and electronic properties are studied by x-ray diffraction (XRD), high-resolution scanning electron microscopy (HRSEM), fourier-transform infrared spectroscopy (FTIR), ultraviolet–visible (UV–Vis) spectroscopy, photoluminescence (PL), vibrating sample magnetometry (VSM), and element-specific x-ray absorption spectroscopy (XAS) and x-ray magnetic circular dichroism (XMCD). XRD and HRSEM analyses confirmed the formation of an inverse spinel structure with uniform and homogeneous grain morphology. VSM measurements revealed robust ferrimagnetic behaviour at room temperature. Enhanced magnetic anisotropy with stronger ferrimagnetic ordering in films is attributed to improved crystallinity, enhanced grain coalescence, and reduced lattice strain. Element-resolved XAS/XMCD results showed that Ni2+ ions preferentially occupy octahedral sites, while Fe3+ ions are distributed over both tetrahedral and octahedral sublattices, consistent with an inverse spinel configuration. Ni2+ L2,3-edge spectra exhibited pronounced sensitivity to crystal field perturbation caused by structural defects and oxygen vacancies. Such distortions, combined with unquenched orbital angular momentum and strong spin–orbit coupling, induced spin canting and magnetic moment anisotropy. XMCD sum-rule revealed the finite orbital magnetic moments for both Ni and Fe ions, emphasizing anisotropy originating from local symmetry breaking, cation redistribution, and Fe 3d–O 2p hybridization. These results showed the interplay between cation distribution and lattice distortions in enhancing spin–orbital coupling and magnetic anisotropy, thereby establishing $NiFe_2O_4$ thin films as promising materials for advanced spintronic and magnetoelectronic applications.

Keywords: $NiFe_2O_4$ thin films, X-ray absorption spectroscopy, X-ray magnetic circular dichroism, Magnetic anisotropy, Spin–orbital coupling, Orbital magnetic moment

Abstract ID: 53

TUNING FERROMAGNETISM IN TRANSITION-METAL DOUBLE DOPED CdTe: AN ELEMENT-SPECIFIC STUDY TOWARD SPINTRONIC APPLICATION

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Abstract: Transition metal (TM) doping is an effective method to tailor the optical, electrical, and magnetic properties of the II–VI semiconductors, thereby expanding their potential for multifunctional device applications. In this work, we investigated the ferromagnetism by double-doping with TMs. The Structural, morphological, optical, and magnetic properties were comprehensively characterized using X-ray diffraction (XRD), high-resolution scanning electron microscopy (HR-SEM), atomic force microscopy (AFM), Fourier-transform infrared spectroscopy (FTIR), photoluminescence (PL), vibrating sample magnetometry (VSM), X-ray absorption spectroscopy (XAS), and X-ray magnetic circular dichroism (XMCD). XRD results confirm that Mn- and Cr-co-doped CdTe thin films show a cubic zinc blende structure, indicating successful substitution of Mn and Cr ions at Cd lattice sites without the formation of secondary phases. HR-SEM imaging shows homogeneous surface morphology, and energy-dispersive X-ray spectroscopy (EDS) mapping confirms the uniform distribution of elements over the entire surface. Which confirms the high quality of the film growth. Element-specific XAS and XMCD measurements provide direct evidence that Cr co-doping induces a transition from paramagnetic to ferromagnetic ordering in Mn-doped CdTe, accompanied by a substantial enhancement in the total magnetic moment. The observed ferromagnetism is attributed to double-exchange interactions and strong *sp–d* exchange coupling between the localized 3*d* electrons of Mn^{2+} and Cr^{2+} ions and the charge carriers of the CdTe host lattice. This interaction modifies the electronic structure, strengthens magnetic coupling, and stabilizes ferromagnetic ordering at room temperature. The demonstrated enhancement of ferromagnetic properties highlights Mn-Cr co-doped CdTe as a promising candidate for next-generation spintronic applications.

Keywords: Diluted magnetic semiconductors, Ferromagnetism, XMCD, Spintronics

Abstract ID: 54

FIRST-PRINCIPLES (DFT) AND SCAPS-1D BASED NUMERICAL INVESTIGATION OF LEAD-FREE Cu_2XSnS_4 (X = Fe, Mn) MAGNETIC ABSORBER SOLAR CELLS

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Abstract: A hybrid methodology combining Density Functional Theory (DFT) and SCAPS-1D simulation was applied in this work to optimize the performance of magnetic Cu_2XSnS_4 = (X=Fe or Mn) double perovskite based solar cells. This quaternary chalcogenide material which consists of Cu_2FeSnS_4 (CFTS) and Cu_2MnSnS_4 (CMTS) are non-toxic, environmentally sustainable, earth abundant, and serve as a lead-free alternative to conventional Pb perovskite solar cells. DFT functioned as a first principles calculation method to characterize the structural and optical properties of the Cu_2XSnS_4 absorber material whereas SCAPS-1D provided a means of simulating and optimizing the solar devices structural parameters and performance. In order to optimize the performance of the device, the SCAPS-1D simulations focused on determining the optimal physical dimensions of the absorber layer and evaluating various electron transport layers (ETL) and hole transport layers (HTL) that could affect the device's performance; This included ETL materials such as ZnO, WS_2 and SnO_2, while HTL materials used included CBTS, NiO and Spiro-MeOTAD[1]. The study also provided an examination of the performance of devices in terms of temperature, series and shunt resistance. The research findings contained in this study contribute to future double perovskite solar cell design and optimization to enhance solar cell efficiency [2].

Keywords: DFT, SCAPS – 1D, Structural and Optical Stability, Double perovskite, solar device.

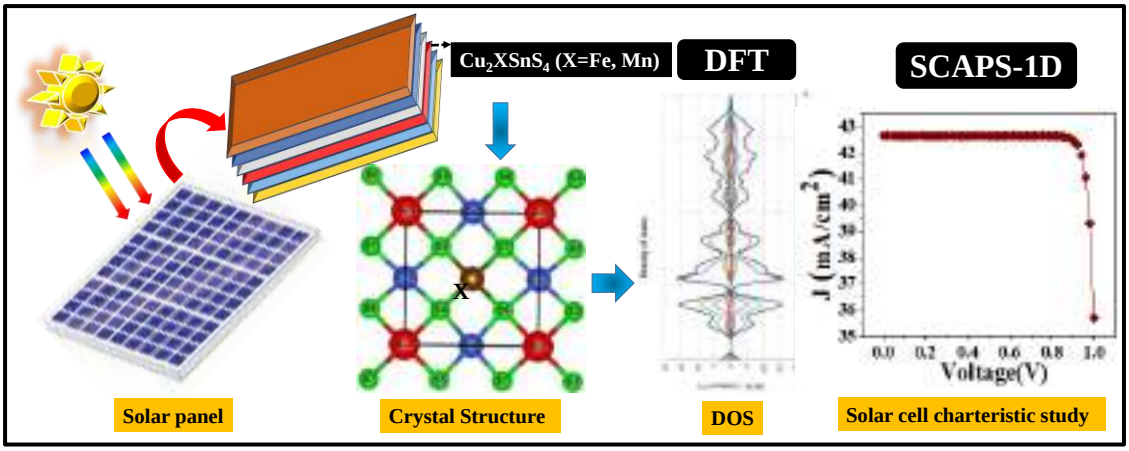


Fig. 1: DFT calculation in SCAPS 1D simulation for a Double Peroskite solar cell device.

References:

[1] A. Isha, A. Kowsar, A. Kuddus, M.K. Hossain, M.H. Ali, M.D. Haque, M.F. Rahman, Heliyon 9 (2023) e15716. https://doi.org/10.1016/j.heliyon.2023.e15716

[2] M.K. Jyolsna Raj, K. Mohanta, S. Devasia, B. G. Priyadarshini, Journal of Physics and Chemistry of Solids 208 (2026) 113193. https://doi.org/10.1016/j.jpcs.2025.113193

Abstract ID: 55

Fe-Al-Si MAGNETIC NANOCOMPOSITES BY HIGH ENERGY BALL MILLING

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Abstract: Advances in the synthesis technique like high-energy ball milling might be an interesting green and solvent-free alternative to expensive and complex chemical approaches to synthesizing Metal Metrix Magnetic Nanocomposites. In high-energy ball-milled intermetallics, if the alloying process is not allowed to reach completion, the presence of intermediate magnetic/nonmagnetic phases would lead to a nanocomposite with interesting bulk and microscopic magnetic properties [1-3]. In present study we report computational and experimental analysis of magnetic properties of $Fe_3Al_xSi_{(1-x)}$ (where x = 0.2-0.8) intermetallics. For the experimental investigation of magnetic behaviour, $Fe_3Al_xSi_{1-x}$ nanosystems (x = 0.2–0.8) were synthesized via mechanical alloying. First-principles calculations of hyperfine interactions for the Fe-Al-Si compositions, performed using the SPRKKR package in a fully relativistic spin-polarized framework, indicate that the magnetic moments at the two inequivalent Fe crystallographic sites align parallel to the applied magnetic field. Furthermore, the bulk magnetic contributions from these two Fe sublattices exhibit ferromagnetic coupling. However, through high energy ball milling, Fe-Al-Si ball milled nano composites has been successfully synthesized with very high saturation magnetisation in the range of 104 emu/g to 177 emu/g in the grain size of 10 ± 2. Field Emission Scanning Electron Microscopy images shows that no regular morphology has been found, particles are in micron size flakes like aggerated structures. The Curie temperature of these MA samples is in the range of 700^{o}C, combine with excellent bulk magnetization with soft ferromagnetic nature make Fe-Al-Si nanocomposites suitable candidate for high temperature applications.

Keywords: FeAlSi, Magnetic nanocomposites, soft ferromagnets, highenergy ball milling

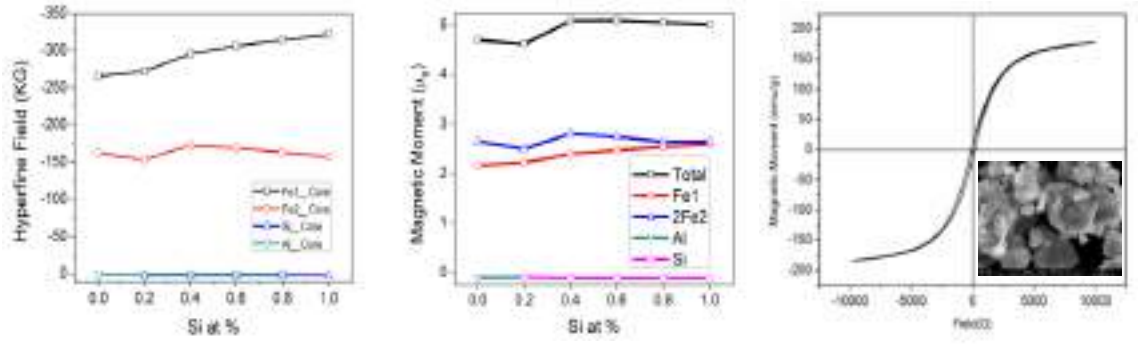


Fig. 1: Theoretically calculated hyperfine fields, theoretically calculated bulk magnetic moment $Fe_3Al_xSi_{(1-x)}$, M-H curve of $Fe_3Al_{0.8}Si_{0.2}$, SEM Image of $Fe_3Al_{0.8}Si_{0.2}$

References:

[1] I Guan, X Chen, L Zhang, J Wang, C Liang, Phys. Status Solidi A 213, No. 6, (2016), 1585-1591
[2] B.V. Neamţua, M. Nasuib, T.F. Marincaa, F. Popaa, I. Chicinaşa, surface and coating technology, 330, (2017), 219-227
[3] R. Rajeeth Kumar, A.K. Jeevanantham, Materials Science and Engineering: B, Volume 323, Part A (2026), 118760

Abstract ID: 56

ADVANCING THE FRONTIERS OF SPIN-ORBITRONICS THROUGH OXIDE INTERFACE

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Abstract: Advancements in spin-orbitronics have brought us closer to creating devices that process information with exceptional efficiency and ultra-low power consumption. Recently, developments in logic and memory devices leveraging the electron's spin, in addition to its charge, have shown promise in revolutionizing information storage and processing. A critical component for the success of these devices is the strong interaction between the electron's spin and its orbital moments, known as the Rashba effect. This interaction enables easy manipulation of spin currents and can significantly reduce energy consumption, facilitating voltage-driven magnetization switching for logic and memory applications, as proposed by Intel®. However, achieving a substantial Rashba effect at zero applied voltages has been a challenge in traditional semiconductor and metallic systems.

In this talk, I will present innovative strategies for engineering functional oxide interfaces to harness these emergent phenomena. Our approach focuses on orbital engineering of interfacial functional oxides to produce systems with large spin-orbit coupling (SOC). I will begin by discussing the electron gas theory and its application in inducing lattice and orbital polarization at $SrTiO_3$-based interfaces. Experimental data will illustrate how polarization can be controlled through atomic-level orbital hybridization, demonstrating a significant Rashba SOC effect at zero applied voltages. I will further discuss graphene/oxide hybrids that display room-temperature colossal magnetoresistance and proximity-induced magnetism when coupled with ferrimagnetic insulators.

Using pulsed-laser deposition, ferromagnetic resonance, X-ray magnetic circular dichroism and ab-initio modeling, these studies provide insight into spin-orbit-driven transport and interfacial magnetism. Collectively, the results outline design principles for next-generation spin-orbitronics and quantum devices.

Keywords: Spin-orbitronics, Multi-functional Oxide Interfaces, Orbital engineering, Thin film and heterostructures.

References:

[1] Nano Letters 20 4, 2493 (2020).
[2] Physical Review B 102, 125145 (2020).
[3] Physical Review Letters 129, 187203 (2022).
[4] Advanced Materials 36, 2305763 (2024).
[5] Advanced Material, 32, 2002201 (2020).
[6] Journal of Alloys and Compounds, 164830, (2022).
[7] Advanced Functional Materials, 35, 2414188 (2025).

Abstract ID: 57

VIOLATION OF THE STANDARD SLATER-PAULING RULE IN THE ANTI-HEUSLER ALLOY Al_2MnCu

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Abstract: Heusler alloys constitute an important class of intermetallic compounds with the general formulae X_2YZ (full Heusler), Y_2XZ (inverse Heusler), XYZ (half-Heusler), and XX′YZ (quaternary Heusler), where X and Y are transition metals, and Z is a p-block element[1]. The magnetic properties of Heusler alloys, consisting of four (or three) atoms per formula unit, are commonly described by the well-known Slater-Pauling (S-P) rule. According to this rule, the total magnetic moment (m_t) can be expressed as m_t = [VEC − 24 (18)] μ_B/f.u., where VEC denotes the total valence electron count[2]. Consequently, no four atomic (full-, inverse- or quaternary) Heusler alloys having VEC = 24 are theoretically expected, as well as experimentally reported, to have any magnetic ordering. Intriguingly, a newly discovered Heusler compound, Al_2MnCu, with an unconventional formula unit Z_2XY, coined as an anti-Heusler alloy, exhibits a clear violation of this rule. Despite having a valence electron count of 24 [(Al) 3 × 2 + 7 (Mn) + 11 (Cu)], Al_2MnCu exhibits not only a room temperature ferromagnetic ordering (T_C = 315 K) but also a large magnetic moment of 1.8 μ_B/f.u. This anomalous behaviour contradicts the standard Slater-Pauling framework and necessitates a revised description. Accordingly, a modified Slater-Pauling rule, m_t = (VEC-26) μ_B/f.u., has been formulated for anti-Heusler compounds, employing molecular hybridisation theory[3].

Keywords: Anti-Heusler alloy, Slater-Pauling Rule, VEC 24

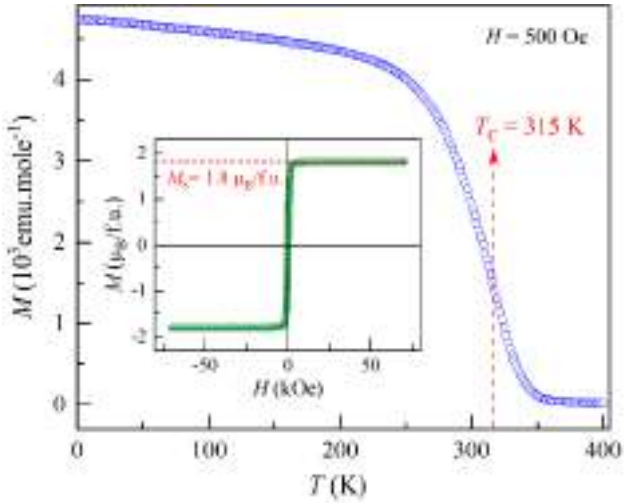


Fig. 1: M(T) curve depicts T_C ~315 K, and M(H) curve exhibis M_S ~1.8 μ_B/f.u.

References:

[1] Prog. Solid State Chem. 39, 1 (2011).

[2] J. Kübler, Theory of itinerant electron magnetism, Oxford University Press, 2000

[3] Phys. Rev. B 111, 174417 (2025).

Abstract ID: 58

STRUCTURAL, MAGNETIC, AND FERROELECTRIC STUDY ON LEAD-FREE (1-*x*)[(0.5)Ba($Zr_{0.2}Ti_{0.8}$)O_3-(0.5)($Ba_{0.7}Ca_{0.3}$)TiO_3]-xNZFO] CERAMICS

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Abstract: The (0.5)Ba(Zr0.2Ti0.8)O3-(0.5)(Ba0.7Ca0.3) TiO3 without lead Multiferroic composites doped with NZFO(BCZT-NZFO, x = 00, 0.15, and 0.20) were made using a solid-state technique. Phase dominance's impact on the undoped and (BCZ-BCT)-NZFO composites was thoroughly examined in terms of their microstructure, and dielectric, magnetic, and electric properties [1]. The XRD study validates the mixed structural evolution in composite samples without any detectable secondary phase production, the perovskite phase in BCZ-BCT, the cubic spinel phase in NZFO, and the doped samples. Scanning electron micrographs reveal a bigger matrix of undoped BZT-BCT, NZFO grains with smaller (BCZ-BCT) grains strewn throughout the composite. The room temperature demonstrates frequency-dependent dielectric characteristics for both pure BZT-BCT, NZFO and composites. The dielectric properties of composite samples with ferroelectric phase dominance are enhanced. Both pure BZT-BCT, NZFO, and composite samples exhibit long-range ferromagnetic ordering, as indicated by a distinctive ferromagnetic M-H hysteresis loop with temperature variations range and also M-T Graphs. The highest measured values in NZFO, Ms = 85.7416 emu/g and Mr = 19.65514 emu/g are found in the ferrite sample that is dominated by the ferrite phase and in composite sample BCZT-0.15NZFO and BCZT-0.20NZFO have Ms = 3.28326 emu/g and Mr = 0.34853 emu/g and Ms = 4.08768 emu/g and Mr = 0.39607 emu/g. It has been discovered that composites with ((1-x)BCZT-xNZFO, x = 0.15, and 0.20) ferroelectric phase dominance have a higher coercive field Hc= 220 Oe and 243 Oe value and are useful for opening up possibilities for multifunctional devices with novel features [2].

Keywords: Composite, ferroelectric, magnetism, and phase formation

References:

[1] Indrani Coondoo, Jo˜ao Vidal, Igor Bdikin, R. Surmenev, Andrei L. Kholkina, Magnetoelectric coupling studies in lead-free multiferroic ($Ba_{0.85}Ca_{0.15}$) ($Zr_{0.1}Ti_{0.9}$)O_3 ($Ni_{0.7}Zn_{0.3}$)Fe_2O_4 ceramic composites ceramics international 48 (2022)

[2] M. Singh, J. Singh, S. Kumar, An observation of multiferroism in (12x)BCZT–xNZFO-based 3-0 type composites Bull. Mater. Sci. 46 (2023)

Abstract ID: 59

INFLUENCE OF FILM THICKNESS AND SUBSTRATE TEMPERATURE ON STRUCTURAL AND MAGNETIZATION BEHAVIOUR OF Fe-Ga/Ta FILMS GROWN ON Si/SiO_2 SUBSTRATES

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Abstract: Thin films of FeGa alloys have potential applications in MEMS devices such as micro-sensors and micro-actuators [1]. Fe–Ga alloys outperform rare earth–iron alloys, offering excellent mechanical and magnetic behaviour [2]. Numerous studies were carried out on FeGa thin films with different deposition conditions. However, a systematic study to understand the effect of physical and structural features on magnetic behaviour of Ta buffered Fe-Ga films is still elusive. This study reports the influence of film thickness and substrate temperature on the magnetic and structural features of Ta-buffered Fe-Ga films grown on Si/SiO_2 substrates. Fe–Ga films were deposited at room temperature with thicknesses from 25–100 nm, and a 100 nm film was further studied at substrate temperatures of 100 °C, 300 °C, and 500 °C to examine thickness and temperature effects. Glazing incidence X-Ray Diffraction studies (GI- XRD) revealed A2 phase in all the films. Crystallite size and residual strain in films were estimated from GI-XRD patters using Williamson-Hall method. From X-Ray Reflectivity (XRR) analysis, structural features like film density, film roughness were estimated. X-Ray Reflectivity studies also revealed presence of oxide layer, whose features were matching to Fe_2O_3 layer. Magnetic behaviour of films was understood from Vibrating Sampling Magnetometry studies. Saturation magnetization was observed to increase with an increase in the density of the Fe-Ga layer. The observed reduction in saturation magnetization correlates with increase in oxide layer thickness. The coercivity of films is observed to be influenced by factors such as crystal size, film roughness, and residual strains within the films.

Keywords: Film density, Residual Strain, Saturation Magnetization, Coercivity

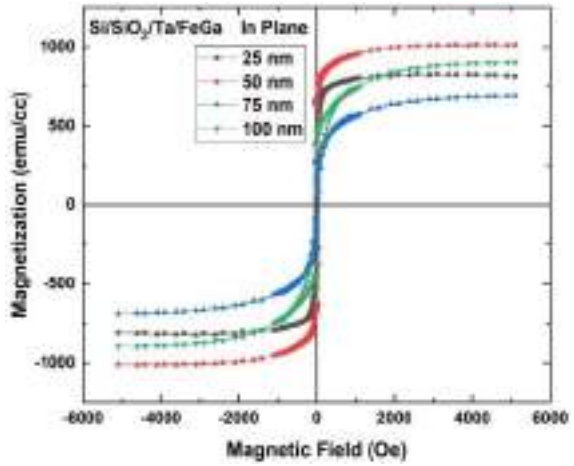


Fig. 1: In-Plane hysteresis loop of Si/SiO_2/Ta/FeGa films deposited with different thicknesses.

References:

[1] Y. Torii et al. /Journal of Magnetism and Magnetic Materials 290–291 (2005) 861–864.

[2] H. Basumatary et al. /Journal of Magnetism and Magnetic Materials 384 (2015) 58–63.

Abstract ID: 60

CONTROLLING THE NÉEL TEMPERATURE OF $YCrO_3$ EPITAXIAL THIN FILMS THROUGH STRAIN AND OXYGEN VACANCY ENGINEERING

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Abstract: Perovskite rare-earth orthochromites ($RCrO_3$) have emerged as a promising material for spintronic applications due to their strain-tunable magnetic ordering and ferroelectricity. Among these, $YCrO_3$ (YCO) is a prominent multiferroic material characterized by G-type canted antiferromagnetism and a bulk Néel temperature (T_N) of approximately 141 K [1]. In this study, we have investigated the modulation of T_N in YCO epitaxial thin films through substrate-induced lattice strain. Using pulsed laser deposition (PLD) at 750°C, YCO films were grown on $LaAlO_3$ (LAO) and $SrTiO_3$ (STO) substrates under varying oxygen partial pressures (50–200 mTorr). While LAO provides a minimal compressive strain (~0.1%), STO induces a significant tensile strain of -2.9%. In agreement with prior studies, our results indicate that tensile strain from STO enhances T_N relative to films grown on LAO substrate [2]. Furthermore, we demonstrate that oxygen vacancy concentration—controlled via deposition pressure—acts as a secondary tuning parameter, with higher oxygen pressures correlating to higher Néel temperatures T_N as shown in the inset of Fig.1(a & b) below. These findings offer a pathway for modulating the Néel temperature in YCO thin film, facilitating its practical use in future antiferromagnetic spintronic devices.

Keywords: Antiferromagnetic spintronics, Rare-earth orthochromites, Pulsed laser deposition (PLD), Ferroelectric material

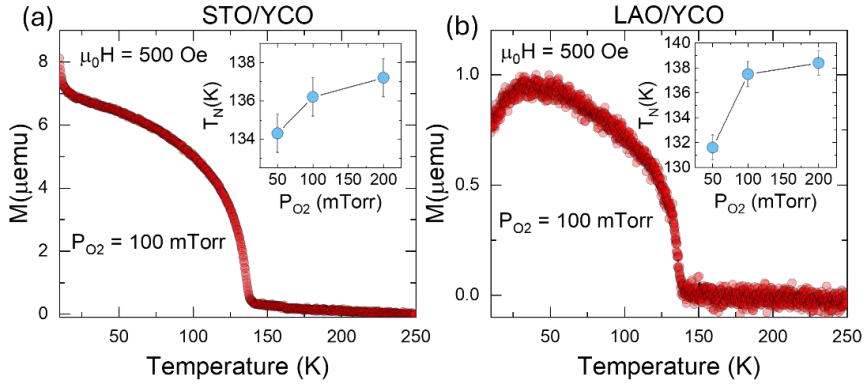


Fig. 1: Temperature-dependent field-cooled magnetization of YCO thin films deposited at 700°C under 100 mTorr O_2 partial pressure on (a) STO and (b) LAO substrates. The inset illustrates the relationship between Néel temperature (T_N) and oxygen partial pressure (P_{O2}) during deposition.

References:

[1] C. R. Serrao, A. K. Kundu, S. B. Krupanidhi, U. V. Waghmare, and C. N. R. Rao, Phys. Rev. B **72**, 220101(R) (2005).

[2] J. H. Lee, L. Marcano, R. Aeschlimann, M.-A. Mawass, C. Luo, A. Gloter, J. Varignon, F. Radu, S. Valencia, and M. Bibes, APL Mater. **10**, 081101 (2022).

Abstract ID: 61

MAGNETIC COUPLING AND HEAT GENERATION: STRUCTURAL AND AC INDUCTION CHARACTERISTICS OF Fe_3S_4/Fe_3O_4 NANOCOMPOSITES

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Abstract: Recent advances in nanotechnology have accelerated the development of magnetic nanocomposites owing to their large surface area, tunable composition, and remarkable magnetic characteristics. In particular, multiphase magnetic nanoparticles (MNPs) composed of two or more distinct phases exhibit properties that differ significantly from single-phase systems due to interfacial interactions. Key magnetic parameters such as saturation magnetization, coercivity, remanent magnetization, blocking temperature, and magnetic anisotropy are strongly influenced by exchange coupling between the constituent phases. These features make bimagnetic nanocomposites highly promising for magnetic hyperthermia applications, where controlled heat generation under an alternating magnetic field is essential for effective cancer therapy [1,2]. In this study, Fe_3S_4/Fe_3O_4 nanocomposites were synthesized via a solvothermal approach using Fe_3O_4 seed particles of two different sizes (~80 nm and ~8 nm) to investigate the effect of seed size on structural, magnetic, and induction heating properties. Structural analysis confirmed the successful formation of the biphasic composites with well-defined interfaces. Magnetic measurements performed revealed that composites derived from 80 nm Fe_3O_4 seeds exhibited stronger interfacial exchange coupling, leading to enhanced saturation magnetization and superior heating performance. Notably, the specific absorption rate (SAR) was significantly higher for the 80 nm seed-based composites compared to those prepared with 8 nm seeds. These results highlight the critical role of interface-mediated exchange coupling in optimizing magnetic behavior and heating efficiency. Overall, Fe_3S_4/Fe_3O_4 nanocomposites demonstrate excellent colloidal stability, favorable magnetic properties, and efficient heat generation, underscoring their potential as advanced materials for magnetic hyperthermia applications.

Keywords: Magnetic nano composites, Manganites, Greigite, Magnetic hyperthermia

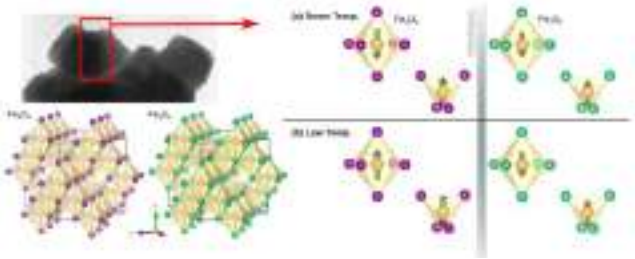


Fig. 1: Illustration of coupling in Fe_3S_4/Fe_3O_4 nanocomposite.

References:

[1] Helena Gavilán, Alvaro Gallo-Cordova et al, Magnetic hyperthermia in focus: emerging non-cancer applications of magnetic nanoparticles, *Nanoscale*,17, 27734-27761, 2025

[2] Jalili, H., Aslibeiki, B., Hajalilou, A., Musalu, O., Ferreira, L. P., & Cruz, M. M. (2022). Bimagnetic hard/soft and soft/hard ferrite nanocomposites: Structural, magnetic and hyperthermia properties. *Ceramics International*, *48*(4), 4886-4896, 2022.

Abstract ID: 63

OBSERVATION OF OUT-OF-PLANE SPIN-ORBIT TORQUE IN A POLYCRYSTALLINE Py/$IrMn_3$ HETEROSTRUCTURE

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Abstract: In the pursuit of low-power, high-density, non-volatile memory and logic technologies such as spin-orbit torque magnetic random-access memory (SOT-MRAM), the generation of out-of-plane spin polarization has emerged as a promising pathway for efficient magnetization control. Antiferromagnetic (AFM) materials have recently attracted significant attention as robust spin current sources due to their ultrafast dynamics, negligible stray fields, and intrinsic stability. Several AFM systems have been explored to produce out-of-plane spin polarization capable of enabling field-free magnetization switching in materials exhibiting perpendicular magnetic anisotropy (PMA). For practical technological implementation, however, it is essential to realize efficient spin current generation from polycrystalline sputtered films rather than relying on costly single-crystalline materials that are difficult to integrate into large-scale device fabrication. In this work, we report the observation of out-of-plane spin polarization in polycrystalline $IrMn_3$/Permalloy bilayer [1] grown by sputtering techniques. Our measurements demonstrate that the generated out-of-plane spin polarization is sufficiently strong to switch the magnetization of an adjacent ferromagnetic layer possessing PMA without the need for any external magnetic field. The demonstrated mechanism offers a technologically relevant strategy for manipulating magnetization in PMA systems, paving the way for next-generation spintronic memory and logic devices that combine ultrahigh density with low power consumption.

Keywords: Spin-orbit torque, Antiferromagnets, Out-of-plane spin polarization, Perpendicular magnetic anisotropy, Field-free magnetization switching,

References:

[1] Karim, M. R. *et al.* Observation of out-of-plane spin-orbit torque in a polycrystalline Py/$IrMn_3$ heterostructure. Phys. Rev. B 110 (2024) 245423.

Abstract ID: 64

EVOLUTION OF CLUSTER-GLASS LIKE MAGNETISM IN Mn SUBSTITUTED Fe_2VAl HEUSLER ALLOYS

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Abstract: The magnetic ground state of Mn-doped Fe_2VAl Heusler alloys remains controversial due to reports of competing ferromagnetic, superparamagnetic, and spin-glass-like behavior. In this work, we present a systematic investigation of the structural and magnetic properties of arc-melted $Fe_2V_{1-x}Mn_xAl$ alloys ($0 \leq x \leq 0.8$) to clarify the nature of magnetism induced by Mn substitution at the V site. X-ray diffraction confirms the formation of a single-phase cubic structure, with the $L2_1$ phase retained up to intermediate Mn concentrations and a gradual evolution toward B2-type disorder at higher Mn content [1]. The lattice parameter increases monotonically with Mn concentration, consistent with Vegard's law. Magnetization isotherms show a progressive enhancement of magnetic moment with Mn content, while all compositions remain paramagnetic at room temperature. Low-temperature measurements reveal the absence of long-range ferromagnetic order, despite the emergence of hysteresis and finite coercivity at higher Mn concentrations [2]. Zero-field-cooled and field-cooled magnetization curves exhibit clear bifurcation and a characteristic freezing temperature that depends on Mn concentration and applied magnetic field, indicating interacting magnetic clusters. AC susceptibility measurements further support a cluster-dominated magnetic state. Modified Langevin fit to low temperature magnetization data also shows presence of finite clusters in the system.These results suggest that Mn substitution enhances inter-cluster interactions, leading to a cluster-glass-like magnetic ground state rather than true long-range ferromagnetism in $Fe_2V_{1-x}Mn_xAl$ alloys.

Keywords: Heusler alloys, Fe_2Val, Structural disorder, Magnetic clusters, AC susceptibilty.

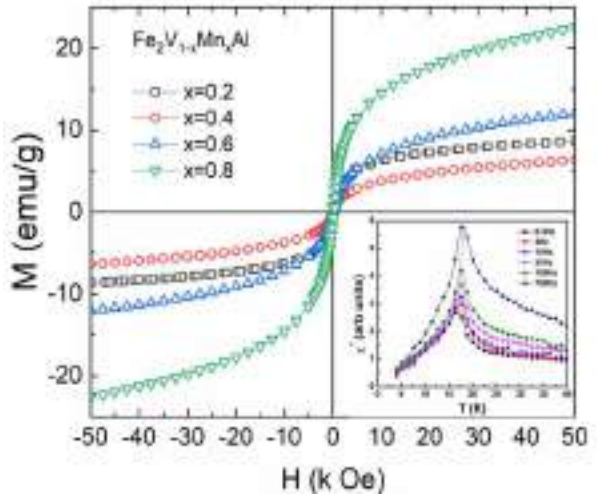


Fig. 1: Magnetic Isotherms at 5K. Inset : Imaginary part of a c susceptibilty vs T of $Fe_2V_{0.2}Mn_{0.8}Al$ at various frequencycies

References:

[1] M. Yin, P. Nash, and S. Chen, Intermetallics., vol. 57, pp. 34–40, 2015, doi: 10.1016/j.intermet.2014.10.001.

[2] Y. Jirásková, J. Buršík, D. Janičkovič, et al., Materials, vol. 12, no. 5, Mar. 2019, 10.3390/ma12050710

Abstract ID: 65

STRUCTURAL & ELECTROMAGNETIC CHARACTERIZATIONS OF MODIFIED $(Ni_{0.45}Zn_{0.55})_xCo_{1-x}Fe_2O_4$ AND ITS INCORPORATION IN A SPLIT RING RESONATOR FOR MICROWAVE ABSORPTION APPLICATIONS

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Abstract: This work reports the synthesis, structural–magnetic characterization, and electromagnetic performance of a hybrid microwave absorber that integrates split-ring resonators (SRRs) with a Ni–Zn–Co spinel ferrite substrate of composition $(Ni_{0.45}Zn_{0.55})_xCo_{1-x}Fe_2O_4 (x = 0.0–1.0)$. The processing involved oxide mixing, ball-milling, and calcination at 1000°C, pelletization with 3% PVA, and sintering at 1100°Cfor 4 h, followed by comprehensive XRD, FTIR, and magnetic measurements. Thermogravimetric and differential thermal analyses confirmed stable phase formation above 1000°C. X-ray diffraction showed single-phase spinel across all compositions; Rietveld-derived parameters indicate a slight increase in lattice parameter with Ni–Zn substitution and crystallite sizes of 107–162 nm. FTIR spectra exhibited the characteristic spinel bands near 573–589 cm^{-1} and 411 cm^{-1}, corroborating phase purity. Magnetically, room-temperature *M–H* Loops revealed soft magnetic behavior with a maximum saturation magnetization of Ms = 101.28 emu/g and a reduction in coercivity with increasing Ni–Zn content, attributes favorable for microwave loss without excessive hysteresis. The absorber architecture employs periodic SRR unit cells, modeled with Floquet excitation in HFSS; the SRRs furnish strong electric/magnetic resonances for impedance matching, while the ferrite contributes intrinsic magnetic loss via spin-domain wall relaxation, jointly enhancing the absorption bandwidth and depth. Microstrip simulations across 1–20 GHz demonstrate pronounced reflection suppression and high absorption, validating the hybrid design strategy. Overall, the synergy between the compositional tuning of $(Ni_{0.45}Zn_{0.55})_xCo_{1-x}Fe_2O_4$and SRR-based resonance engineering yields a thin, broadband, and efficient microwave absorber. The results highlight clear pathways to optimize impedance matching and magnetic loss for stealth, electromagnetic interference (EMI) mitigation, and related high-frequency applications.

Keywords: spinel ferrite; split-ring resonator; microwave absorber; solid-state synthesis; magnetic loss; XRD/FTIR; scattering parameters.

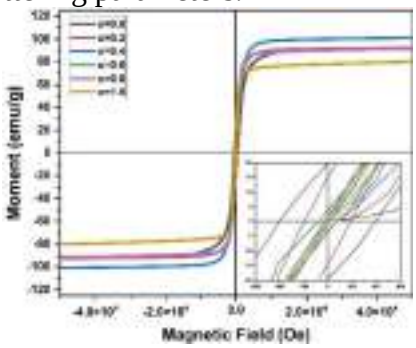


Fig. 1: The room temperature **M−H** curves (up to an applied magnetic field of ± 50 kOe) of the sintered $(Ni_{0.45}Zn_{0.55})_xCo_{1-x}Fe_2O_4$ ferrite samples.

References:

[1] Goldman, A. Modern Ferrite Technology. Springer, New York (2006).
[2] Pozar, D. M. Microwave Engineering (4th Edition). Wiley, New York (2011).

Abstract ID: 66

INTERFACE-INDUCED STRUCTURAL AND MAGNETIC PROPERTIES OF SNO_2/CR_2O_3 HETEROJUNCTION NANOCOMPOSITES

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Abstract: We report the effect of the interface on the structural and magnetic properties of SnO_2/Cr_2O_3 nanocomposites with varying Cr_2O_3 ratios (1:0.5, 1:1, 1:2), synthesized via the hydrothermal-calcination method. The influence of Cr_2O_3 on the magnetic and structural properties of the prepared SnO_2/Cr_2O_3 nanocomposites was systematically investigated using powder X-ray diffraction, Raman, UV-Visible optical absorption spectroscopy, and magnetic measurements. Powder X-ray diffraction studies confirmed a rutile tetragonal structure for SnO_2 and a rhombohedral phase for Cr_2O_3 in the prepared SnO_2/Cr_2O_3 nanocomposites. The estimated average crystallite size of the prepared nanocomposites was 7.5-8.6 nm, indicating a nanometric size. The lattice parameters and unit cell were found to be a = 4.72-4.75 Å, c = 3.17-3.25 Å, and V = 71.5-72.2 Å^3, indicating a significant increase due to Cr_2O_3 doping. Raman spectroscopy analysis revealed that the characteristic Raman modes corresponded to the rutile tetragonal and rhombohedral structures. The observed slight broadening and intensity variations in the Raman modes indicate strong interfacial interaction between SnO_2 and Cr_2O_3. The optical absorption spectra showed a bandgap of 4.7, 4.8, and 5 eV for Cr_2O_3 doping ratio of 1:0.5, 1:1, and 1:2, respectively. Magnetic investigations demonstrated room-temperature ferromagnetism in the prepared nanocomposites. Notably, the prepared nanocomposite with a 1:1 ratio of SnO_2/Cr_2O_3 showed a large saturation magnetization of 1.2×10^{-2} emu/g and a noticeable coercivity of 206 Oe. The present investigations suggested that the studied nanocomposites have potential applications in spintronics and magneto-optics devices.

Keywords: Interface effect, SnO_2/Cr_2O_3, Hydrothermal, Ferromagnetism, Doping.

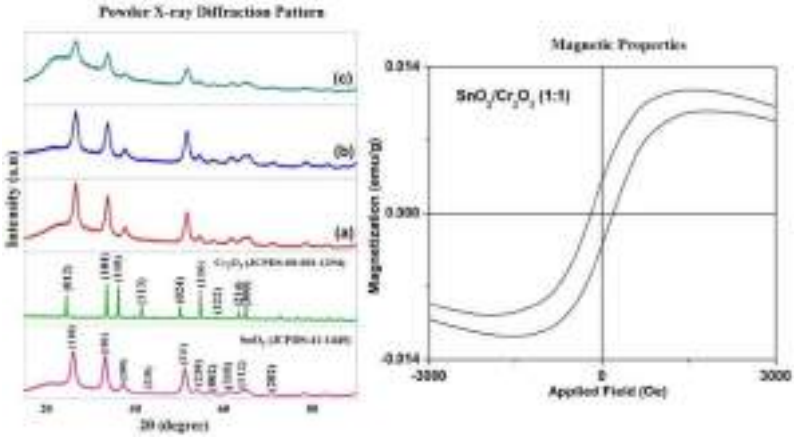


Fig. 1. PXRD pattern of SnO_2/Cr_2O_3 nanocomposites with varying Cr_2O_3 ratios (a) 1:0.5, (b) 1:1, (c) 1:2 Field-dependent magnetization of SnO_2/Cr_2O_3 (1:1) nanocomposite.

References:

[1] Y. Fan, F. Wang, G. Wen, F. Li, C. Zhang, et al, J. Appl. Phys. 114 (2013) 233903.
[2] A. M. Ismail, Fawzy G. El Desouky, Sci Rep 13 (2023) 4997.
[3] P.D. Borges, L.M. Scolfaro, H.W. Leite Alves, et al, Nanoscale Res Lett 6 (2011) 146.

Abstract ID: 67

NEW METHODS FOR CRITICAL ANALYSIS: REVEALING THE SIMULTANEOUS EXISTENCE OF UNIVERSALITY CLASSES IN NONTRIVIAL MAGNETIC SYSTEMS

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Abstract: In magnetic systems, the microscopic constituents exhibit power law behavior near the paramagnetic transition temperature, T_C. The critical exponents (CEs) associated with the physical quantities that demonstrate singular behavior at T_C illustrate the critical behavior, specifically the range and type of exchange interactions emerging in magnetic systems. Existing methodologies for analyzing critical behavior of magnetic systems provide limited and often incomplete explanations for the observation of CE values not belonging to any single universality class (UC), particularly in nontrivial magnetic systems with competing interactions. Additionally, field-dependent variations in CE values that do not belong to any single UC suggest a need to reevaluate both the technical approaches and theoretical frameworks related to critical phenomena. To solve these discrepancies, we present new methodologies for critical analysis aimed at determining both the range of exchange interaction(s) and appropriate values of CEs [1]. We analyze the magnetic behavior of trivial Ni and nontrivial Gd using computational and experimental investigations. Our findings demonstrate that (i) the critical behavior remains the same on either side of T_C, (ii) the critical behavior associated with local electron moments remains unaffected by the magnetic field, and (iii) in Gd, the critical role of competing interactions becomes evident: local electron moments follow a three-dimensional Ising-type short-range (SR) interaction, while itinerant electron moments exhibit a mean-field-type long-range (LR) Ruderman-Kittel-Kasuya-Yosida (RKKY) interaction. This LR interaction weakens under an external magnetic field due to the localization of itinerant electrons, leading to a field-dependent (FD) change in the CE values.

Keywords: Critical phenomena, New methods, Magnetic phase transitions, Field-dependent critical behavior

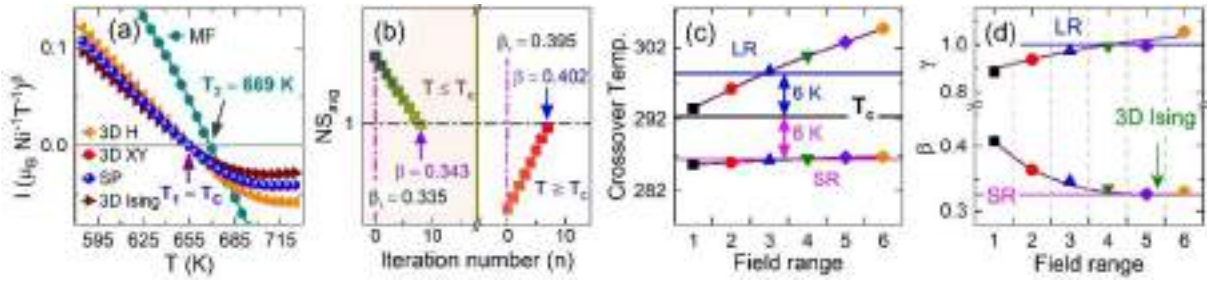


Fig. 1: New proposals of intercepts (a) and average of normalized slopes (b) analyses (linear fit to MAPs) for critical analysis. FD crossover temp. of intercepts (c) and obtained CE values (d).

References

[1] H. C. Chauhan, U. C. Roy, S. Dan, A. Thamizhavel, and P. Das, Phys. Rev. B 113 (2026), 024414.

[2] H. C. Chauhan, B. Kumar, A. Tiwari, J. K. Tiwari, and S. Ghosh, Phys. Rev. Lett. 128 (2022), 015703.

Abstract ID: 68

EFFECT OF THERMALLY DRIVEN CATION REDISTRIBUTION ON THE STRUCTURAL AND MAGNETIC CHARACTERISTICS OF COPPER SUBSTITUTE ZINC FERRITE

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Abstract: Magnetic-spinels are well-established systems because of their remarkable applications in microwave devices, isolators, circulators, super-capacitors, and phase-shifters. In this work, we choose Cu-doped $ZnFe_2O_4$ spinel oxides and study the effect of synthesis condition on the cationic redistribution and its impact on the structural and magnetic properties. Normal spinel $ZnFe_2O_4$ has an antiferromagnetic phase transition at very low temperature ~ 10 K. Cu-substitution in Zn-site enhanced the transition temperature towards room temperature. Moreover, Cu^{2+} exhibits a high migration rate with low activation energy ($E_a \leq$ 0.1 eV), so that it can swiftly migrate from tetrahedral and octahedral sites. As a result, cationic redistribution created in the spinel ferrites which tuned the structural and magnetic properties. In the present work, we prepared $Zn_{0.7}Cu_{0.3}Fe_2O_4$ (ZCFO) spinel ferrite and sintered at three different temperature. Variation of sintering temperature redistribute the cations as well as modify the particle size of the system. Low-field dc magnetic susceptibility measurements reveal an enhancement in susceptibility as the sintering temperature is reduced. In addition, ac-susceptibility data indicate that samples sintered at 1048 K (ZCFO-1048) and 1148 K (ZCFO-1148) display spin-glass behavior, with glass transition temperatures of approximately 49.2 K and 47.1 K, respectively, along with cluster-glass behavior at higher temperatures around 317 K and 330 K. These magnetic features are not observed in the sample sintered at 1248 K (ZCFO-1248). Moreover, the sample annealed at 1048 K shows a magnetocaloric effect, achieving a maximum isothermal entropy change of about 1.21 J kg^{-1} K^{-1} at μ_oH = 5T.

Keywords: ferrite, cationic redistribution, spin-glass, magnetocaloric.

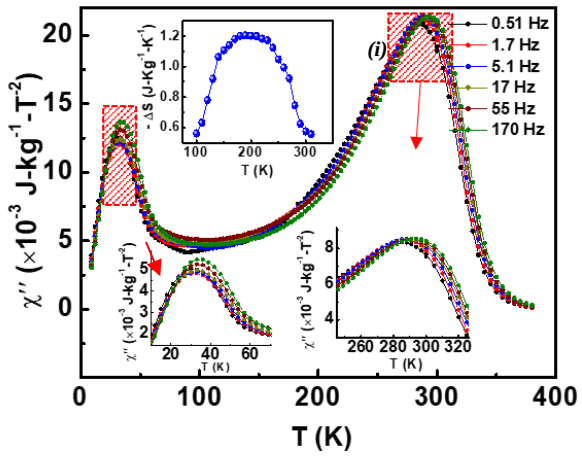


Fig. 1: χ'' vs T for ZCFO-1048 at different frequencies along with the magnified views. Inset *(i)* isothermal change in entropy (ΔS_M) as a function of temperature @ μ_oH = 5T.

Abstract ID: 69

HARNESSING HYDROGEN DECREPITATION FOR THE DIRECT RECYCLING OF SINTERED MAGNETS: MICROSTRUCTURE AND MAGNETIC PROPERTIES

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Abstract: The escalating demand for rare earth permanent magnets, particularly Nd-Fe-B, coupled with supply chain vulnerabilities and environmental concerns associated with primary mining, necessitates the development of sustainable recycling strategies. This study investigates the efficacy of the Hydrogen Decrepitation (HD) process for the direct recycling of end-of-life sintered Nd-Fe-B magnets. Waste sintered magnets were subjected to controlled hydrogen exposure at ambient temperature and pressure, resulting in their systematic disintegration into a coarse powder due to the anisotropic hydrogen absorption and volume expansion of the intergranular Nd-rich phase. The resultant dehydrogenated powder was subsequently re-sintered into fully dense magnets. Comprehensive microstructural characterization via scanning electron microscopy and energy-dispersive X-ray spectroscopy revealed a uniform grain structure with clean grain boundaries in the recycled magnets, comparable to virgin counterparts. Magnetic property measurements demonstrated that the recycled magnets retained over 90% of the intrinsic coercivity and remanence of the original material, with values reaching 1120 kA/m and 1.25 T, respectively. The HD process effectively liberates grains without significant oxidation or contamination, preserving the critical microstructure responsible for magnetic hardening. These findings confirm that hydrogen decrepitation offers a viable, energy-efficient, and scalable short-loop recycling route for sintered magnets, contributing directly to a circular economy for critical raw materials and reducing the carbon footprint of permanent magnet production.

Keywords: Hydrogen Decrepitation, Recycling, Sintered Nd-Fe-B Magnets, Rare Earth Elements, Circular Economy, Magnetic Properties

References:

[1] I.R. Harris, A. Williams, R.S. Mottram, J. Alloys Compd. 217 (1995) 6-12.
[2] O. Gutfleisch, K. Güth, T.G. Woodcock, L. Schultz, Adv. Mater. 23 (2011) 2662-2667.
[3] M. Zakotnik, I.R. Harris, A.J. Williams, J. Alloys Compd. 469 (2009) 10-16.
[4] K. Binnemans, P.T. Jones, B. Blanpain, T. Van Gerven, Y. Yang, A. Walton, M. Buchert, J. Clean. Prod. 51 (2013) 1-22.

Abstract ID: 70

VALORIZATION OF Fe_3O_4 WASTE FROM ILMENITE PROCESSING FOR MAGNETORHEOLOGICAL APPLICATIONS IN BLADELESS WIND ENERGY SYSTEMS

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Abstract: Industrial ilmenite processing for TiO_2 production generates Fe_3O_4-rich magnetic waste that remains underutilized despite its intrinsic ferromagnetic potential[1]. This work proposes a systematic framework for valorizing Fe_3O_4 waste into functional magnetorheological (MR) materials for adaptive damping applications in vortex-induced vibration (VIV)-based bladeless wind energy systems. The study is structured in three stages. First, the recovered magnetic fraction will be characterized using X-ray diffraction (XRD) for phase identification, scanning electron microscopy (SEM) for morphology analysis, and vibrating sample magnetometry (VSM) to determine key magnetic parameters including saturation magnetization (M_s), remanence (M_r), and coercivity (Hc). Second, purified and size-refined Fe_3O_4 particles will be surface-modified and dispersed in silicone oil to formulate MR suspensions with controlled particle volume fractions. Third, field-dependent rheological measurements will be conducted to evaluate magnetically induced yield stress and structural chain formation under applied magnetic flux density. A magneto-mechanical coupling model is proposed to relate magnetic properties to tunable damping performance in a bladeless wind turbine structure. The controllable damping capability of the MR system is expected to enable resonance regulation under varying wind conditions, thereby improving dynamic stability and energy harvesting efficiency. This proposed study establishes a circular economy pathway for converting magnetic industrial waste into high-value smart materials for sustainable renewable energy applications.

Keywords: Fe_3O_4 waste, magnetorheological materials, vortex-induced vibration, bladeless wind turbine, circular economy, adaptive damping, magnetic materials.

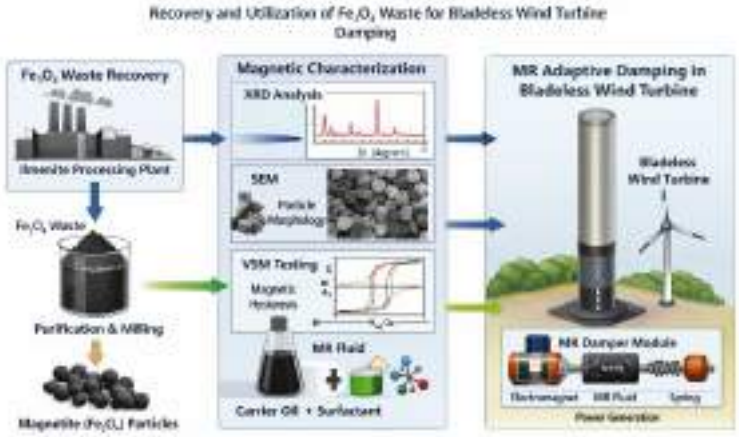


Fig. 1: Schematic representation of Fe_3O_4 waste recovery, magnetic characterization, and integration into an MR-based adaptive damping module for bladeless wind turbines.

References:

[1] M. S. Abdelgalil, K. El-Barawy, Y. Ge, L. Xia, Processes 11 (2023) 2570.

Abstract ID: 71

DESIGN AND DEVELOPMENT OF A FIRST ORDER REVERSAL CURVE MEASUREMENT ENABLED VARIABLE TEMPERATURE VIBRATING SAMPLE MAGNETOMETER

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Abstract: In this paper we present the design, construction and calibration of a sensitive vibrating sample magnetometer (VSM) and temperature variable setup with a capability to measure magnetization of magnetic materials from 100Kto 400 Kwith First Order Reversal Curve (FORC) measurement facility. It uses a bipolar power supply to energize an electromagnet capable of attaining±1 Tesla field, subwoofer speaker for vibrating the sample and the induced voltage in four coil setup is measured by a lock-in amplifier. All hardware is controlled by a customized LabView program. The cryostat is designed such that the temperature can be varied continuously from 100Kto 400Kusing liquid nitrogen up to room temperature and forced nitrogen gas/air for high temperatures study.We report here the VSM sensitivity of up to 10^{-2} emu/gm and can measure much weaker signals. The FORC protocol in this system is implemented via a dedicated virtual instrument in LabView capable of magnetic field reversal and termination at appropriate point to study domain nucleation field. The detailed analysis of the data is done using the open-source resources.We present the FORC measurement for $Co_{0.5}Zn_{0.5}Fe_2O_4$, a ferrimagnet. To establish the sensitivity of the instrument we present the results of magnetization measurement with temperature and phase transition study of $La_{0.4}Ca_{0.6}MnO_3$ and $La0_{.75}Sr_{0.25}MnO_3$.

Keywords: Vibrating sample magnetometer (VSM), First Order Reversal Curve (FORC), LabView program, Low temperature, Maganetization.

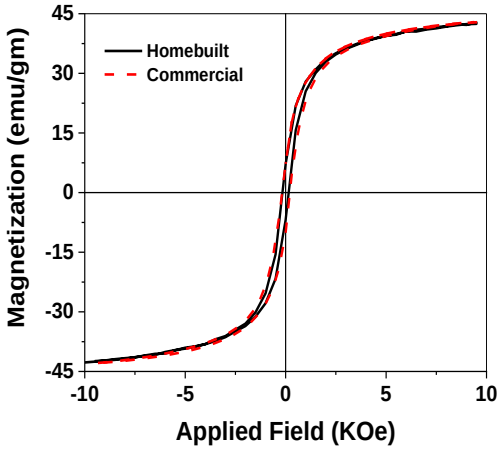


Fig. 1: Overlay of the M-H loop data for the sample $Co_{0.5}Zn_{0.5}Fe_2O_4$ taken from home built VSM shown in black and commercial instrument Microsense VSM VZ10, shown in red lines.

References:

[1] Pratheek, Hanamanta Badiger, Nutan Kumari Sah, et al., *Phys. Scr.* **99** (2024) 085932.

Abstract ID: 72

CALCINATION AND COMPOSITIONAL TUNING OF MULTIFUNCTIONAL PROPERTIES IN Gd-SUBSTITUTED $NiFe_2O_4$ NANOFERRITES

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Abstract: Gadolinium-substituted nickel ferrite nanoparticles, $NiFe_2{-}xGdxO_4$ (x = 0.00–0.25), were synthesized via a sol–gel auto-combustion method followed by calcination at 950°C and 1200°C to elucidate the influence of Gd substitution and thermal treatment on their structural, optical, magnetic, and dielectric properties. Rietveld-refined X-ray diffraction analysis confirmed the formation of a single-phase cubic spinel structure, with enhanced crystallinity, increased crystallite size (24.0862nm- 34.1566nm) and grain size (151nm-212.33nm) at higher calcination temperature due to thermally driven grain growth.Optical studies revealed composition-dependent band gap modulation influenced by lattice strain and dopant-induced electronic structure variations. NFGO-1200 samples exhibited higher band gap values up to x = 0.15, whereas NFGO-950 samples showed relatively higher values beyond this composition, reflecting the competing effects of structural ordering and defect formation.VSM studies revealed a reduction in saturation magnetization with increasing Gd content, attributed to magnetic dilution and disruption of Fe^{3+}–O–Fe^{3+} superexchange interactions. However, higher calcination temperature showed enhanced magnetization. Dielectric measurements conducted over 100 Hz–1 MHz and 100–600°C revealed a high dielectric constant (~10^5) with low dielectric loss, governed by Maxwell–Wagner interfacial polarization and hopping-mediated charge transport. Impedance analysis indicated non-Debye relaxation behavior consistent with the Cole–Cole model, while the high DC resistivity (~10^6 Ω·cm) confirms strong insulating characteristics. These findings demonstrate that controlled Gd substitution combined with optimized calcination temperature enables effective tuning of multifunctional ferrites for high-frequency and microwave device applications.

Keywords: Gd-doped nickel ferrite; sol–gel auto-combustion; spinel structure; superexchange interaction; dielectric properties; Maxwell–Wagner polarization; impedance spectroscopy.

Abstract ID: 73

INVESTIGATION ON HIGHLY SPIN-POLARIZED NEW SPIN GAP-LESS FERROMAGNETIC SEMICONDUCTORS FOR SPIN-ELECTRONICS

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Abstract: In recent time newly discovered class of materials with unique electronic band properties, namely, zero-spin-gap ferromagnetic semiconductors has gained enormous attention because of its remarkable transport properties which might be employed in spintronic devices. Theoretical investigation and experimental realization of several newly predicted spin-gapless semiconductor (SGS) compounds belonging to the family of ternary and quaternary Heusler alloys have been carried out in this work. Calculations of the spin-polarized band-structure in the optimized structures (negative formation-energies) reveals the SGS nature of the predicted compounds, Ti_2CoSi, CoTiVGa, CoTiVIn, FeVTiGe, FeVTiSn, FeCrZrGa [1]. Absence of spin-down electronic-states around the Fermi energy (E_F) for a wide range and for spin-up electronic states just touching of DOS at E_F confirms their SGS nature. Adherence of nearly integer saturation magnetization to the Slater–Pauling rule, together with the nearly temperature-independent resistivity or conductivity further confirms their SGS nature. Calculated mechanical properties and analyses of the elastic constants demonstrate mechanical stability according to the Born stability criteria. Further, the SGS nature of Ti_2CoSi thin-film grown on p-Si substrate have been confirmed through series of investigations, namely, (i) negative temperture coefficient of resistivity (TCR) value of the order -10^{-9} to -10^{-10} Ω m/K, (ii) low and nearly independent conductivity (~10^5 S/cm) (iii) quantum linear magnetoresistance in low temperature (iv) temperature-independent relatively low charge carrier concentrations (~10^{19} cm^{-3}). Furthermore, implementation of highly-spin-polarized SGS ferromagnetic tunnel contact for efficient spin-injection into p-Si semiconductor in the heterostructure SGS/SiO_2/p-Si employing both conventional 3-terminal and non-local Hanle-measurements have been demonstrated [2].

Keywords: Spin gapless semiconductor, Huesler alloy, ferromagnetic tunnel contact, non local Hanle meaurement, spin diffusion length

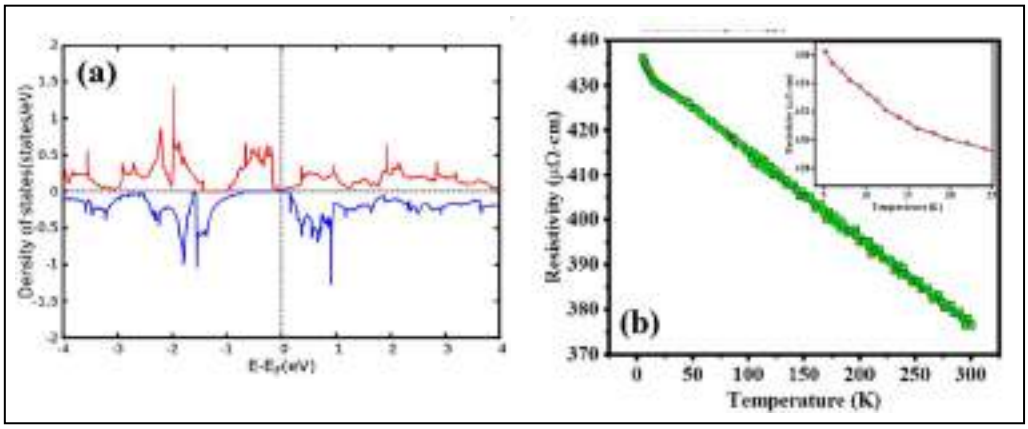


Fig. 1: (a) Calculated density of states (SGS nature) and (b) linear temperature dependent electrical resistivity with negative slope confirming SGS nature of Ti_2CoSi films.

References:

[1] Bishnu Chakraborty and T. K. Nath, Int. J. of Mod. Phys. B 450 (2026) 2650077.
[2] Nilay Maji, Bishnu Chakraborty and T. K. Nath, Appl. Phys. Lett. 122 (2023) 092404

Abstract ID: 74

UNRAVELING LOW TEMPERATURE RKKY-TYPE CLUSTER SPIN GLASS-LIKE BEHAVIOR AND ROOM TEMPERATURE LARGE MAGNETOCALORIC RESPONSE IN HEXAGONAL FULL HEUSLER-LIKE ALLOY $Mn_2(Ti_{0.2}Fe_{0.8})Sn$

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Abstract: The full Heusler alloy system Mn_2TiSn has been reported to exhibit peculiar structural as well as very complex magnetic feature. Low-temperature (~120 K) cluster spin glass (SG) like behavior is observed in high-quality polycrystalline metastable full Heusler-like alloy Fe doped $Mn_2(Ti_{0.2}Fe_{0.8})Sn$, which, at room temperature, exhibits an exceptional Mg_3Cd (or Ni_3Sn) type hexagonal structure (Space group $P6_3/mmc$, no. 194, Strukturbericht designation-$D0_{19}$) instead of a cubic structure like full Heusler alloy. Low-temperature cluster SG ordering is investigated through temperature-dependent AC susceptibility at five frequencies, with data fitted using the Vogel–Fulcher law model and critical slowing down model, yielding a Mydosh parameter of 0.0089. Additional evidence from field-cooled cooling memory effect, temperature-dependent coercivity, and isothermal temporal relaxation of remanent magnetization fitted via the Kohlrausch Williams Watt model further supports the presence of cluster SG behavior [1]. The nonzero Vogel–Fulcher temperature and absence of universal scaling in M versus H/T curves rule out noninteracting superparamagnetism, reinforcing SG characteristics. Using Tholence criteria, the SG is identified as Ruderman–Kittel–Kasuya–Yosida (RKKY) type, likely driven by geometric frustration or quenched disorder, as indicated by the frustration parameter, X-ray diffraction, and Raman studies. Furthermore, Room temperature large cooling power per unit volume, high working temperature span (~ 20 K), a significant refrigerant capacity (RC) of 285.51 mJ cm^{-3}, relative cooling power (RCP) of 295.70 mJ cm^{-3} and moderate magnetocaloric response across Curie temperature are also achieved in this alloy indicating its potency to exhibit substantial cooling power in a minimal volume [2].

Keywords: Full Huesler alloy, Spin glass, crtitical slowing down model, memory effect, magnetocaloric response

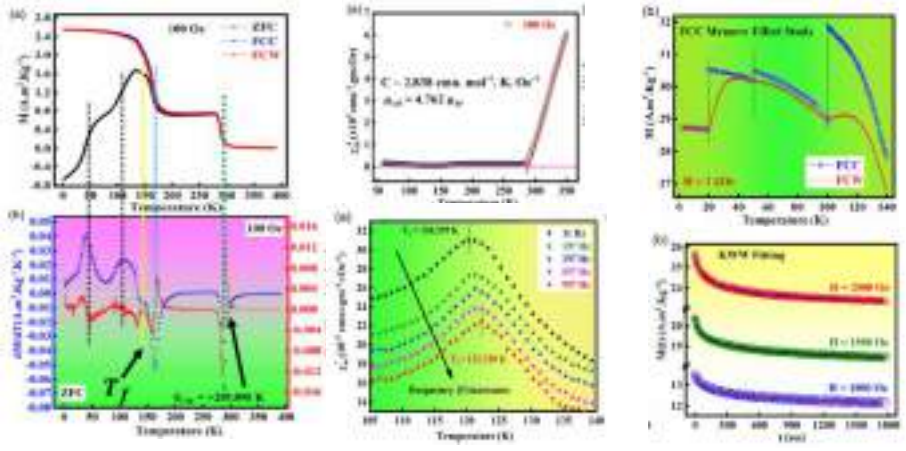


Fig. 1: (a) M-T behaviour (b) dM/dT vs. T plot (c) χ^{-1} vs. T plot (d) real part of ac susceptibility (χ'_{ac}) vs. T at different frequencies (e) memory effect (f) magnetic relaxation plots

References:

[1] S. Mandal, T. K. Nath, physica status solidi (RRL) – Rapid Research Letters, 20 (2026) e202500343.

[2] S. Mandal, T. K. Nath, Materials Today Physics, 58 (2025) 101864.

Abstract ID: 75

SEMICONDUCTING-TO-METALLIC CROSSOVER AND SPIN-GLASS BEHAVIOR IN $Fe_2(Mn,Cr)Al$ HEUSLER ALLOYS

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Abstract: Heusler alloys are promising platforms for investigating the interplay between electronic structure, magnetic exchange interactions, and charge transport. A comparative study of Fe_2MnAl and Fe_2CrAl is presented to elucidate how Mn/Cr substitution governs magnetic correlations and carrier scattering mechanisms [1-3]. Low-temperature DC magnetization measurements reveal spin-glass behavior, indicating competing ferromagnetic and antiferromagnetic interactions [2,4]. In the paramagnetic regime, susceptibility follows a modified Curie–Weiss law including a temperature-independent Pauli paramagnetic term [5-6]. The extracted θ_{CW} (−20 K for Fe_2MnAl and −2 K for Fe_2CrAl) suggest stronger antiferromagnetic correlations in the Mn-containing compound. Mean-field analysis yields Curie temperatures of 370 K and 342 K, confirming magnetic ordering above room temperature. Isothermal magnetization measurements demonstrate soft magnetic behavior with reduced saturation magnetization (11–15 emu/g), and the field dependence is well described by the Langevin function, indicating cluster-mediated magnetization processes. Electrical resistivity exhibits distinct conduction mechanisms where Fe_2MnAl shows semiconducting behavior analyzed using the Cote–Meisel framework incorporating Debye–Waller and Debye–magnon contributions, whereas Fe_2CrAl displays metallic transport consistent with Bloch–Grüneisen fitting and finite residual resistivity attributable to spin-disorder scattering. Both alloys exhibit negative magnetoresistance of 2–3% over 5–300 K following Kohler scaling. X-ray photoelectron and valence band spectroscopy further reveal modifications in near-Fermi electronic states. The results demonstrate how compositional tuning controls cooperative magnetic behavior and transport crossover in Fe_2-based Heusler alloys.

Keywords: Heusler alloys, Spin-glass behavior, Exchange interactions, Spin-disorder scattering, Magnetotransport

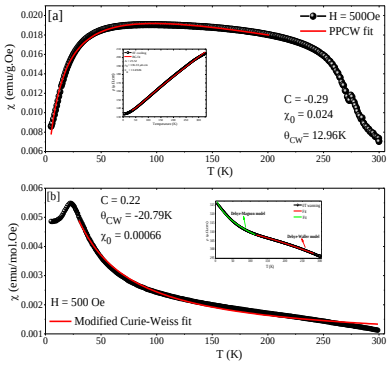


Fig. 1: DC susceptibility curve fitted with Curie-Weiss model and inset showing the resistivity behaviour of Fe_2MnAl [a] and Fe_2CrAl [b] with carrier scattering models

References:

[1] I. Das, E.V. Sampathkumaran and R. Vijayaraghavan, Phys. Rev. B. 44, 159 (1999).
[2] M. Acet, E. Duman, E.F. Wassermann, et al., J. Appl. Phys. 92, 3867 (2002).
[5] Saha, R., Srinivas, V., and Venimadhav, A. J. Magn. Magn. Mater. 324(7), 1296-1304 (2014).
[6] M. Belkhouane, S. Amari, A. Yakoubi, et al., J. Magn. Magn. Mater. 377, 211 (2015).

Abstract ID: 76

VISIBLE LIGHT-DRIVEN PHOTO-FENTON DEGRADATION OF TEXTILE DYES USING MAGNETIC $ZnFe_2O_4$ NANOPARTICLES

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Abstract: In the present research study, the synthesis of magnetic $ZnFe_2O_4$ (ZnFO) NPs carried out using glycine-assisted solution combustion synthesis method. Subsequent characterizations via comprehensive analytical techniques were performed to investigate the structural, optical, and photocatalytic properties of ZnFO NPs. XRD analysis revealed the crystallite size to be 13.89 nm. UV-vis spectroscopy revealed a band gap of 2.0 eV, while PL spectroscopy was performed to identify emission characteristics. BET analysis confirmed a mesoporous surface with 2.70 m^2/g surface area, 0.013 cm^3/g pore volume, and 3.61 nm average pore diameter. FE-SEM analysis revealed high degree of particle agglomeration, while EDX analysis confirmed the presence of Zn, Fe, and O atoms, further confirming the absence of impurity elements. Among many reaction pathways, Photo-Fenton process resulted in the maximum degradation of dyes. The photo-Fenton evaluation against methylene blue (MB), indigo carmine (IC), textile industry effluent (IE), and mix dyes revealed that ZnFO degraded 97.6% MB in 90 minutes, 100% IC in 40 minutes, while 47.60% of IE and 63.77% of mix dyes were degraded in 120 minutes. Operating parameters such as catalyst loading and pH of the dye solution critically influenced degradation. All degradation reactions followed first-order kinetics (R^2>0.95), and the NPs demonstrated good stability over five cycles by maintaining >90% degradation efficiency in the fifth cycle. Radical quenching experiments revealed that •OH radicals and electrons were primary reactive species responsible for the photo-Fenton degradation process.

Keywords: Photo-fenton, Zinc Ferrite, Methylene blue, Indigo carmine, Dye degradation, Textile dyes

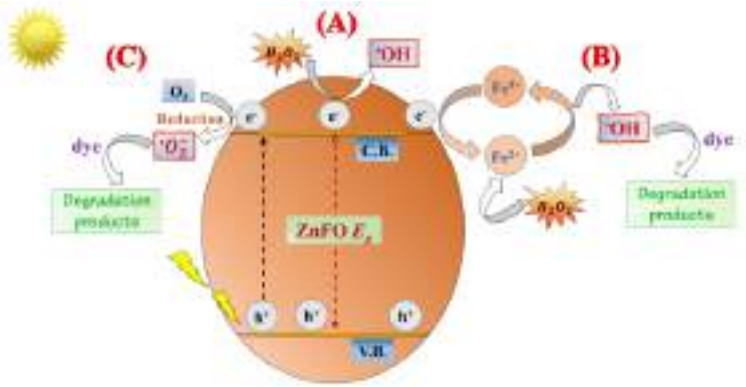


Fig. 1: Proposed photo-Fenton degradation mechanism over ZnFO NPs.

References:

[1] K.V. Kadam, S.S. Phalake, M.S. Lad, Emergent Mater. 7 (2024) 1489–1501.

Abstract ID: 77

EXCHANGE BIAS IN NONCOLLINEAR-AFM/FM HETEROSTRUCTURE

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Abstract: Exchange bias (EB) is an important interfacial magnetic phenomenon observed at antiferromagnet (AFM)/ferromagnet (FM) interfaces, manifested as a shift of the magnetic hysteresis loop when cooled below the AFM Néel temperature (T_N) in the presence or absence of an external magnetic field. Field-cooled and zero-field-cooled conditions give rise to conventional EB and spontaneous EB, respectively. Since its discovery in the Co/CoO system by William H. Meiklejohn and Charles P. Bean, EB has been central to spintronic technologies such as spin valves, magnetic sensors, and magnetic tunnel junctions [1]. While extensively studied in collinear AFMs, non-collinear AFM systems such as Mn_3Sn and Mn_3SnN remain relatively unexplored. At the interface of a non-collinear AFM and a ferromagnet like Permalloy (NiFe), the triangular Mn spin structure introduces complex exchange coupling, leading to richer interfacial spin textures [2, 3] than conventional collinear AFM/FM systems. Here, we report the growth of Mn_3SnN/NiFe bilayer thin films with three crystallographic orientations—(100), (110), and (111)—using magnetron sputtering. Magnetic measurements reveal clear exchange bias characterized by shifts along both the field and magnetization axes, along with asymmetric hysteresis loops. The magnitude of EB and loop shape vary significantly with growth orientation, indicating direction-dependent uncompensated spin configurations comprising pinned and rotatable [4, 5] components at the interface. These results demonstrate that crystallographic orientation effectively tunes interfacial exchange coupling in non-collinear AFM/FM heterostructures, making this system highly promising for orientation-engineered, low-power spintronic applications.

Keywords: Exchange bias, Thin film, Non-collinear antiferromagnet, Spintronics

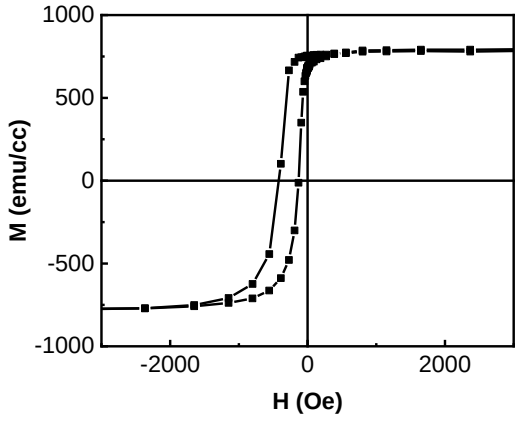


Fig. 1: M-H loop for Mn_3SnN[111]/NiFe at 25K after field cooled at 1T

References:

[1] W.H. Meiklejohn and C.P. Bean, Phys. Rev. 105, 904 (1957)
[2] Sarah Jenkins et al. Physical Review B102,140404(R) (2020)
[3] James M. Taylor et al., Physical Review Materials3,074409(2019)
[4] H Ohldag et al., Physical Review Letters Volume 91 Number 1 (2003)
[5] M. Gruyters, D. Schmitz, Physical Review Letters 100, 077205 (2008)

Abstract ID: 78

INVESTIGATION OF INDUSTRIAL STEEL SCRAP FOR POTENTIAL RECYCLING APPLICATIONS

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Abstract: The increase in the demand of sustainable materials and conservation of resources has increased the necessity in recycling the industrial metal wastes with efficacy [1]. In the present research, compositional and structural properties of TATA Steel industrial scrap were examined based on the reducing bulk scrap into micro and nano sized particles. This was aimed at identifying its possible reuse and value addition by means of advanced material characterization. The huge scrap materials were subjected to mechanical treatment to create fine particles in the micro and nano range after which they were subjected to detailed structural characterization. The findings indicate that the processed scrap nanoparticles has significant amount of Fe/FeO phases and incorporation of carbon with mean grain size of 20 nm. Morphological examination reveals that the particles are found as aggregates with sizes between 1 to 5 µm and nanometers, which means that there is a partial agglomeration in the course of processing. The iron oxide phases and carbon implies that it can be used in catalysis, magnetic materials and sustainable engineering systems [2]. The scrap material has potential to be used as an encouraging precursor of magnetorheological fluid preparation. These MR fluids can be used in tunable devices including shock absorbers, clutches, prosthetics and vibration control systems. The recycling of metals which basically entails the gathering, sorting, and reuse of scrap into useful materials is pivotal in the saving of natural resources and cutting on the use of energy and greenhouse gases. The present work shows that the recycling of industrial steel scrap is possible and that the recycled products can be efficiently developed materials with high compositional and functional importance, which help in the strategies of a circular economy and sustainable development of materials [3].

Keywords: Nanomaterial, Metal recycling; Industrial scrap Nanoparticles; Sustainable materials; Waste valorization

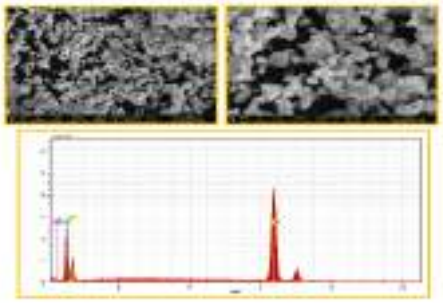


Fig. 1: SEM and EDAX analysis of TATA steel scrap afte mechanical mill process.

References:

[1] Das, Biki, S. Prakash, P. S. R. Reddy, et al., Resources, conservation and recycling 50, no. 1 (2007) 40-57.
[2] Kumar, S., Singh, H., Singh, H., Soni, H., Bechelany, M., & Singh, J., Sustainability, 17(5), (2025) 2100.
[3] Mwebembezi, T., Wakatuntu, J., Jjagwe, J., Kanyesigye, et al., Heliyon, 10(6), (2024) e28153.

Abstract ID: 79

HIGH ENTROPY CONTROL OF EXCHANGE BIAS EFFECT IN PEROVSKITES

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Abstract: Perovskite oxides are extensively studied due to their structural versatility, which allows precise tuning of physical properties. In particular, double perovskites provide a robust platform for exploring diverse magnetic and multifunctional phenomena, including ferromagnetism, magnetodielectric coupling, magnetocaloric effects, and exchange bias [1]. High-entropy materials are characterized by the incorporation of multiple principal elements in near-equiatomic ratios, leading to large configurational entropy and stabilized single-phase structures [2]. Recently, high-entropy oxides have attracted attention, where multicomponent cation disorder enhances configurational entropy and strongly modifies magnetic interactions. Thermodynamic entropy provides an effective route to tune magnetic properties in perovskite oxides. This work investigates double perovskites, including La2CoMnO6 (LCMO) and high-entropy compositions of the form (La, Sm, Nd, Tm, X)0.4CoMnO6 (X = Bi (LSNTB) , Dy (LSNTD)). Increasing A-site disorder enhances configurational entropy and modifies magnetic behavior. While LCMO exhibits conventional ferromagnetism without exchange bias, the high-entropy samples, LSNTB and LSNTD, show glassy magnetic features with clear exchange-bias effects. The results highlight entropy-driven disorder as a key factor in stabilizing exchange-biased states without artificial interfaces.

Keywords: High-entropy oxides, Double perovskites, Exchange bias, Configurational entropy, Magnetic anisotropy.

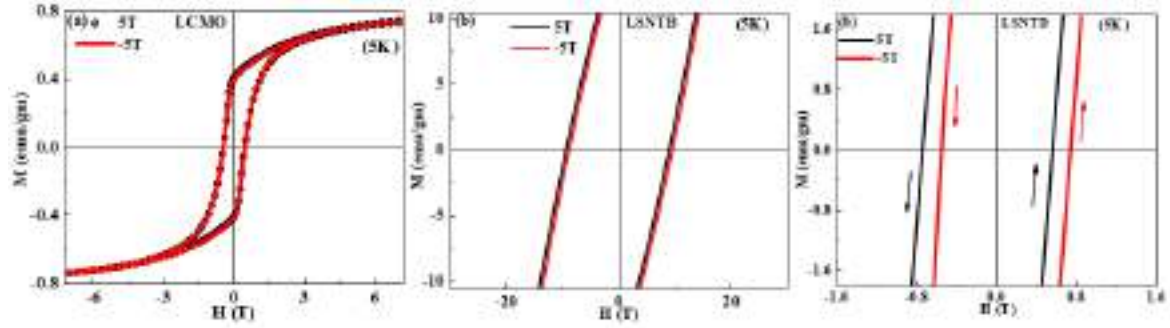


Fig. 1: Exchange–bias behavior at 5 K after cooling the sample under ±5 T

References:

[1] K. D. Chandrasekhar, A. K. Das, C. Mitra, and A. Venimadhav, Journal of Physics: Condensed Matter, vol. 24, no. 49, p. 495901, 2012.

[2] R. Witte, A. Sarkar, L. Velasco, R. Kruk, R. A. Brand, B. Eggert, K. Ollefs, E. Weschke, H. Wende, and H. Hahn, Journal of Applied Physics, vol. 127, no. 18, 2020.

Abstract ID: 80

β-PHASE ENHANCEMENT AND IMPROVED FERROELECTRIC–PIEZOELECTRIC PERFORMANCE OF PVDF VIA UNIAXIAL STRETCHING FOR VIBRATIONAL SENSORS

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Abstract: Nowadays, piezoelectric polymers play a vital role in flexible electronics, portable devices, and wearable technologies due to their excellent electromechanical properties.[1] Among them, polyvinylidene fluoride (PVDF) is widely recognized for its superior mechanical strength, chemical resistance, thermal stability, and significant pyroelectric and piezoelectric coefficients, making it suitable for sensing and energy-harvesting applications.[2] However, achieving high-performance PVDF-based vibrational sensors remains challenging because PVDF preferentially crystallizes in the non-ferroelectric α-phase rather than the electroactive β-phase[3] In this work, pristine PVDF films were fabricated using the solvent casting method, followed by uniaxial stretching at different stress levels (5, 10, 15, 18, and 20 N/mm^2) to enhance the β-phase content. The β-phase fraction increased from 73% to 78.3% at an optimal stretching stress of 15 N/mm^2. Thermal analysis confirmed improved crystallinity and β-phase formation after stretching. Ferroelectric properties were investigated through P–E hysteresis measurements at frequencies of 1 Hz, 10 Hz, and 100 Hz. The maximum polarization of 0.44 μC/cm^2 was obtained at an applied electric field of 109 kV/cm at 1 Hz. The polarization values decreased with increasing frequency, indicating frequency-dependent ferroelectric behavior. The piezoelectric response, evaluated using d_{33} measurements, showed enhanced piezoelectric coefficients with increasing β-phase content. The results demonstrate a strong correlation between mechanical stretching, β-phase enhancement, and improved ferroelectric and piezoelectric performance. The simple fabrication process and enhanced electromechanical properties make stretched PVDF films promising candidates for next-generation flexible, self-powered vibrational sensors.

Keywords: PVDF, β-phase, piezoelectric, Uniaxial stretching, vibrational sensors

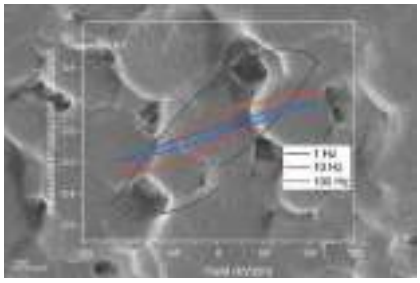


Fig. 1 SEM micrograph of spherulite β phase PE lopp of PVDF film

References:

[1] T. Prabhakaran, V.V. Singh, J. HemalathaPiezoelectric Polymers and Polymer Composites for Advanced Applications,(2025)243–275.

[2] P. Thandapani, R. Aepuru, F. Béron, M. Ramalinga Viswanathan, K. Varaprasad, F.L. Zabotto, J.A. Jiménez, J.C. Denardin, ACS Appl. Polym. Mater. 5 (2023) 5926–5936.

[3] T. Prabhakaran, J. Hemalatha, RCS advance 6(2016)86880–86888.

Abstract ID: 81

TAILORING SOFT FERROMAGNETIC PHASES VIA La SUBSTITUTION AND OPTIMISATION OF SINTERING TEMPERATURE IN M-TYPE BARIUM HEXAFERRITE

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Abstract: Hexagonal ferrites are of global interest for permanent magnet and high density data storage applications due to their intersting magnetic properties, saturation magentisation, coercivity and magnetocrysatlline anisotropy. High levels of Rare-earth doping to barium hexaferrite excites due to its variations in structural and other properties it offers. In the present study, high concentrations of La doped Barium hexaferrites, $Ba_{(1-x)}La_{(x)}Fe_{12}O_{19}$, (x=0.25, 0.30) were prepared using ball milling followed by solid state route. The effect of sintering temperture (1150˚C and 1300˚C) on phase formation, magnetic and multiferroic properties were systematically investigated. Rietveld refinement of X-ray diffraction data of prepared samples confirms that single phase magnetoplumbite structure is achieved only at higher sintering temperature (1300˚C), whereas the samples sinered at 1150˚C exhibit α-Fe_2O_3 as secondary phase along with major M-phase. The magnetic measurements reveal significant shift from hard magnetic phase (at1150˚C) to soft ferromagnetic phase at higher sintering temperature(1300˚C) attributed to grain growth. Consequently, samples sintered at 1150˚C display higher coercivity, but lower saturation magnetisation(M_s) due to secondary phase. Magnetic transition temperature increased with La doping indicating enhanced super-exchange interaction. Ferroelectric properties were suppressed for high sintered samples. High temperature sintering of high concentrations of La doped BHF(barium hexaferrite) yields a soft magnetic phase with significantly improved saturation magnetisation making it an ideal candidate for SMPS(Switched Mode Power Supply) applications. Conversely, lower sintering temperature is prefferable, when high coercivity and multiferroic properties were needed.

Keywords: Soft ferromagnet, Ball milling, M-type Barium hexaferrites, Super exchange interaction.

Abstract ID: 82

STRUCTURE & MAGNETIC PROPERTIES OF Cr/$SmCo_5$/Pt/$Co_{20}Fe_{60}B_{20}$ MULTILAYERS: EFFECTS OF Ne^+ ION IMPLANTATION & He^+ ION IRRADIATION

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Abstract: Magnetic and structural properties of Si-substrate/Cr/SmCo5/Pt/Co20Fe60B20 multilayer thin films have been investigated before and after low energy gaseous ion implantation & ion irradiation. SmCo5/CoFeB bilayer film shows exchange spring magnetic behavior. Interface quality plays an important role in the performance of this bilayer system. We have incorporated a very thin Pt layer in between SmCo5 & Co20Fe60B20 layers to reduce interdiffusion. Two multilayer samples have been irradiated with 45 keV He+ ions & 15 keV Ne+ ions respectively at a fluence of 3×1016 ions/cm2 to study the ion beam induced changes of structural and magnetic properties. The internal structure of the multilayer samples before and after irradiation has been very minutely characterized by the X-ray reflectivity (XRR) study. Theoretical simulation was carried out to extract the information of individual layer thickness, electron density, and surface & interface roughness of the multilayer samples and its modifications due to both ion implantation and ion irradiation. XRR analysis reveals that there are significant changes in the internal structure of both the samples after impinging ion beams. Monte Carlo simulation study corroborates the XRR results. VSM study of the pristine sample shows magnetic anisotropy with in-plane easy axis and out-of-plane hard axis. Azimuthal in-plane MOKE measurement of pristine sample shows two-fold uniaxial anisotropy. This uniaxial anisotropy reduces after He+ ion irradiation whereas four-fold anisotropy arises after Ne+ ion implantation. This change of the magnetic properties is due to the ion beam induced structural modifications of the multilayer samples.

Abstract ID: 83

OPTICAL CONTROL OF MAGNETIZATION IN FERROMAGNETIC/PMN-PT MULTIFERROIC HETEROSTRUCTURES

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Abstract: The discovery of optically driven magnetization control has revolutionized spintronics, introducing a groundbreaking scientific paradigm that harnesses light-induced strain to manipulate magnetic order. This contactless and energy-efficient approach utilizes photostriction lightinduced strain generated in ferroelectric materials through the combined effects of the bulk photovoltaic response and inverse piezoelectricity. The light-driven ferroelectric manipulation stands out as a promising yet underexplored avenue. Recently, $PbTiO_3$-based compounds, particularly PMN-PT ($Pb(Mg_{1/3}Nb_{2/3})O_3–PbTiO_3$), have gained attention due to their exceptional piezoelectric and electromechanical properties. PMN-PT exhibits photo-strictive behavior, making it a promising candidate for optically controlled domain engineering. Figure 1 shows photo induced strain in the PMN-PT lattice via X-ray diffraction. In FM/PMN-PT heterostructures, light illumination induces non-thermal strain in PMN-PT, which is mechanically transferred to the adjacent FM magneto strictive layer (e.g., Fe, Ni, or Co), resulting in modulation of magnetic anisotropy, domain configuration, or net magnetization. As research advances, FM/PMN-PT heterostructures are emerging as versatile platforms for optically tunable magnetoelectric devices, with significant potential in low-power spintronics, adaptive logic, and high-speed optomagnetic memory systems.

Keywords: Thin films, Photostriction, Visible light, magnetism, multiferroics, optomagnetic memories.

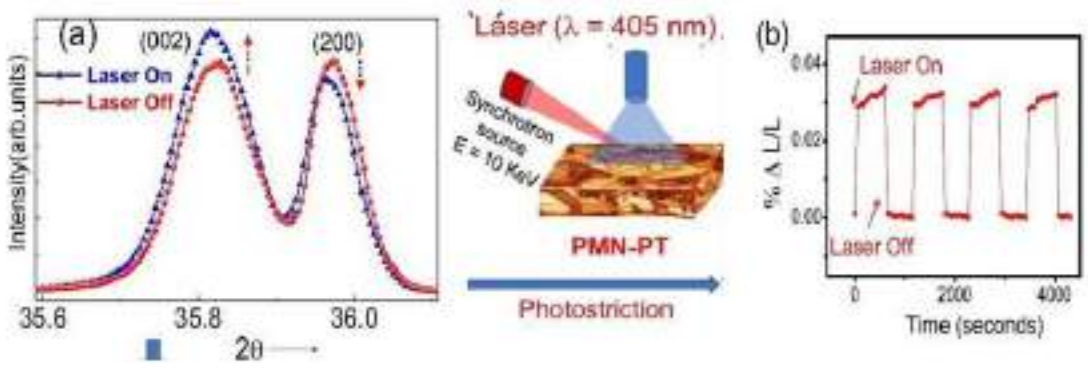


Fig. 1: (a) XRD patterns of PMN- PT (002) under laser illumination, (b) Time- dependent strain response (% ΔL/L) of PMN-PT (002) under laser ON/OFF cycle.

References:

[1] A. Ahlawat, S. Chowdhury, R.Roy, R. Raj, S. Ghosh, et al., "Photostriction-Driven, Light-Modulated Magnetization in Fe/PMN-PT Heterostructures" Advanced Functional Mater. e22373 (2026).

Abstract ID: 84

STRUCTURAL AND MAGNETIC PROPERTIES OF HYDROTHERMALLY PREPARED $Fe_{100-x}Co_x$ ALLOYS FOR SOFT MAGNETIC APPLICATION

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Abstract: In this work, we present the successful synthesis of $Fe_{100-x}Co_x$ (x=60, 50, & 40) by eliminating the requirement for high annealing temperatures and inert gas atmosphere, using simple hydrothermal process at relatively low temperatures. The observed X-Ray Diffraction (XRD) investigation shows changes in the lattice constants and also shifts in the peak positions with varying the Fe and Co concentrations. Changes in the structural and magnetic parameters were observed with the alteration of the Fe/Co ratios, and the Vibrating Sample Magnetometer (VSM) result showed a maximum saturation magnetization (M_s) of 236.05 emu/g. The thorough structural and magnetic investigation results have been discussed in this work. This low temperature hydrothermal method is believed to have potential applications in synthesizing other binary alloy nanoparticles, and the obtained magnetic results reveal excellent soft magnetic properties.

Keywords: Hydrothermal method; Alloy; X-Ray Diffraction; Vibrating Sample Magnetometer.

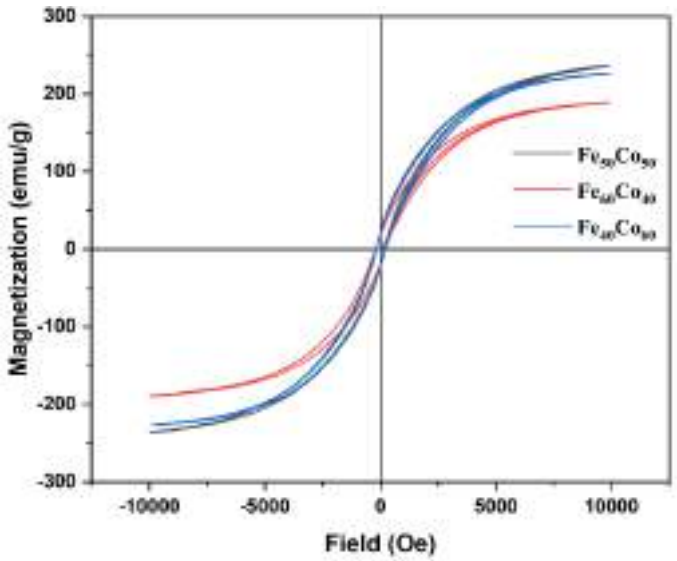


Fig. 1: Magnetization as a function of the applied magnetic field recorded at 300K of $Fe_{100-x}Co_x$ alloys.

References:

[1] Liu, Zhen, et al. "Hydrothermal synthesis of FeCo alloys with excellent microwave Absorption: Effect of reaction time." *Journal of Magnetism and Magnetic Materials* 568 (2023): 170365.

[2] Karipoth, Prakash, et al. "Magnetic properties of FeCo alloy nanoparticles synthesized through instant chemical reduction." *Journal of Applied Physics* 120.12 (2016).

Abstract ID: 85

INVESTIGATING THE STRUCTURAL, MAGNETIC, AND MICROWAVE ABSORPTION PROPERTIES OF $BaMe_2Fe_{16}O_{27}$ (Me=Co, Zn, And Ni)

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Abstract: The study investigates the structural and magnetic properties of W-type hexaferrites (WHF) with the general formula $BaMe_2Fe_{16}O_{27}$ (Me = Co, Zn, Ni). A sol–gel auto-combustion route was employed, followed by annealing at 1300 °C for 5 hours with a heating rate of 3 °C/min to obtain the final powders. These samples were characterised by XRD, FESEM, EDX, and VNA and their data was further analysed using Rietveld refinement, LAS and the Jiles–Atherton (J–A) model to interpret the structural and magnetic behaviour. The results show that Zn_2WHF has the largest lattice parameters and thus the largest unit cell volume among the compositions studied. The average grain size for all samples is in the range 1.5 to 11.4 μm. Compared to the other compositions, Co_2WHF exhibits the highest saturation magnetisation, with M_s = 91.59 emu/g. This enhanced magnetisation is attributed to stronger superexchange interactions and improved internal coupling between domain walls. Furthermore, Zn_2WHF with M_s = 76.99 emu/g, low coercivity (H_c) and a large grain size of 11.4 μm, show high potential as a microwave absorbent material [1].

Keywords: XRD, VSM, VNA.

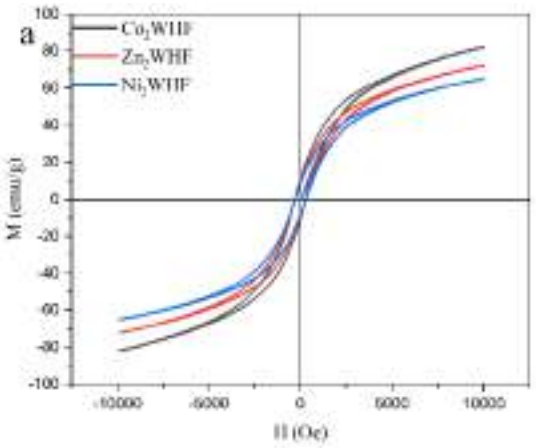


Fig. 1: M-H loop obtains from VSM.

References:

[1] G. Qi, Y. Liu, Y. Chen, Q. Liu, J. Chen, et al., J. Mater. Sci. Mater. Electron. 32(21) (2021) 25769–25781.

Abstract ID: 86

HIDDEN INVERSION ASYMMETRY IN SKYRMION-HOSTING CENTROSYMMETRIC HEXAGONAL MnPtGa

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Abstract: Recent decades witnessed vast attention to the chiral topological spin-textures such as skyrmions owing to their tremendous potentiality for spintronics. In noncentrosymmetric magnets, the asymmetric Dzyaloshinskii-Moriya interaction (DMI) has been claimed as a key ingredient in stabilizing the skyrmionic textures. However, the stabilization mechanism of spin-textures has remained debatable in centrosymmetric magnets where DMI vanishes. The local inversion symmetry breaking (LISB) in an otherwise average centrosymmetric magnet has recently been realized as a key factor in impacting the many emergent macroscopic properties [1,2], and even the stabilization of spin-textures by LISB-induced DMI in the centrosymmetric systems has also been recently proposed. The Ni_2In-type hexagonal compound MnPtGa has recently been identified as an interesting system that hosts very stable Neel-type spin-textures in a wide-temperature range. However, the concrete origin of spin-textures in such compounds remains debatable, and no attempt has been made to probe LISB experimentally. Here, we present the first experimental evidence of LISB and its consequence over topological spin-textures in the hexagonal MnPtGa compound by atomic pair distribution function study using high-Q synchrotron x-ray diffraction data. Our finding shows the presence of local noncentrosymmetric trigonal structure (P3m1) embedded in the global centrosymmetric hexagonal structure ($P6_3/mmc$) in this compound (Fig. 1) and suggests the local DMI is another key factor behind stabilization of toplological spin-textures in such centrosymmetric compounds. Our results offer a new platform for looking at the possibility of such spin-textures and various topological phenomena in the vast class of centrosymmetric magnets.

Keywords: Skyrmion, Dzyaloshinskii-Moriya Interactions, Local Symmetry Breaking, Atomic Pair Distribution Function

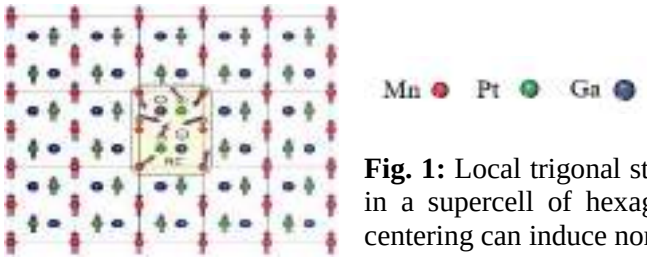


Fig. 1: Local trigonal structure (P3m1, light yellow region), embedded in a supercell of hexagonal structure ($P6_3/mmc$), where atomic off-centering can induce noncollinear (NC) spin structure.

References:

[1] Q. Zhang, Y. Zhang, M. Matsuda, V. O. Garlea, J. Yan, et al., J. Ame. Chem. Soc. 144, 14339 (2022).
[2] M. dos Santos Dias, N. Biniskos, F. Santos, K. Schmalzl, J. Perssonet et al., Nat. Commun. 14, 7321 (2023).

Abstract ID: 87

MULTIFUNCTIONAL $Ni_{0.5}Zn_{0.5}Fe_2O_4$ MAGNETIC NANOPARTICLES AND THEIR COMPOSITES FOR MAGNETICALLY RECOVERABLE PHOTOCATALYSIS AND OTHER APPLICATIONS

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Abstract: Magnetic spinel ferrites are promising multifunctional materials due to their tunable magnetic properties and field-assisted recoverability [1]. In this work, $Ni_{0.5}Zn_{0.5}Fe_2O_4$ nanoparticles (NZ-asp) were synthesized using a facile hydrothermal method and investigated as functional magnetic nanostructures for photocatalytic and hyperthermia applications. Structural characterization using X-ray diffraction confirmed the formation of single phases spinel ferrite with an average crystallite size of ~ 23 nm after being annealed at 750°C (NZ-750). They were further characterized using spectroscopic and microscopic techniques, with particular emphasis on vibrating sample magnetometry (VSM) to evaluate their magnetic behavior. The results for NZ–750 revealed soft ferrimagnetic characteristics suitable for efficient magnetic separation and reuse with M_s as 76.28 emu/g, M_r as 9.872 emu/g and H_c as 79.55 Oe. The photocatalytic activity was examined through the visible-light degradation of bisphenol-A ($C_{15}H_{16}O_2$), demonstrating effective pollutant removal. The intrinsic magnetic nature enabled rapid post-reaction recovery of the catalyst and sustained reusability over repeated cycles, highlighting its potential for sustainable wastewater treatment. To further enhance functional performance, reduced graphene oxide (rGO) was incorporated as a secondary modification, improving charge transport while retaining magnetic response [2]. Additionally, the nanoparticles seem to exhibit efficient heat generation under an alternating magnetic field, confirming their applicability in magnetic hyperthermia [3]. These findings position $Ni_{0.5}Zn_{0.5}Fe_2O_4$ as a versatile magnetic material bridging environmental remediation and magnetically driven applications.

Keywords: $NiZnFe_2O_4$, Photocatalysis, Bisphenol A, Magnetic recovery, Hyperthermia.

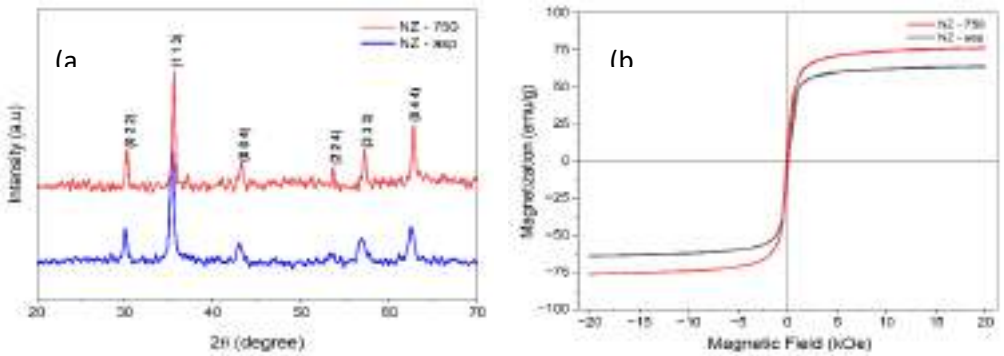


Fig. 1. (a) XRD patterns and (b) M-H hysteresis loops of NZ - asp and NZ - 750 nanoparticles

References:

[1] Kefeni, K. K., Mamba, B. B., & Msagati, T. A, Sep. Purif. Technol. 188 (2017) 399-422.

[2] Agarwal, B., Rani, M., & Shanker, U, Diam. Relat. Mater.153 (2025) 112115.

[3] Ghayour, H., Abdellahi, M., Ozada, N., Jabbrzare, S., & Khandan, A, J. Phys. Chem. Solids. 111 (2017) 464-472.

Abstract ID: 89

EXPLORING THE POTENTIAL OF STRONTIUM HEXAFERRITE NANOPARTICLES FOR ADVANCED ELECTROMAGNETIC SHIELDING AND MAGNETIC HYPERTHERMIA THERAPY

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Abstract: This study explores the multifunctionality of $Sr_2Co_2Fe_{12-x}Cu_xO_{22}$ nanoparticles, created using a chemical co-precipitation method. We successfully produced pure, nanoscale particles and investigated their dual potential for microwave absorption and magnetic hyperthermia cancer therapy. The structural and magnetic properties were investigated using different characterization methods, while the microwave and self-heating properties were determined using a vibrating sample magnetometer (VSM) and induction heating system[1,2]. Our magnetic measurements showed that adding copper makes the material magnetically softer, which is beneficial for its high-frequency performance. The sample with x =5% copper demonstrated exceptional properties. It achieved excellent microwave absorption in the X-band, with a strong reflection loss of -26.31 dB at 9.46 GHz, meaning it can block nearly 99.8% of incoming waves. Simultaneously, this same composition proved effective for hyperthermia, rapidly heating to a therapeutic temperature of 40.53°C, which meets clinical requirements for cancer treatment, displaying it as a promising candidate for advanced electromagnetic shielding and targeted cancer therapy.

Keywords: Strontium hexaferrite, hyperthermia, microwave, nanoparticle.

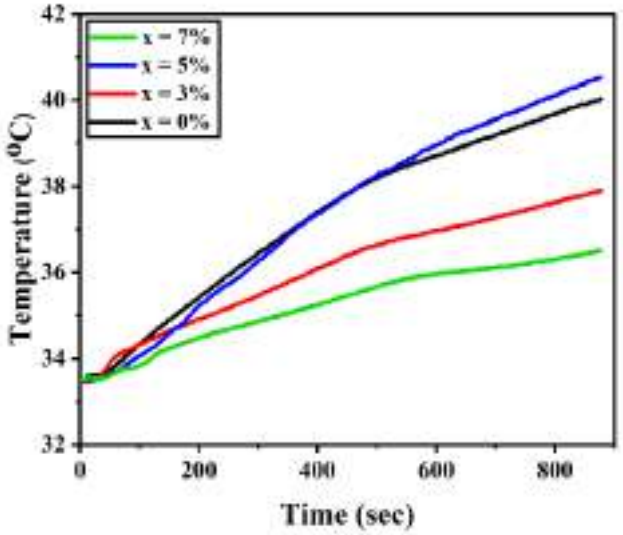


Fig. 1: Time-dependent temperature deviation graph of $Sr_2Co_2Fe_{12-x}Cu_xO_{22}$ (x=0%, 3%, 5%, 7%).

References:

[1] I. Mohammed, J. Mohammed, T.T. Carol T, A.K. Srivastava, Ceram. Int. 49 (2023) 16467–16476.
[2] M. Jamir, C. Borgohain, J.P. Borah, J. Magn. Magn. Mater. 580 (2023).

Abstract ID: 90

FIELD INDUCED SPIN DYNAMICS IN AN ANTIFERROMAGNET HoIrSi

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Abstract: A comprehensive study of structural and magnetic properties of a rare-earth based system; HoIrSi, is carried out using x-ray diffraction and magnetization measurements. The sample is synthesized using arc melting technique [1]. HoIrSi crstallizes in the *TiNiSi*-type (*Pnma*) crystal structure with a non-magnetic SiO_2 phase. Temperature dependent DC susceptibility reveal the presence of two successive antiferromagnetic transitions at 4.6 K (T_{N1}) and 4 K (T_{N2}). The positive value of Curie-Weiss constant suggests the dominance of ferromagnetic exchange interactions [2]. On application of 2 kOe field, a divergence between zero field cooled and field cooled curve is observed below T_{N2}. Magnetic isotherms shows a spin flop transition at 2 kOe and a metamagnetic transition at 5 kOe, accompanied by a hysteresis between these two fields. Above 5 kOe field, a forced ferromagnetic state is observed where magnetic moments try to align with the field direction. AC susceptibility and thermoremenant magnetization analysis confirm the dynamical behaviour of spins in 2-5 kOe. Our studies indicate a field-induced spin dynamics arising due to the competition between antiferromagnetic and ferromagnetic interactions.

Keywords: Spin dynamics, Rare - earth based systems, Metamagnetism, Competing interactions

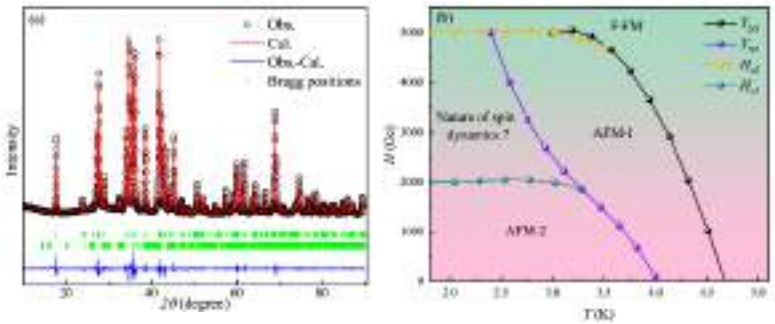


Fig. 1: (a) Reitveld refined XRD pattern at room temperature. (b) Temperature vs field phase diagram using magnetization data.

References:

[1] Szytuła, A., et al. *J. Alloys Compd.* **316**, 58-63 (2001).

[2] S. Mugiraneza, A M. Hallas. *Communications Physics* **5**, 95 (2022).

Abstract ID: 91

UNFOLDING THE ROLE OF INTERLAYER INTERACTIONS TO CHARGE DENSITY WAVE SIGNATURES IN FINITE SIZE 6R-TaS_2 LAYERED STRUCTURES

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Abstract: The 5*d* transition metal chalcogenides with layered structures are known to be promising van der Waals (vdW) materials displaying novel physical properties including charge density wave (CDW) and superconducting state (SCS) even in their pristine two-dimensional (2D) structures [1,2]. A. Archari et al.(2022) showed recently the dominance of the SCS and CDW in the 6R-TaS_2 phase from respective 1H- and 1T-layers of TaS_2 monolayers [2]. S. Wang et al.(2024) also recently have validated amalgamation of SCS and CDW characters due to weakening of Josephson junction with external critical pressure, P_c = 2.9 GPa [3]. So, we employ first-principles calculations based on Density Functional Theory (DFT) with on-site Hubbard *U* to investigate the role of electronic correlations and vdW interactions to explore pressure driven SCS and CDW in the present natural 2D-vdW solid 6R-TaS_2. The DFT+*U* calculations with *U* = 3.0 and 6.0 eV on Ta(5*d*) yields its lattice parameters, structural stability, Ferrimaganetic ground state with superior agreement to known experimental values. Also, …1H-1T-1H… interlayer coupling, highlighting the necessity of higher correlation *U* = 6.0 eV for this system to corroborate these electronic and magnetic states across the theoretical pressure, P_t = 3.9 GPa. Projected bands dispersion of Ta-5*d* orbitals primarily distinguishes two Ta atoms (Ta1 and Ta2) leaving the d_{z^2} state non-degenerate in the TaS_2 octahedrons (biprismatic) at the lowest energy with a single unpaired electron and leaves $d_{xy}/d_{x^2-y^2}$ and d_{yz}/d_{xz} pairs degenerate and empty. Electronic bands structure reveals distinct transitions and anisotropy in electronic states (**Figure 1**).

Keywords: 5*d*-Metal dichalcogenides; First-principles Calculations; DFT+*U*; Charge-density Wave; 6R-TaS_2

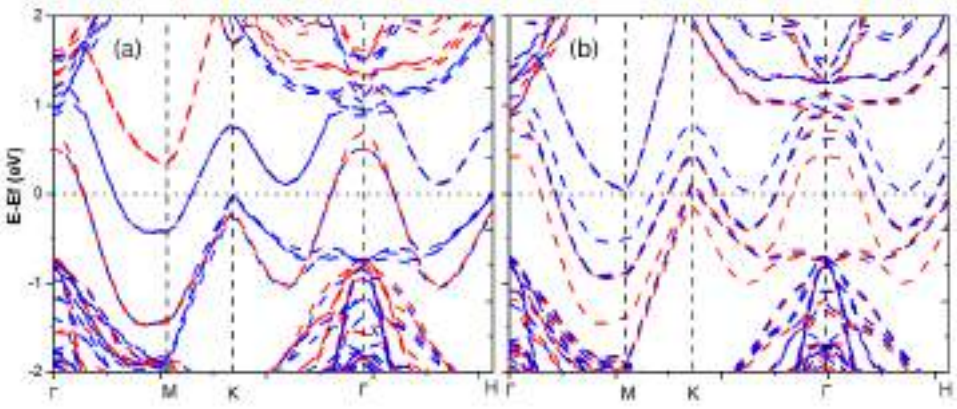


Fig. 1: Calculated electronic bands dispersion (red: up spin-channel; blue: down spin-channel) from DFT+*U* calculations with *U* = 6.0 eV at **(a)** 0.0 GPa and **(b)** 3.9 GPa.

References:

[1] K Rossnagel, J. Phys.: Condens. Matter 23 (2011) 213001.
[2] A. Achari et al., Nano Lett. 22 (2022), 6268-6275.
[3] S. Wang et al., Phys. Rev. Lett. 133 (2024), 056001.

Abstract ID: 92

FIRST EVIDENCE OF A MAGNETOELASTIC-BASED GIANT INTRINSIC TERAHERTZ PHASE SHIFT FOR 6G AND BEYOND COMMUNICATION

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Abstract: Terahertz (THz)–based communication is expected to become a practical technology [1, 2]. Central to these systems is efficient beam steering, enabled by phase shifters. However, most existing phase-shifting approaches are technologically complex and depend on expensive and elaborate infrastructure, limiting their scalability and widespread adoption. In this work, we report the first experimental evidence of a giant intrinsic THz phase shift arising from a fundamentally new THz phase-shifting mechanism. Using THz spectroscopy, we observe an unprecedented large phase shift of ~600° at ~0.9 THz in $Ba_3BiIr_2O_9$ across its magnetoelastic transition near 72 K, accompanied by a figure-of-merit four to five times higher than that of existing free-space phase modulators exceeding 90°. Theoretical analysis corroborates our observations, revealing that spin–phonon coupling plays a pivotal role in renormalizing the dielectric function. We further extend this concept to $Ba_3BiRu_2O_9$, which exhibits a giant phase shift of ~565.96° at 0.75 THz and a linear phase–frequency response from 0.10 to 0.75 THz across its magnetoelastic transition at ~165 K, nearly twice that of $Ba_3BiIr_2O_9$. Notably, these demonstrated materials enable rare magnetic-field control of THz phase shift. Finally, we propose a proof-of-concept MODEM (modulation–demodulation) architecture for THz communication, highlighting the transformative potential of this mechanism for next-generation THz photonics.

Keywords: Terahertz Spectroscopy, Magnetoelastic, Magnetoelectric, Phase shifter, 6G communication, Spin-phonon coupling

References:

[1] Wang, W., Tan, Y. J., Tan, T. C., Kumar, A., Pitchappa, P., Szriftgiser, P., Singh, R. *Nature*, *632*(8025), 522-527 (2024).

[2] Jiang, W., Zhou, Q., He, J., Habibi, M. A., Melnyk, S., El-Absi, M., Leung, V. C. *IEEE Communications Surveys & Tutorials*, *26*(4), 2326-2381 (2024).

Abstract ID: 93

GROUND STATE OF CLASSICAL HEISENBERG MODEL WITH DMI AND ANISOTROPY

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Abstract: Research interests in Heisenberg model systems in 2D are of renewed interest in understanding how reduced dimensionality, spin–orbit coupling, anisotropy, and Dzyaloshinskii–Moriya interaction (DMI) give rise to exotic ground states and non-collinear spin textures. These studies are of great interest for discovering novel magnetic phases and enabling future applications in spintronics and quantum materials.[1-3] We explore the ground state of the classical 1D Heisenberg model in the presence of DMI and crystal field anisotropy. Beginning with an overview of ordered and disordered magnetic states in materials in the context of Ising, XY, and Heisenberg models, the work focuses on one and two-dimensional Heisenberg models where spin–orbit coupling and anisotropic interactions play a crucial role. The study examines ground states under different limiting cases: only anisotropy, only DMI, and the combined effect of both interactions. By formulating and solving the governing equations, the numerical results are compared with experimental data, particularly in layered magnetic compounds such as $(C_7H_9NBr)_2CuCl_4$.[4] The findings highlight the significance of ground state analysis in understanding low-temperature magnetic phases and provide insights into non-collinear spin orders and lay the foundation for studying finite-temperature phase diagrams in these systems.

Keywords: Spintronics, DMI, Anisotropy, Layered magnetic compound.

References:

[1] Komatsu, H., Nonomura, Y., & Nishino, M. (2021)., Physical Review B, 103(21), 214404.
[2] Cui, Q., Wang, L., Zhu, Y., Liang, J., & Yang, H. (2023)., Frontiers of Physics, 18(1), 13602.
[3] Ga, Y., et al. (2022)., npj Computational Materials, 8(1), 1-7.
[4] P. Biswal et al. Manuscript under communications.

Abstract ID: 94

VARIATION OF THE MAGNETOIMPEDANCE RATIO WITH SURFACE MODIFICATION OF THE SUBSTRATE OF THE ELECTRODEPOSITED PERMALLOY

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Abstract: Magnetic sensors play a key role in the automobile industry, the medical field, and non-destructive testing. MI sensors are particularly important in applications where the detection of weak magnetic fields is essential. The change in the electrical impedance of a soft ferromagnetic alloy in the presence of a DC magnetic field is known as the magnetoimpedance (MI) effect [1]. The MI effect has been reported in melt-spun ribbons, electrodeposited microwires, and sputtered thin films. The synthesis of electrodeposited microwires is relatively simple, and they exhibit a large magnetoimpedance effect due to their circular magnetic permeability, compared to melt-spun ribbons and sputtered thin films. We have carried out MI studies on electrodeposited Permalloy ($Fe_{20}Ni_{80}$) coated onto 100 μm Cu wires. Permalloy is a soft magnetic material with high magnetic permeability, very low coercivity, low magnetostriction, and low magnetic anisotropy [2]. Before coating with Permalloy, the Cu wires were etched in nitric acid (HNO_3) and polished with emery paper to create surface roughness for better adhesion of the Permalloy film. The MI measurements were performed using an IM 3536 LCR meter with an AC of 10 mA over a frequency range from a few Hz to 8 MHz. A uniform DC magnetic field was applied using Helmholtz coils. Figure 1 shows the MI curves of the permalloy-coated Cu wires etched with a) HNO_3 and b) emery. The large MI ratio 519% at 100 kHz has seen in the Permalloy coated on Cu wire that was etched in HNO_3.

Keywords: Sensors, Coercivity, magnetostriction, permeability, electrodeposition

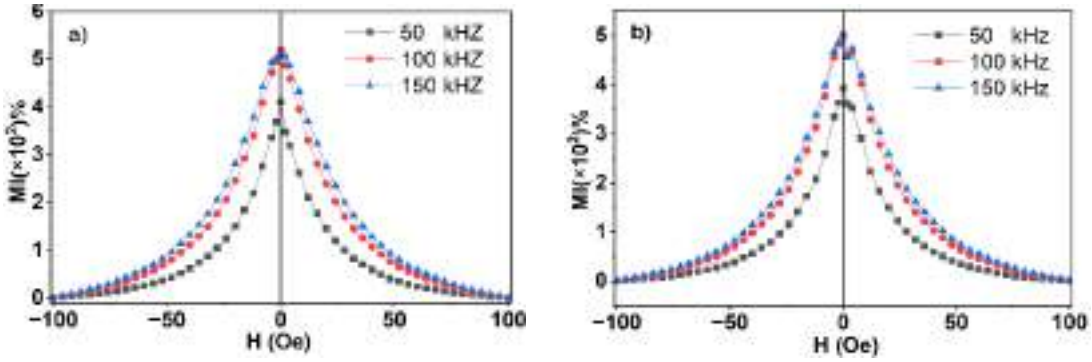


Fig. 1 MI curves of the permalloy-coated Cu wires etched with a) HNO_3 and b) emery.

References:

[1] L.V. Panina, K. Mohri, Appl. Phys. Lett. 65 (1994) 1189-1191

[2] S. Ostanin. J. B.Staunton, S. S. A. Razee, B. Ginatempo, Ezio Bruno, J. Magn. Magn. Mater. 295 (2005) 110-120.

Abstract ID: 95

STRAIN MEDIATED MAGNETOELECTRIC COUPLING IN Fe_3O_4 DOPED P(VDF-TrFe) NANOCOMPOSITES: ENHANCED MAGNETOELECTRIC COUPLING IN NANOCOMPOSITES PREPARED BY SOLUTION CASTING USING DOCTORS BLADE METHOD

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Abstract: Magnetoelectric (ME) nanocomposites comprising magnetostrictive and piezoelectric phases are promising for multifunctional device applications due to their ability to couple magnetic and electric properties in a single material platform [1]. In this work, we systematically investigated the effect of varying Fe_3O_4 nanoparticles volume fraction on the room-temperature ME response of P(VDF-TrFE) matrix[2]. Nanocomposite films were fabricated by incorporating Fe_3O_4 nanoparticles at multiple volume percentages (0.5%, 1%, 1.5%, 2% and 2.5%) into the P(VDF-TrFE) matrix using solution casting technique. SEM confirmed homogeneous nanoparticle dispersion at low loadings, whereas higher concentrations led to aggregation of nanoparticles within the matrix. XRD and FTIR analyses showed preservation of the electroactive β-phase, with subtle changes in crystallinity at elevated filler contents. Dielectric measurements show an enhancement in the relative permittivity from 5.5 for pure P(VDF-TrFE) to 11 for 2.5 % Fe_3O_4 doped P(VDF-TrFE) with increasing Fe_3O_4 content. Magnetic characterization demonstrated that saturation magnetization (Ms) scaled proportionally with increasing Fe_3O_4 content, confirming retention of nanoparticle magnetic functionality within the polymer scaffolds. Importantly, dynamic ME measurements displayed a non-linear dependence on nanoparticle loading, with a maximum ME voltage coefficient of ~180 mV/Oe.cm at 1.5 vol.% under a bias DC field of 2000Oe superimposed with an AC field of 1.05Oe at frequency 10 kHz, applied perpendicular to the plane of sample. Beyond 1.5%, aggregation reduced effective stress transfer, leading to a slight decline. These results highlight Fe_3O_4/P(VDF-TrFE) nanocomposites as promising candidates for smart materials, spintronic devices and energy harvesting applications.

Keywords: Magnetoelectric, magnetostrictive, ferroelectric, piezoelectric.

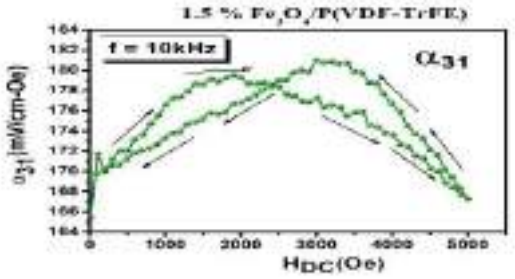


Fig. 1 ME coupling in 1.5 % Fe_3O_4 Doped P(VDF-TrFE)

References

[1] C. W. Nan, M. I. Bichurin, S. Dong, D. Viehland, and G. Srinivasan, *J Appl Phys*, vol. 103, no. 3, 2008,
[2] R. Belouadah, L. Seveyrat, D. Guyomar, B. Guiffard, and F. Belhoura, *Sens Actuators A Phys*, vol. 247, pp. 298–306, 2016.

Abstract ID: 96

STRUCTURAL, ELECTRICAL AND OPTICAL PROPERTIES OF COBALT DOPED STRONTIUM HYDROXYAPATITE

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Abstract: Strontium hydroxyapatite ($Sr_5(PO_4)_3OH$, SrAp) is a biocompatible material widely used in bone tissue engineering and bioelectronics due to its structural similarity to natural bone mineral and excellent chemical stability [1]. To investigate the emergence of magnetism and functional property modifications, cobalt was substituted into SrAp at 1, 3, 5, and 10 mol% concentrations. Structural refinement was performed using FullProf software. The hexagonal apatite structure remained intact with slight lattice parameter changes, confirming successful cobalt incorporation. Although for 3%, 5%, and 10% cobalt doping, strontium phosphate ($Sr_3(PO_4)_2$, SrP) secondary phase peaks consistently appeared at about 10-11%, indicating stable phase composition by performing double phase Rietveld analysis [2]. Dielectric measurements showed the 10% Co-doped SrAp had the highest dielectric constant ($\epsilon' = 32.61$ at 1 kHz), suggesting enhanced polarization and charge carrier densities [3]. UV-visible spectroscopy revealed cobalt-induced absorption peaks at 531 nm, 574 nm, and 635 nm corresponding to Co^{2+} electronic transitions, confirming the role of cobalt in tuning optical properties [3]. These findings demonstrate that cobalt doping in $Sr_5(PO_4)_3OH$ retains the primary crystal structure while significantly enhancing dielectric and optical functionalities, making Co-doped SrAp a promising candidate for multifunctional biomedical and photonic applications [2].

Keywords: Strontium hydroxyapatite, Cobalt substitution, Electrical conductivity, Optical band gap

References

[1] N.P. Balsara, L.J. Fetters, N. Hadjichristidis, D.J. Lohse, C.C. Han, W.W. Graessley and R. Krishnamoorti, Macromolecules 1999, 32, 6137-6147.
[2] H. Takahashi, T. Yashima, M. Kakihana, M. Yoshimura, Journal of Materials Chemistry 2002, 12, 2070–2077.
[3] J. Zhang, C. Liu, Y. Li, J. Sun, P. Wang, K. Di, Y. Fang, S. Liu, Langmuir 2009, 25, 13591–13598.

Abstract ID: 97

DATA DRIVEN PREDICTION OF SPIN-WAVE DYNAMICS IN PERMALLOY MAGNONIC BRAGG GRATINGS USING HIGHER ORDER DYNAMIC MODE DECOMPOSITION

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Abstract: We investigate the application of Higher-Order Dynamic Mode Decomposition (HODMD) [1] as a data-driven framework to reduce the computational burden for predicting backward volume spin wave (BVSW) dynamics in a Bragg grating formed by periodic surface grooves. Micromagnetic simulations were performed for a waveguide of cell size 2 x 2 x 1 nm and gridsize 4096 x 100 x 8 cells, with permalloy as the material. We used a saturation magnetization M_s=800 kA/m and exchange coefficient A_{ex}=13 pJ/m. Each groove in the magnonic Bragg grating [2] structure has grating depth d_{gr}=4 nm, width w_{gr}=10 nm and length l_{gr}=100 nm. Magnetization dynamics m_z (x, y, z=4 nm, t) are extracted from a 3 ns simulation run and the probe region spans 3402 x 100 cells and is 559 cells away from the leftmost edge. The HODMD model is trained on magnetization data for first 3 ns time window and subsequently used to predict dynamics during an extrapolated 15 ns interval. We have compared two dispersion curves, one obtained by FFT on m_z for the 3 ns, and the other obtained from HODMD model. Our results show that HODMD accurately captures the dominant BVSW modes and reliably predicts the emergence of magnonic bandgap corresponding to the groove depth while also displaying reduced numerical noise. The method significantly reduces the required simulation time. We believe HODMD assisted micromagnetic simulation will be an efficient and robust tool for predicting magnetization dynamics.

Keywords: HODMD, BVSW, Permalloy, Magnonic Bragg Grating

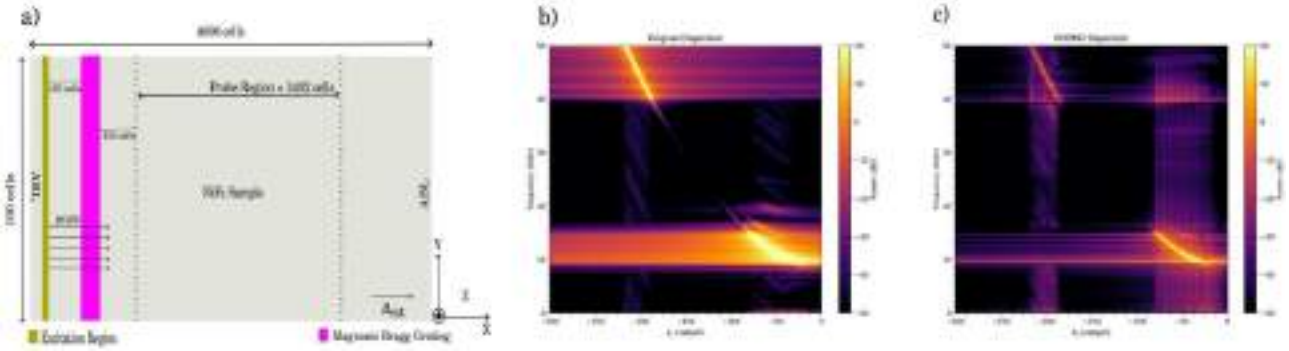


Fig. 1: a) Simulation geometry, b) Simulated ground truth for 0 to 3 ns, c) Dispersion curve obtained with HODMD for 0 to 15 ns.

References:

[1] S. L. Clainche, J. M. Vega, SIAM Journal on Applied Dynamical Systems 16 (2017) 882-925

[2] Morozova, M. Sadovnikov, Alexandr Matveev, O Sharaevskaya, Anna Sharaevskii, Yu Nikitov, Journal of Physics D: Applied Physics, (2020) 1361-6463.

Abstract ID: 98

TWO-DIMENSIONAL ELECTRON GAS AT $NIFE_2O_4/ALO_X/SRTIO_3$ HETEROINTERFACES: TOWARD SPIN-CHARGE CONVERSION THROUGH THE INVERSE RASHBA-EDELSTEIN EFFECT

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Abstract: The efficiency of the spin-charge conversion in a two-dimensional electron gas (2DEG) via the inverse Rashba-Edelstein effect (λ_{IEE}) is proportional to the Rashba spin-orbit coupling coefficient (α_R) and charge carrier mobility (μ_e) of the 2DEG. $SrTiO_3$ based 2DEGs with large α_R and moderate $\mu_e \approx 10^3$ $cm^2/V.s$ at low temperatures can be formed by depositing metals like Al on $SrTiO_3$ at room temperature by magnetron sputtering [1], which is a cost-effective way to create 2DEGs in $SrTiO_3$-based heterointerfaces without involving pulsed-laser deposition of epitaxial oxides like $LaAlO_3$ at high temperatures (≥ 600°C). Spin–charge conversion via ferromagnetic resonance spin-pumping was performed on $AlO_x/SrTiO_3$-based 2DEGs using the metallic ferromagnet NiFe as spin current source. A large value of $\lambda_{IEE} \approx 28$nm at 15K was obtained, [2] which is nearly two orders of magnitude larger than that of the $LaAlO_3/SrTiO_3$ based 2DEG. However, for intrinsic magnonic spin current generation, a magnetic insulator is desired. We identified the room temperature ferrimagnetic insulator $NiFe_2O_4$ as a potential spin current source for spin-charge conversion in $AlO_x/SrTiO_3$-based 2DEG as $NiFe_2O_4$ thin films possess low Gilbert damping constant α_{FM} ($\approx 10^{-4}$) compared to NiFe ($\alpha_{FM} \approx 10^{-3}$), indicating the possibility of achieving even higher λ_{IEE} in $NiFe_2O_4/AlO_x/SrTiO_3$ compared to $NiFe/AlO_x/SrTiO_3$. [3] Using reactive radio frequency sputtering, we demonstrate that $NiFe_2O_4$ thin film can be grown on top of $AlO_x/SrTiO_3$ at 150°C without compromising the mobility and charge carrier density of the 2DEG at the $AlO_x/SrTiO_3$ interface. Coexistence of Kondo-like screening and weak-antilocalization effect was also observed at low temperatures in $NiFe_2O_4/AlO_x/SrTiO_3$ heterostructure.

Keywords: 2D electron gas (2DEG), ferrimagnetic insulator, Kondo effect, spintronics.

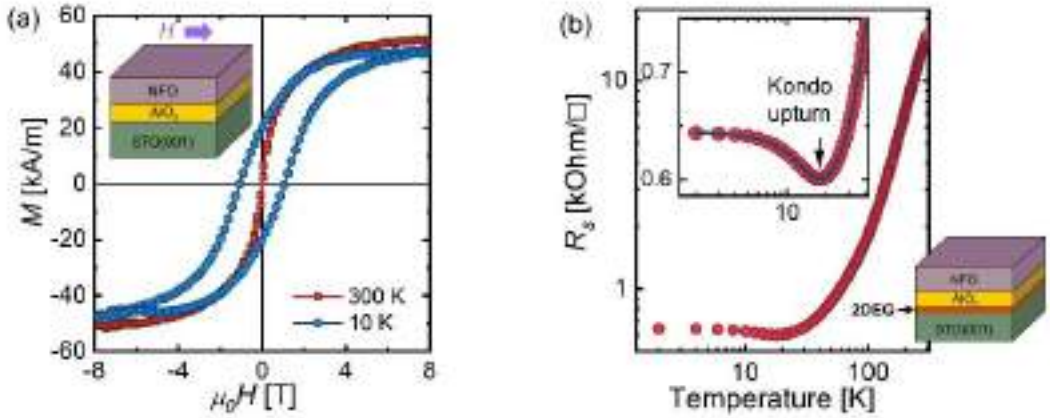


Fig. 1: (a) Magnetic field dependent magnetization (M) at 10 and 300 K, and (b) temperature dependent sheet resistance (R_s) of the $NiFe_2O_4/AlO_x/SrTiO_3$ heterostructure

References:

[1] L. M. Vicente-Arche et al., Metal/SrTiO 3 Phys. Rev. Mater. 5, 64005 (2021).

[2] D. C. Vaz et al., Mapping Nat. Mater. 18, 1187 (2019).

[3] A. V Singh, B. Khodadadi, J. B. Mohammadi, et al., Bulk Adv. Mater. 29, 1701222 (2017).

Abstract ID: 99

MAGNETIC AND MAGNETO-TRANSPORT STUDY OF EPITAXIAL HALF DOPED PSMO THIN FILM

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Abstract: In this work, we investigate the Magnetic and transport properties of $Pr_{0.5}Sr_{0.5}MnO_3$ epitaxial thin films with Thickness = 80 nm,160 nm and 200 mm were deposited on single crystal LAO (100) (3.72A) , STO (100) (a=3.905A), LSAT (100) (3.86 A), and LAO (110) (3.72 A) substrate by the pulsed laser deposition (PLD) technique. Thin film and Polycrystalline Pr0.5Sr0.5MnO3 revealed ferromagnetism below 200 K , followed by coexistence of the FM and AFM phases between 80 K and 160 K, and purely AFM phase below 80 K[1-2]. .XRD pattern indicates that with different thickness are, epitaxial growth and almost a single phase..The 80 nm film grown on LAO and STO show the insulating behaviour in the measured temperature range 50 K -300 K at zero field. Below 50 K , the resistivity value cross the limiting value of our measuring instrument. At the magnetic field of 9 T the measuring temperature reaches up to 5 k. The peak MR value is higher in case of PSMO/LAO (160 nm) in comparison to PSMO/STO, which reveals that epitaxial strain is the Key factor controlling the CMR.The magnetic hysteresis loop depends on the composition, size and imperfection of a material. Coercive fields (Hc) and remanent magnetisation (Mr) increase with increasing film thickness and also depend on strain. The Hc are 0.1026,0.1864 at 10 K, 5 K for 160 nm film and 0.0212 for 80 nm film on LAO and 0.1756 at 5 K for 160 nm film on STO.

Keywords: Magnetization, Epitaxial, Magneto-resistance, Transport properties,

References:

[1] P.H. Wagner, V.Metlushko, L.Trappeniers, PRB. 55 (1997) 6.
[2] AK Pramanik, A Banerjee, PRB.79 (2009) 21.

Abstract ID: 101

VOLTAGE-GATED SPIN-ORBIT TORQUE MAGNETIC TUNNEL JUNCTIONS AS A RESERVOIR FOR ENERGY-EFFICIENT TIME SERIES PREDICTION

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Abstract: The need for energy-efficient temporal data processing has accelerated the adoption of reservoir computing to reduce training complexity. Consequently, spintronic devices are prime candidates for physical reservoir computing (RC) possessing to their inherent nonlinearity and nanoscale dimensions. In this work, we presented a hardware efficient RC based on a voltage-gated spin-orbit torque (VGSOT) magnetic tunnel junction (MTJ) [1]. The VGSOT architecture uses the voltage-controlled magnetic anisotropy (VCMA) effect to dynamically balance the magnetic energy barrier [2]. This mechanism provides a tunable nonlinear dynamics important for high-dimensional feature mapping. Furthermore, we implemented the reservoir using a time-multiplexing technique, where a single VGSOT-MTJ functions as virtual nodes, significantly minimizing the hardware footprint. The system is evaluated on the chaotic Mackey-Glass time-series prediction, a standard benchmark for determining memory capacity and nonlinear processing capabilities [3]. Additionally, we have conducted a comprehensive performance analysis by varying the chaotic delay parameter (τ) to test the robustness. The reservoir demonstrates remarkable adaptability across different regimes of chaotic complexity, achieving a low normalized root mean square error (NRMSE) of 0.0231 at normal chaos $\tau = 17$ and maintaining stability up to 0.0356 at complex chaos $\tau = 50$. The system achieves an average NRMSE of 0.0294 for $\tau = 17$ to 50, validating the VGSOT-MTJ as a robust, low-power solution for real-time temporal signal processing at the edge.

Keywords: VGSOT, reservoir computing, time series prediction, neuromorphic computing

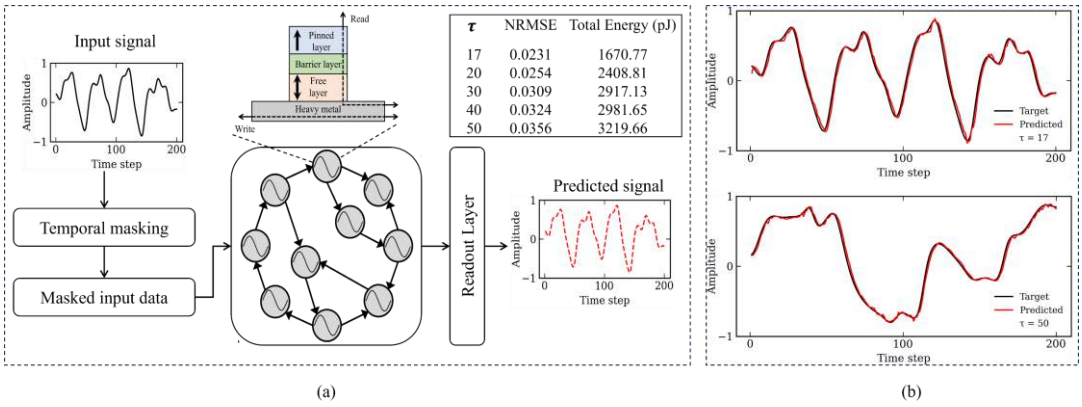


Fig. 1: (a) VGSOT-based physical reservoir computing for chaotic time-series prediction. A single VGSOT-MTJ processes temporally masked inputs through time-multiplexing to emulate a high-dimensional virtual neurons. Non-linear resistance states feed into a linear readout for prediction, which shown in tabular form for different τ with NRMSE and total energy. (b) Target and predicted Mackey-Glass waveforms for standard ($\tau = 17$) and highly chaotic ($\tau = 50$) delay parameters.

References:

[1] Y. C. Wu, J. Phys. Rev. Appl. 15 (2021) 064015.
[2] S. Li, Y. Jiang, J. AIP Advances 13 (2023) 025030.
[3] M. C. Mackey, L. Glass, J. Science 197 (1977) 287-289.

Abstract ID: 102

GIANT MAGNETO-THERMAL RESISTANCE EFFECT IN A $Co_{50}Fe_{50}$/Cu MULTILAYER STUDIED VIA ANALYSIS OF ELECTRON AND LATTICE THERMAL CONDUCTIVITIES

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Abstract: Thermal switches have recently attracted the considerable attention due to their potential in promoting the thermal management of electronic devices. The giant magneto-thermal resistance (GMTR) effect is a phenomenon in which the thermal conductivity (κ) changes with the magnetization configuration in alternating stacks of ferromagnetic and nonmagnetic materials. The GMTR effect offers distinct advantages including noncontact, high durability, and high scalablilty. Recently, Nakayama et al. observed significant GMTR in the epitaxial $Co_{50}Fe_{50}$/Cu multilayers which exceeds a magnetoresistance effect [1]. However, the underlying mechanism remains to be uncovered. In this study, we investigate GMTR effect in a $Co_{50}Fe_{50}$/Cu multilayer through a combination of experiments and numerical simulations. The huge change of the cross-plane thermal conductivity between paralallel (P) and antiparallel (AP) cofiguration $\Delta\kappa$ ($=\kappa_P - \kappa_{AP}$) of 37 W m^{-1}K^{-1} was observed in the present system, which is 1.5 times larger than the previous value for a magnetic multilayer. The spin-depenent electron thermal conductivity (κ_{ele}) was analyzed by the two-current model [2] combined with the Wiedemann-Franz law. The result shows the κ_{ele} accounts for only 35% of the $\Delta\kappa$, suggesting the presence of additional spin-dependent heat carriers. Furthermore, the investigation of the lattice thermal conductivity (κ_{lat}) using non-equilibrium molecular dynamics simulations suggests the additional spin-dependent heat carrier contribution is significantly large in the P configuration ($\kappa_{ele} + \kappa_{lat} < \kappa_P$) but nearly negligible in the AP configuration ($\kappa_{ele} + \kappa_{lat} \sim \kappa_{AP}$) [3]. These findings facilitate the elucidation of the mechanism of huge GMTR and underscore its potential of the thermal switching technologies for future electronic devices.

Keywords: Thermal management, Spintronics, Spin caloritronics, Magnetic multilayer

References:

[1] H. Nakayama et al., Appl. Phys. Lett. **118**, 042409 (2021).
[2] T. Valet and A. Fert, Phys. Rev. B **48**, 7099 (1993).
[3] F. Makino et al., Phys. Rev. B **112**, 054407 (2025).

Abstract ID: 103

THERMAL EVOLUTION OF MAGNETIZATION AND MAGNETOELECTRIC COUPLING IN SOL-GEL SYNTHESIZED LITHIUM FERRITE

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Abstract: This study investigates the structural, electrical, magnetic, and magnetoelectric (ME) properties of lithium ferrite synthesized via a sol-gel auto combustion method. Rietveld-refined X-ray diffraction confirmed the material's structural integrity. Temperature-dependent DC resistivity measurements (300 K to 400 K) confirmed Arrhenius conduction [1], with an activation energy (E_A) of 0.69 eV. Magnetic characterization demonstrated robust high Curie temperature (T_C) of ~895 K. Isothermal magnetic hysteresis loops measured from 296 K to 973 K showed a systematic reduction in saturation magnetization, coercivity, and remanence with increasing temperature. Notably, the thermal evolution of the saturation magnetization was found to closely adhere to Bloch's $T^{3/2}$ law [2]. Furthermore, magnetoelectric measurements confirmed true ME coupling nature [3], where both first $\left(\frac{\alpha}{d}\right)$ and second-order $\left(\frac{2\beta}{d}\right)$ ME coefficients decreased monotonically as temperature increased from 300 K to 400 K. These findings underscore the material's high-temperature magnetic stability and promising ME response for advanced multifunctional applications.

Keywords: Sol-gel, Ferrimagnetism, Curie Temperature, Bloch Law, Magnetoelectric

References:

[1] A. Barik, M. R. Sahoo, R. Ghosh, S. Tiwary, S. Kuila, D. Takhar, B. Birajdar, and P. N. Vishwakarma, J. Phys. D. Appl. Phys. 55 (2022) 165880.
[2] R. Sharif, S. Shamaila, F. Shaheen, J. Y. Chen, M. Khaleeq-ur-Rahman, and K. Hussain Appl. Phys. Lett. 102 (2013) 013114.
[3] R. Ghosh, A. Barik, M. R. Sahoo, S. Tiwary, P. D. Babu, S. D. Kaushik, and P. N. Vishwakarma, J. Appl. Phys. 132 (2022) 224107.

Abstract ID: 104

COMPREHENSIVE MAGNETIZATION ANALYSIS OF SUPERPARAMAGNETIC INTERACTING NANOPARTICLES: ROLE OF PARTICLE SIZE DISTRIBUTION AND DIPOLAR INTERACTIONS

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Abstract: Understanding the collective magnetic response of nanoparticle assemblies requires simultaneous consideration of intrinsic size variation and interparticle interactions. In this work, oleic-acid-coated magnetite nanoparticles are synthesized and their magnetization behavior is systematically analyzed. Structural characterization confirms single-phase magnetite formation, while transmission electron microscopy reveals nearly spherical particles with an average diameter of ~7 nm following a log-normal distribution. Room-temperature magnetization isotherm exhibit superparamagnetic behavior without hysteresis. The magnetic response is modeled using successive approaches based on the Langevin formalism followed by incorporation of experimentally determined size distribution. To account for interaction effects, a mean-field framework is introduced, where the effective magnetic field includes a contribution proportional to the magnetization. Independent estimation of particle size distribution parameters and ferrimagnetic susceptibility reduces fitting uncertainty and enhances reliability of extracted interaction parameters. Comparative analysis demonstrates that inclusion of dipolar coupling significantly improves agreement between theoretical predictions and experimental data, indicating that interaction effects play a dominant role in shaping the magnetization curve. The combined model incorporating both size distribution and dipolar interactions provides the most accurate representation of the magnetic behavior. The study establishes a consistent and physically meaningful methodology for analyzing interacting superparamagnetic nanoparticle systems, which is relevant for fundamental investigations of cooperative magnetic phenomena and advanced magnetic material applications.

Keywords: Nanoparticles; Superparamagnetism; Magnetization; Susceptibility

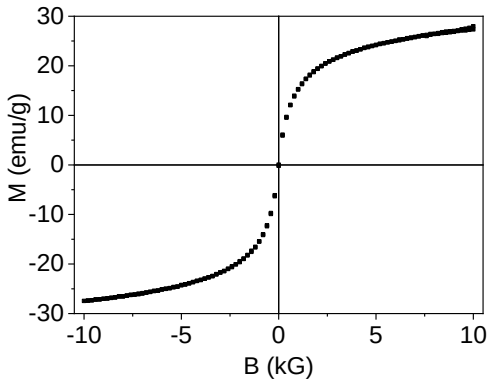


Fig. 1: M-B Loop for the magnetite particles at 295 K.

References:

[1] D.A. Balaev, S.V. Semenov, A.A. Dubrovskiy, et al., J. Magn. Magn. Mater. 440, 199 (2017).
[2] M. Tadic, S. Kralj, Y. Lalatonne, L. Motte, Appl. Surf. Sci. 476, 641 (2019).

Abstract ID: 105

COUPLED PHONONS AND INTERTWINED DENSITY WAVES IN TRILAYER NICKELATES $PR_{4-x}LA_xNI_3O_{10}$

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Abstract: The trilayer nickelates Rn+1NinO3n+1 (n=3, R= Pr, La) exhibit a transition from a high-temperature metallic phase to a low-temperature unstable metallic state, known as the metal-to-metal transition (TMMT), associated with intertwined charge and spin density waves. In nickelates, understanding lattice contributions is essential for unraveling the interplay among charge, orbital, and spin degrees of freedom that give rise to recently reported emergent phenomena [2-3]. To elucidate the role of lattice degrees of freedom (DoF) in this correlated state, we investigate the lattice dynamics of the trilayer nickelates series Pr4-xLaxNi3O10 (x = 0, 0.4, 1, 2, 3.6, and 4) via X-ray diffraction, specific heat and temperature- and polarization-dependent Raman scattering [4]. All compositions undergo the TMMT at low temperatures, marked by enhanced electronic correlations, with the spin density wave (SDW) preceding the charge density wave (CDW). The transition is accompanied by pronounced anomalies in phonon self-energy parameters (frequency and linewidth), and several modes exhibit nearly an order-of-magnitude change in their softening rates, revealing strong lattice-electronic coupling. An induced SDW on the Pr sublattice emerges at ~20 - 30 K for x = 0, 0.4, and 1 via coupling to the Ni sublattice, and weakens systematically with La substitution. A specific-heat anomaly at $T_1 \approx 4.8$ K in $Pr_4Ni_3O_{10}$, attributed to antiferromagnetic ordering of Pr^{3+} ions in the rocksalt layers, is progressively suppressed upon doping. These results highlight lattice DoF as a key mediator of correlated ground states in trilayer nickelates.

References:

[1] H. Li, *et al.*, Nat. Commun. 8, 704 (2017)
[2] S. Deswal, *et al.*, Appl. Phys. Lett. 127, 071903 (2025)
[3] M. Samarakoon, *et al.*, Phys. Rev. X 13, 041018 (2023)
[4] S. Deswal, *et al.*, Phys. Rev. B 112, 235151 (2025)

Abstract ID: 106

MAGNETOTRANSPORT STUDY OF Cr-DOPED LAYERED DIRAC SEMIMETAL NiTeSe

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Abstract: Transition-metal dichalcogenides (TMDCs), with their layered van der Waals structure, exhibit intriguing phenomena such as charge density waves, superconductivity, and topological states, making them highly versatile for both fundamental research and technological applications. $NiTe_2$ has been established as a Type-II Dirac semimetal in which external pressure and magnetic doping induce superconductivity and ferromagnetism, respectively [1]. Its isostructural counterpart NiTeSe (kitkaite) is a paramagnetic, ambient-stable layered compound hosting type-II Dirac fermions. ARPES measurements combined with DFT calculations reveal tilted Dirac cones located close to the Fermi level (–0.3 eV) [2]. NiTeSe is also reported to exhibit distinct charge transport in comparison to NiTe2, therefore it would be intriguing to investigate the topological features manifested in transport as well as in magnetization on its magnetically doped counter parts in order to tune the magnetic behaviour and study the interplay between magnetism and topology in this 2D van der Waal material**.** In this work, high-quality single crystals of pristine NiTeSe and Cr-doped $Ni_{0.97}Cr_{0.03}TeSe$ were successfully synthesized. Structural characterization via XRD and EDS confirms their single-phase crystalline nature with correct stoichiometry. Electrical resistivity measurements indicate metallic behavior in both samples. Magnetoresistance exhibits weak positive behavior in pristine NiTeSe, whereas the Cr-doped sample shows negative magnetoresistance at low temperatures. These observations suggest that magnetic interactions introduced through Cr doping break time-reversal symmetry, potentially driving the Dirac semimetal toward a Weyl semimetal state [3]. Hall measurements confirm electrons as the dominant charge carriers in both crystals.

Keywords: Transition-metal dichalcogenides; 2D van der Waals materials; Dirac semimetal; Single crystals; Magnetotransport measurements.

References:

[1] W. B. Wu, Y. Q. Chen, L. X. Gao, L. Z. Zhang, Q. L. Xiao, J. Y. Ge, Phys. Status Solidi B 260 (2023) 2300272.

[2] I. Vobornik, A. B. Sarkar, L. Zhang, D. W. Boukhvalov, B. Ghosh, L. Piliai, C. N. Kuo, D. Mondal, J. Fujii, C. S. Lue, M. Vorokhta, H. Xing, L. Wang, A. Agarwal, A. Politano, Adv. Funct. Mater. 31 (2021) 2106101.

[3] L. Zhang, Y. Sun, D. Zhao, X. Liu, J. Lai, J. Ren, Q. Wang, K. Tanigaki, Appl. Phys. Lett. 125 (2024) 053103.

Abstract ID: 107

MODULATIONS IN THE SPIN POLARIZATION OF Fe_4GeTe_2 MONOLAYER UNDER UNIAXIAL STRAIN

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Abstract: This study utilizes first-principles calculations to explore the impact of uniaxial strain on the electronic properties and spin polarization of the 2D metallic ferromagnet Fe_4GeTe_2 monolayer, a material notable for its near room temperature transition[1,2]. The analysis confirms that the monolayer remains dynamically stable within a strain range of -3% to +7%. In its equilibrium state, Fe_4GeTe_2 maintains a robust metallic ferromagnetic identity, characterized by a net magnetic moment of $2.1\mu_B$\Fe atom. This state is further defined by a pronounced asymmetry in the density of states, where the inequality between spin-up and spin-down populations at the Fermi level confirms its significant spin polarization. A critical finding of this research is the sensitivity of spin states near the Fermi level to mechanical deformation, while tensile strain effectively amplifies both magnetic moments and spin polarization, compressive strain suppresses these properties. By demonstrating that the material's magnetic profile can be modulated through uniaxial strain, these results highlight Fe_4GeTe_2 as a prime candidate for strain-engineered 2D spintronic devices, offering a practical blueprint for tuning high-temperature magnetic responses in low-dimensional systems.

Keywords: first-principles calculations, uniaxial strain, density of states, spin polarization

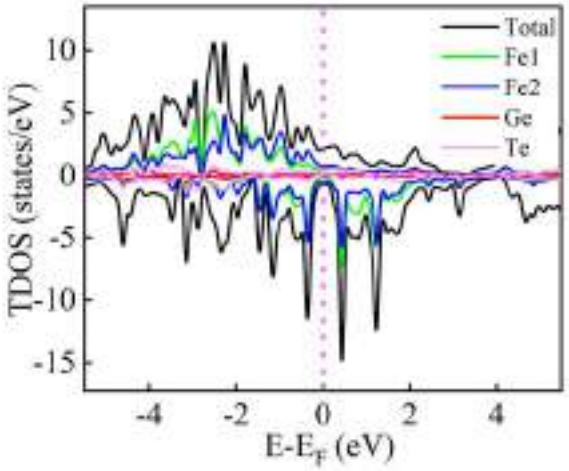


Fig. 1: Spin-polarized total Density of States and the DOS of Fe1, Fe2, Ge and Te of the pristine Fe_4GeTe_2 monolayer (ε= 0%)

References:

[1] S. Mondal, N. Khan, S. M. Mishra, B. Satpati and P. Mandal, *Phys. Rev. B*, 2021, **104**, 094405.
[2] J. Seo, D. Y. Kim, E. S. An, K. Kim, G.-Y. Kim, et al., *Sci. Adv.*, DOI:10.1126/sciadv.aay8912.

Abstract ID: 108

CIRCULAR PATHWAYS FOR NdFeB MAGNETS: PROSPECTS AND LIMITATIONS OF SHORT-LOOP RECYCLING

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Abstract: Rare-earth permanent magnets based on Nd–Fe–B alloys are critical components in modern technologies ranging from electric vehicles and wind turbines to robotics and consumer electronics [1]. However, their widespread use has intensify concerns over supply security and environmental impact due to the extraction and refining of rare earth elements [2]. Short-loop magnet-to-magnet recycling, which directly regenerates spent NdFeB magnets into new functional magnets with minimal downcycling, presents a promising strategy to close the material loop and reduce reliance on primary resources. Hydrogen Decrepitation (HD) and Hydrogenation–Disproportionation–Desorption–Recombination (HDDR) plays a central role in the recycling and microstructural refinement of NdFeB permanent magnets. In the HD process, hydrogen is absorbed preferentially along Nd-rich grain boundary phases, causing volumetric expansion lead to spontaneous fragmentation of bulk magnets into fine powder. In contrast, the HDDR process involves controlled hydrogenation at elevated temperatures, where the $Nd_2Fe_{14}B$ phase disproportionates into Nd hydride, α-Fe, and Fe_2B; subsequent hydrogen desorption under vacuum leads to recombination into a refined nanocrystalline $Nd_2Fe_{14}B$ structure. HDDR thus not only facilitates recycling but also enhances coercivity through grain refinement and texture development. Together, these hydrogen-assisted techniques are key enablers of magnet-to-magnet recycling and sustainable production of high-performance NdFeB magnets [3].In this work we present the current state of short-loop NdFeB recycling technologies, discuss critical technical obstacles, and highlights strategies to overcome barriers to commercialization. By advancing efficient magnet-to-magnet recycling pathways, the magnet industry can contribute significantly to sustainable resource management while supporting the global transition toward clean energy technologies.

Keywords: Rare Earth Permanent magnets, NdFeB magnets, Magnet to Magnet Recycling, Hydrogen traetment.



Fig. 1: Schematic of short-loop magnet to magnet recycling of spent NdFeB magnets.

References:
[1] Gutfleisch O., Science, 362 (2018) 547–548
[2] Binnemans K., Jones P. T., Journal of Cleaner Production, 51 (2013) 1–22
[3] Szymański M., Michalski B., Leonowicz M., Miazga Z., Key Engineering Materials, 682 (2016) 308–313

Abstract ID: 109

TAILORING MAGNETIC ANISOTROPY AND RELAXATION IN HEUSLER Co_2FeAl FOR FLEXIBLE AND DIRECTIONAL SPINTRONICS

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Abstract: The ability to control uniaxial magnetic anisotropy (UMA) and magnetization dynamics in thin films is foundational to emerging spintronic and memory devices [1]. Efficient data storage requires high Gilbert damping (α) for rapid suppression of magnetization precession and strong UMA for thermal stability and directional control [1]. While epitaxial films enable tuning via spin-orbit interactions, their applicability is limited by substrate constraints and weak magnetocrystalline anisotropy [2]. Polycrystalline films offer scalability yet suffer from low damping and insufficient anisotropy, often relying on doping that degrades intrinsic properties. Here, we overcome these limitations using a multiscale symmetry-breaking strategy combining: (i) ion-beam sculpted surface nano-ripples, (ii) oblique angle deposition, and (iii) externally applied mechanical stress to maximize and independently tune UMA and Gilbert damping in polycrystalline Co_2FeAl (CFA) Heusler alloy thin films. A CFA thin film deposited obliquely on a mechanically strained nanopatterned substrate [Fig. 1(a)] shows tilted columnar growth that replicates the substrate morphology [Fig. 1(b)], while the applied stress induces tensile strain along the ripple direction. The combined effects of shape anisotropy and magnetoelastic coupling induce a strong in-plane UMA of $(1.25 \pm 0.05) \times 10^5$ erg/cc, among the highest values reported for CFA films, with the easy axis along the ripple direction [Fig. 1(c)]. Crucially, surface ripples and porous nanocolumns increase the surface-to-volume ratio, enabling surface-driven dissipation and enhancing Gilbert damping ($\alpha \approx 0.018 \pm 0.001$) without doping, driven by strain and morphology-induced unquenching of the orbital moment ($m_l/m_s \approx 0.12 \pm 0.01$). In summary, this approach enables independent tuning of anisotropy (via shape and strain) and Gilbert damping (via surface-driven dissipation), opening pathways toward strain-tunable microwave absorbers and efficient data storage.

Keywords: Magnetic anisotropy, Gilbert damping, Nanostructured thin film, Heusler alloy, Strain engineering, X-ray magnetic circular dichroism.

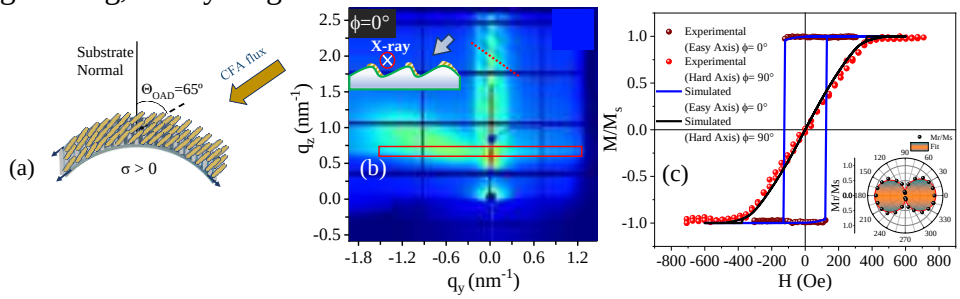


Fig. 1 (a) Schematic of film deposition and its (b) GISAXS pattern. (c) MOKE loops of CFA film measured along (easy axis) and across (hard axis) the ripple length, showing strong UMA.

References:

[1] S. Janardhanan, M. Krawczyk and A. Trzaskowska, Springer, p.1 (2024).
[2] P. He, X. Ma, and S. M. Zhou, Phys. Rev. Lett., Vol. 110, (2013).

Abstract ID: 110

INTERFACE RESOLVED STUDY OF MAGNETISM IN $C_{42}H_{28}/Fe^{57}/C_{42}H_{28}$ WEDGE STRUCTURE UNDER X-RAY STANDING WAVES

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Abstract: Understanding the evolution of ferromagnetic/organic semiconductor (FM/OSC) heterostructures as a function of ferromagnetic layer thickness is critical for optimizing organic spintronic devices [1]. Here, we report a systematic thickness-dependent study of Rubrene ($C_{42}H_{28}$)/^{57}Fe interfaces using a wedge-type trilayer structure: Si/Pd (200 Å)/Rubrene (400 Å)/^{57}Fe (35-55 Å wedge)/Rubrene (400 Å)/Pd (20 Å). The ^{57}Fe layer thickness was continuously varied from 35 Å to 55 Å across a 20 mm Si substrate in a single deposition run by dynamically sliding the substrate and shadow mask within the chamber. This design allows the investigation of a wide ^{57}Fe thickness range deposited under identical deposition conditions, eliminating sample-to-sample variability and ensuring a consistent growth environment. Our results show that at the lowest ^{57}Fe thicknesses, the film is dominated by an intermixing layer with Rubrene, while the progressive formation of a distinct bulk-like Fe layer emerges with increasing thickness [2,3]. This evolution is directly correlated with the onset of ferromagnetism and the development of continuous Fe layers, as evidenced by structural (XRR) and magnetic measurements (MOKE and GI-NRS). The wedge-type configuration enables a robust and efficient approach to probe the thickness-dependent transition from an intermixed interface-dominated regime to a well-defined ferromagnetic layer. Such insights are crucial for understanding how FM/OSC interfaces govern spin injection and magnetotransport, ultimately advancing the design of high-performance organic spintronic devices.

Keywords: Wedge, top and bottom interface, ferromagnet, organic semiconductor.

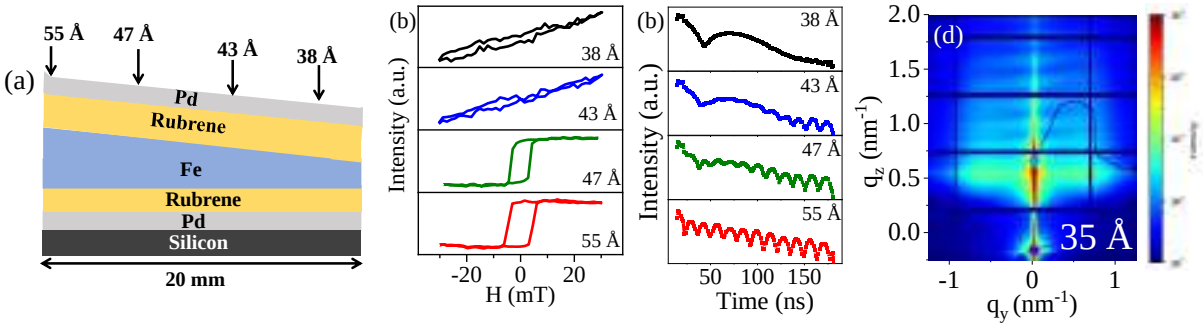


Fig. 1 (a) The sample structure, (b) MOKE loops, (c) Nuclear resonance scattering (Time spectra) at P01, and (d) GI-SAXS image performed at P03 beamline PETRA-III, DESY, Germany.

References:

[1] B. Bin Chen, S.W. Jiang, H.F. Ding, Z.S. Jiang, D. Wu, Chinese Physics B 23 (2014).
[2] Avinash Ganesh Khanderao, Ilya Sergueev, H. C. Wille, and Dileep Kumar, Appl Phys Lett 116, (2020).
[3] S. Kaushik, A.G. Khanderao, M.S. Jamal, I. Sergeev, H.C. Wille, V.R. Reddy, D. Kumar, Hyperfine Interact 242 (2021) 1–9.

Abstract ID: 111

$CoFe_2O_4/MoS_2$ MAGNETIC NANOHYBRID FOR ENHANCED PHOTOCATALYTIC PERFORMANCE

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Abstract: $CoFe_2O_4$ with a spinel structure was synthesized via the sol–gel autocombustion method, and the obtained samples were annealed at temperatures ranging from 250 °C to 750 °C to enhance phase stability, crystallinity, and functional performance. X-ray diffraction (XRD) analysis confirmed the formation of a single-phase cubic spinel structure, and the sharp diffraction peaks indicate crystallite growth and improved structural ordering upon thermal treatment [1]. Optical characterization using UV–Visible spectroscopy demonstrated the bandgap of 1.89 ev in the visible region, suggesting effective utilization of visible light for photocatalytic applications. Raman spectroscopic analysis further validated the structural integrity of the spinel lattice through the presence of characteristic vibrational modes corresponding to A_{1g}, E_g, and T_{2g} symmetry. Magnetic measurements obtained from Vibrating Sample Magnetometry (VSM) for the 750 °C annealed sample revealed ferrimagnetic behavior with considerable M_s (69.2 emu/g), H_c (1260.2 Oe), and M_r (27.4 emu/g), enabling facile magnetic recovery and recyclability of the catalyst.In parallel, $CoFe_2O_4$ /MoS_2 will be synthesized using Hydrothermal method and structurally examined via XRD [2]. The integration of $CoFe_2O_4$ with 2D -MoS_2 is anticipated to facilitate efficient interfacial charge transfer, suppress electron–hole recombination, and enhance visible-light absorption, thereby improving photocatalytic degradation performance toward organic pollutants. The influence of compositional ratio, crystallite size, nanocomposite loading percentage, reusability, and degradation efficiency will be systematically evaluated to elucidate the synergistic interaction between the $CoFe_2O_4$ and 2D- MoS_2. The resulting $CoFe_2O_4$/ MoS_2 nanocomposite is expected to function as an efficient and magnetically recoverable photocatalytic system, offering significant potential for sustainable environmental remediational applications.

Keywords: Spinel $CoFe_2O_4$, Sol-Gel Autocombustion, MoS_2 Nanosheets, Photocatalysis ,Magnetically Separable Nanocomposite.

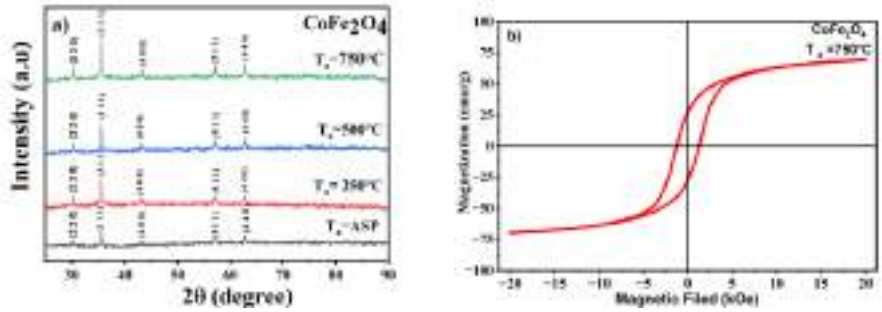


Fig. 1 (a) shows the XRD patterns of $CoFe_2O_4$ samples annealed at different temperature, while (b) presents the M–H hysteresis loop of the sample annealed at 750 °C.

References:

[1] Kalam, Abul, et al. Results in physics 8 (2018): 1046-1053.

[2] Manikandan, R., and Gargi Raina. Physica Scripta 97.12 (2022): 125808.

Abstract ID: 112

SPIN-FLOP TRANSITIONS IN 'Bi' INCORPORATED ORTHORHOMBIC $DyMnO_3$

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Abstract: Single-phase orthorhombic multiferroic $Dy_{1-x}Bi_xMnO_3$ (x = 0 - 0.2) with control on doping contents were prepared through conventional solid-state reaction. The effect of Bi substitution on the structure and magnetic properties of the $DyMnO_3$ was systematically investigated to reveal the magnetic entropy and magnetic ground state properties. XRD results indicate the orthorhombic structure without any impurity phases. The significant change in lattice parameters and Mn-O bond angles was observed as an upsurge in Bi doping content. The specific heat capacity measurements exhibit characteristic transitions at 40 and 19 K corresponding with the alignment of Mn (TMn) spins, and alignment of Mn spins and Dy spins ensuing in the ferroelectric phase, respectively. Notably, the magnetic entropy of the prepared pristine $DyMnO_3$ was estimated as 13 J/mol-K and further declined with increase in Bi doping. Temperature-dependent magnetization investigations demonstrate the magnetic transition below 2 K for Bi doping with x = 0.15 and x = 0.20 which attributes to the ordering temperature of the Dy^{3+} spin moments that creates a sinusoidal incommensurate to the commensurate phase transition. Interestingly, M-H hysteresis curves evidence the metamagnetic (spin-flop) transition within pristine $DyMnO_3$ at a critical magnetic field around ~1.4 T at 2 K. The present findings provide new insight and evidence into the structure and magnetic properties of substituted $DyMnO_3$.

Keywords: Manganites, $DyMnO_3$, $BiMnO_3$, Structural transition, Specific heat, Magnetic entropy, and Spin flop transition

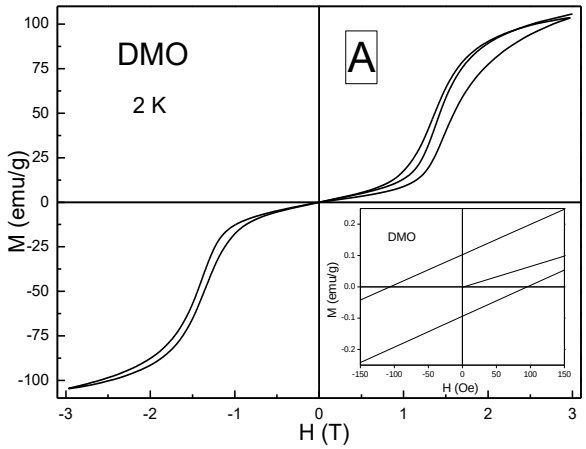


Fig. 1: M-H curve of $Dy_{1-x}Bi_xMnO_3$ (x = 0) samples (A) measured at 2 K for a maximum applied field of 3 T. Insets is enlarged view depicting the coercivity of the sample.

Abstract ID: 113

FIELD-INDUCED KINETIC ARREST AND GIANT MAGNETORESISTANCE IN SAMARIUM STRONTIUM MANGANITE: INSIGHTS FROM UNEQUAL FIELD COOLING AND HEATING STUDIES

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Abstract: Rare-earth manganite perovskites have attracted significant attention due to their tunable magnetotransport properties and potential use in spintronic and non-volatile memory devices [1]. In this study, samarium–strontium manganite ($Sm_{0.7}Sr_{0.3}MnO_3$) was synthesized by the combustion method to achieve fine particle size and homogeneous cation distribution. The temperature-dependent resistivity exhibits a distinct insulator-to-metal transition near 63 K with a large hysteresis at zero magnetic field, confirming a first-order transition between antiferromagnetic insulating and ferromagnetic metallic phases. A giant magnetoresistance of nearly 100 % is observed at low temperature, which decreases gradually with increasing temperature. Magnetic-field-dependent resistivity measurements reveal a virgin curve outside the main hysteresis loop and a butterfly-type pattern (see Fig:1), indicating phase coexistence and kinetic arrest. Cooling and heating in unequal fields (CHUF) analysis further demonstrates field-controlled de-arrest, where higher fields favor the metallic phase and lower fields enhance the insulating state. These results identify $Sm_{0.7}Sr_{0.3}MnO_3$ as a promising material for magnetoresistive memory elements and magnetic sensors, offering insights into field-driven phase transitions and non-ergodic dynamics in correlated oxides.

Keywords: Perovskites,Magnetoresistance, CHUF analysis

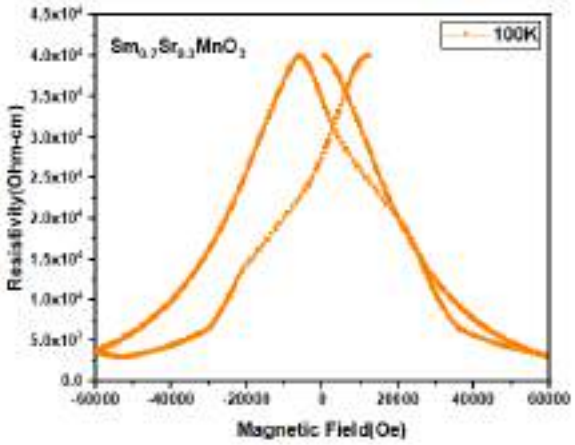


Fig. 1: R-H plot @ 100 K

References:

[1] Feng,Zhang *et al*. 'A Review of Synthesis and Novel Transport Properties of Multivalent Manganate Perovskite: Progress, Opportunities, and Challenges', Advanced Electronic Materials,**10**, (2024).

Abstract ID: 114

TUNABLE SPIN WAVE DYNAMICS IN KAGOME ARTIFICIAL SPIN ICE

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Abstract: Artificial spin ices were originally developed to mimic the behavior of spin ice, such as the rare-earth titanate pyrochlores [1]. The smallest building blocks in artificial spin ices are single-domain nanomagnets arranged in such a way that their moments are frustrated [2]. In this study, we explore the spin wave dynamics in distinct magnetic phases of Kagome Artificial spin ice [3]: Long-range order, Kagome Ice II, and Kagome Ice I by solving the Landau-Lifshitz- Gilbert equation using micromagnetic simulations. The magnetization dynamics changes significantly as the system goes from an ordered state to a disordered state and an asymmetric spin wave propagation is also observed in such system. The asymmetry in magnetic materials is realized through the Dzyaloshinskii–Moriya interaction, as shown in Fig 1. whereas in Kagome artificial spin ice, it arises from the internal magnetic configuration in the absence of DMI. These findings imply the potential to utilize Kagome artificial spin ice structures as reconfigurable, direction-sensitive magnonic platforms for signal routing, spin wave filter and logic operations based on internal magnetic states rather than structural changes.

Keywords: Spintronics, Spin ice, Magnetic texture, Spin waves , Magnetization dynamics

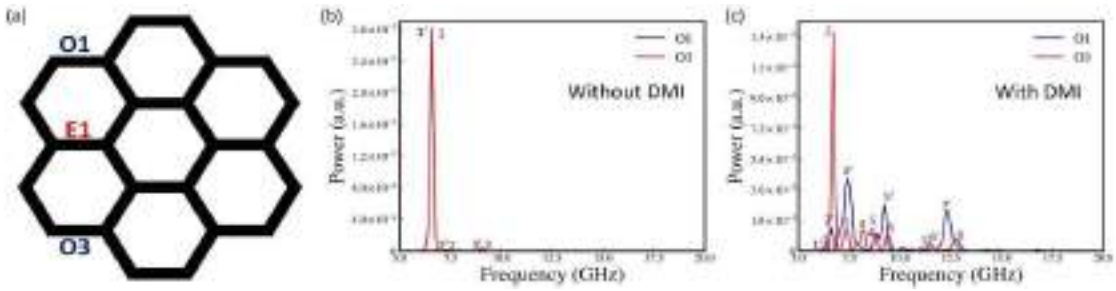


Fig. 1: (a) Schematic of the kagome lattice having uniform magnetization with antenna E1 and observation points O1, O3. (b-c) Simulated FFT spectra at O1, O3 without DMI with DMI.

Acknowledgement

All the authors gratefully acknowledge the financial support of SERB with file Number SRG/2022/000191 and the Axis Bank Grant at Ashoka University for the funding. Ms. Naintara acknowledges SERB with file Number SRG/2022/000191 for the fellowship.

References:

[1] S. T. Bramwell et al., Science, vol. 294, no. 5546, pp. 1495–1501, 2001.
[2] S. H. Skjærvø et al., Nature Reviews Physics, vol. 2, no. 1, pp. 13–28, 2020.
[3] L. Anghinolfi et al., Nature Communications, vol. 6, p. 8278, 2015.

Abstract ID: 115

MULTIFERROIC PROPERTIES OF BISMUTH SUBSTITUTED NICKEL FERRITE

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Abstract: We report evolution of ferroelectric properties in bulk bismuth substituted nickel ferrite with chemical formula $NiBi_{2X}Fe_{2-2X}O_4$ (x = 0.02 – 0.08 at steps of 0.02). No crystal structure deformation or transformation was observed. The Rietveld analysis of X-ray diffraction data showed that the spinel structure sustain itself up to the substitution level x = 0.08 without much change in crystal structure parameters. Without significant changes in magnetic properties, the Neel temperature shows a decrease compared to that of virgin nickel ferrite. The ferroelectric hysteresis loop study indicates improvements in ferroelectricity with increase of bismuth substitution. The XPS studies indicated that with increasing substitution of bismuth ions, Bi^{3+} ions converted into Bi^{5+} ions until x = 0.08 to compensate size effect. After x = 0.08 the no more bismuth substitution is possible and this is reflected in XRD pattern, magnetic properties and ferroelectric hysteresis loops. This way we could induce ferroelectricity in bulk spinel ferrite system. This material may prove to be useful as an economic alternative of available spintronics materials.

Keywords: Ferrites, Multiferroic, XRD, Neel Temperature.

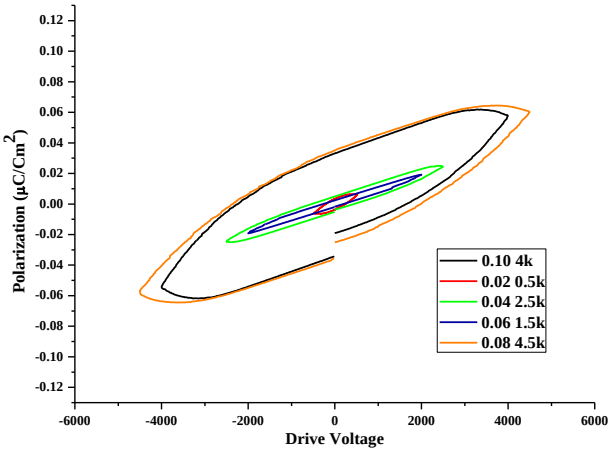


Fig. 1: Ferroelectric loops for $NiBi_{2X}Fe_{2-2X}O_4$.

References:

[1] Joel Cibert, Jean-Francois Bobo and Ulrike Luders, C. R. Physique, 6, (2005), 977-996.
[2] Nicola A. Hill, Annu. Rev. Mater. Res. 2002. 32:1–37.

Abstract ID: 116

BERRY CURVATURE INDUCED GIANT ANOMALOUS AND SPIN TEXTURE DRIVEN HALL RESPONSES IN THE LAYERED KAGOME ANTIFERROMAGNET $GdTi_3Bi_4$

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Abstract: In recent years, layered kagome magnets have emerged as promising platforms for Berry-curvature engineering and unconventional transport phenomena. Here, we present the single-crystal growth, magnetization, and electrical transport characterizations of the van der Waals-like layered antiferromagnet $GdTi_3Bi_4$. The system exhibits pronounced field-induced first-order phase transitions. Comprehensive frequency, temperature, and field-dependent ac susceptibility measurements, and Hall analysis, reveals the formation of a spin-cluster-like glassy magnetic phase attributed to noncollinear spin textures. Additionally, the system demonstrates a colossal anomalous Hall conductivity ($\sigma_{xy}^{A} \approx 8.6(7)\times10^{3}$ Ω^{-1} cm^{-1}at 2 K). Detailed scaling analyses reveal the coexistence of skew scattering and intrinsic Berry-curvature contributions to the anomalous Hall effect. First-principles calculations highlight flat-band near the Fermi level, with *f*-electrons of the Gd ion contributing large intrinsic Hall response. Thus, $GdTi_3Bi_4$ emerges as a rare layered kagome magnet, exhibiting Berry curvature-induced giant anomalous and spin texture-driven Hall responses, providing a versatile platform for exploring spin-texture physics and advancing low-dimensional spintronic functionalities.

Keywords: 2D antiferromagnet, quantum magnet, Berry curvature, anomalous Hall effect, skew scattering, spin texture.

Abstract ID: 117

MAGNETIC FOCUSING SYSTEM FOR HIGH POWER S-BAND MBK

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Abstract: The Magnetic focusing system design and development aspects for the S-band Multi-beam Klystron[1] are discussed in this paper. The intended device has to operate at a cathode voltage of roughly 78 KV, with a total beam current of 400A split equally among all forty beamlets. The electron beam can be contained using a periodic permanent magnetic focusing system. MATLAB was used to analyze the proposed magnetic focusing system after it was simulated in CST-studio. Less than 2% of the magnetic field's axial component is radial component, and more than 99% beam transmission has been attained.

Keywords: Multi-beam klystron , MBK, Reversible Magnetic focusing system (RMFS), Magnetic Focusing system (MFS), Periodic permanent Magnet (PPM)

References:

[1] Edward A. Gelvich, Ludvik M. Borisov, Yevgeny V. Zhary, Anatoli, D. Zakurdayev, Alexandr S. Pobedonostsev, and Victor I. Poognin, “The New Generation of High-Power Multiple-Beam Klystrons”, IEEE Transactions on Microwave Theory and Techniques, Vol. 41, No. I , 1993.

Abstract ID: 118

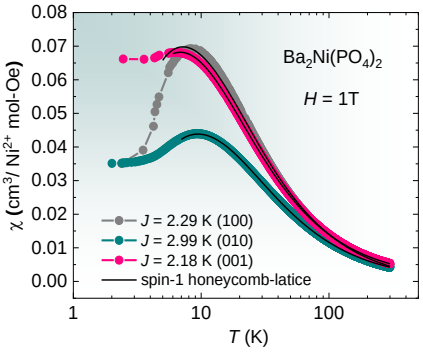
MAGNETIC ANISOTROPY AND LATTICE EXPANSION BEHAVIOR IN SPIN-1 2D HONEYCOMB ANTIFERROMAGNET: $Ba_2Ni(PO_4)_2$

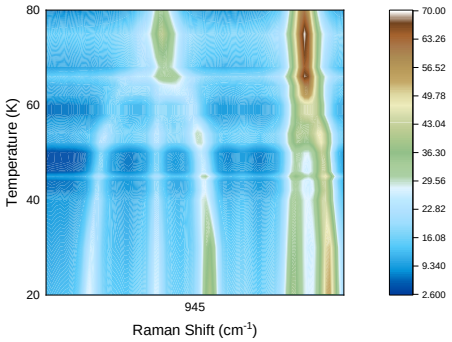
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Abstract: We have investigated the magnetic anisotropic properties and lattice expansion behavior of 2D spin-1 Honeycomb antiferromagnet $Ba_2Ni(PO_4)_2$ single crystal. The single crystal of $Ba_2Ni(PO_4)_2$ is grown by optical floating zone method. It crystallizes in monoclinic symmetry with space group $P\,2_1/n$ [1]. To study the anisotropic properties, we have performed the dc-susceptibility, magnetization and heat capacity measurement in the oriented crystal. The magnetic susceptibility along different crystallographic directions (a, b, c) shows anisotropic nature with slightly different Neel temperature (T_x = 4.3K, T_y = 4.6K and T_z = 4.9K respectively). The susceptibility data is fitted using the spin-1 honeycomb model which gives the exchange coupling along all directions, quite reasonable with the theoretical values. The M-H curve shows field induced transition along 'a' crystallographic axis, while it has straight line along other two directions (b and c). The heat capacity data also indicates three transitions at around 4.3K, 4.6K and 4.9K. In order to study the spin-lattice dynamics, we have performed the low temperature XRD, polarized Raman experiment and larmor diffraction. The low temperature XRD measurement shows lattice contraction at around 150K. The neutron larmor diffraction measurement which is used to study the thermal expansion behavior in the sample shows high temperature anomaly at around 80K which could be related to crystal field excitations, also there is low temperature minima at 4.8K (close to the magnetic ordering temperature) which may indicate spin-phonon coupling in the sample. The polarized Raman study also shows new modes below 80K, which may indicate some structural transition or crystal field excitation in it, however, needs to be further study in great detail which is at the moment underway.





Reference:

[1] Yogi, Arvind, et al. "Stripe order on the spin-1 stacked honeycomb lattice in $Ba_2Ni(PO_4)_2$." Physical Review B 95.2 (2017): 024401.

Abstract ID: 119

FIRST-PRINCIPLES PREDICTION OF MAGNETIC PROPERTIES IN NdFeB PERMANENT MAGNETS USING DENSITY FUNCTIONAL THEORY

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Abstract: Neodymium-iron-boron (NdFeB) permanent magnets, based on the $Nd_2Fe_{14}B$ tetragonal phase, represent the highest-performing class of permanent magnetic materials, with widespread application in electric vehicles, wind turbines, and advanced electromagnetic devices. Their exceptional magnetic performance originates from strong magnetocrystalline anisotropy and high saturation magnetization, both rooted in complex electronic interactions among Fe 3d, Nd 4f, and B 2p states. As demand for rare-earth elements intensifies, accurate first-principles prediction of intrinsic magnetic properties becomes critical for rational material design. This study employs Density Functional Theory (DFT) to systematically investigate the electronic structure, magnetic moments, magnetocrystalline anisotropy energy (MAE), and exchange interactions of $Nd_2Fe_{14}B$. Spin-polarized calculations were performed using the projector augmented wave (PAW) method within the generalized gradient approximation (GGA-PBE), supplemented by Hubbard U corrections for the strongly correlated Nd 4f electrons and explicit spin-orbit coupling to capture relativistic anisotropy contributions. Structural relaxation yielded lattice parameters in excellent agreement with experiment. The computed total magnetic moment (~37.5 μB per formula unit) and MAE (4.5–5.0 MJ/m³) align closely with experimental values, validating the methodology[1]. Exchange coupling constants confirm dominant Fe-Fe ferromagnetic interactions and predict a Curie temperature of ~580 K. Elemental substitution studies involving Co, Dy, Al, Tb, and Ce revealed site-specific effects on anisotropy, coercivity, and thermal stability[2,3]. These results establish DFT as a reliable and predictive computational framework for accelerating the discovery and optimization of high-performance, rare-earth-lean permanent magnets for sustainable energy technologies

Keywords: NdFeB, Permanent Magnets, Density Functional Theory, Magnetocrystalline Anisotropy, Exchange Coupling, 4f Electrons, First-Principles Calculations

References:

[1] Bouaziz, J. et al. (2023). Crucial role of Fe in determining the hard magnetic properties of $Nd_2Fe_{14}B$. Physical Review B, 107, L020401.

[2] Boust, J. et al. (2022). Ce and Dy substitutions in $Nd_2Fe_{14}B$: Site-specific magnetic anisotropy from first principles. Physical Review Materials, 6, 084410.

[3] Zhang, A. et al. (2025). Influence of alloying elements on the stability and magnetic properties of $Nd_2Fe_{14}B$. Computational Materials Science.

Abstract ID: 120

EFFECT OF A-SITE DOPING ON DOUBLE PEROVSKLITE MULTIFERROIC $Y_{2-x}Z_xCoMnO_6$ (Z=Gd & Dy)

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Abstract: Electrically written and magnetically read memory devices can be achieved by utilizing the multifunctionality in Multiferroic materials. The compounds crystallizing into Double-Perovskites are potential multiferroics. Double-Perovskites (DP) still have transition temperature much below room temperature. The strength of ferromagnetic coupling is directly related to the asymmetry in the density of states of spin sub-bands around Fermi level[1,2]. Hence an injection of electrons to conduction band by doping emerges as a natural choice to alter ferromagnetic interactions and eventually to tune ordering temperature[1-2]. The study aims in the selection of suitable doping materials for selected Double-Perovskites and fixing of doping concentration to find an increment in ordering temperature. The phase pure double perovskite structured $Y_{(2-x)}$ Gd_x $CoMnO_6$) and $Y_{(2-x)}$ Dy_x $CoMnO_6$ (x=0.0 to x=0.08 samples is synthesized by employing the technique of Solid state method and fine structure is refined using Reitveld refinement confirms orthorhombic crystal structure with pnma space group. M-H curve of samples(Gd/Dy)doped samples exhibit ferromagnetic nature. The delayed saturation noticed in the M-H curve[3]. M-H isotherms in fields up to 2000 Oe for all samples shows best fit in micromagnetic model, implies the approach to saturation magnetisation are controlled by magnetostatic and magnetocrystalline fluctuations[3]. The irreversibility in magnetization normalized to measurement field , M_{irr}/H-{$M_{FC}(T)$-$M_{ZFC}(T)$}/H deduced from FC and ZFC thermomagnetic curves shows the bifurcation temperature Tb shift to lower temperature with rise in the field. We can see the steady rise in the transition temperature with the doping concentration. AC susceptibility data is also analysed. The effect of doping on ferroelectric data is also done.

Keywords: Double Perovskites, Multiferroic, Ferromaganetic, Ferroelectric

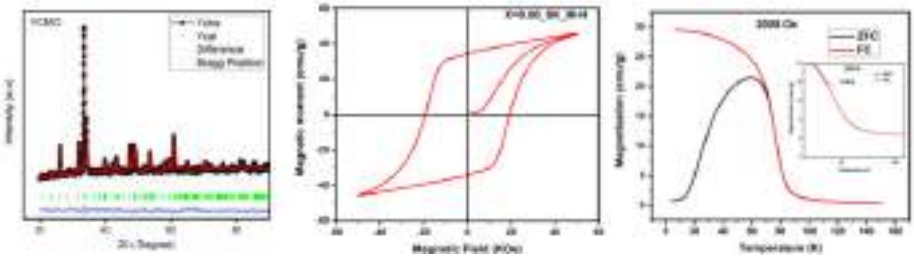


Fig. 1: (a): xrd refinement of pristine sample (b): M-H isotherm of pristine sample at 5K (c): M-T curve of pure sample

References:

[1] Navarro, J., Frontera, C., Balcells, L., Martinez, B., &Fontcuberta, J. (2001). Physical Review B, 64(9), 09241

[2] Rubi, D., Frontera, C., Nogués, J., &Fontcuberta, J. (2004). Journal of Physics: Condensed Matter, 16(18), 3173 .

[3] Mathew, S. P., and S. N. Kaul. "Magnetization processes in nanocrystalline gadolinium." Journal of Physics: Condensed Matter 24.25 (2012): 256008.

Abstract ID: 121

MAGNETIC FRUSTRATION AND SPIN DYNAMICS IN SPIN-DISORDERED $Ho_2Ge_xTi_{2-x}O_7$ SYSTEM

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Abstract: Following the resonating-valence-bond (RVB) concept proposed by Philip W. Anderson [1], magnetically frustrated systems have attracted considerable attention due to their exotic low-temperature magnetic ground states. In such systems, spin dynamics are governed by competing dipolar and exchange interactions along with crystal-field effects. In the present work, chemical pressure has been employed to tune the structural and magnetic properties of the $Ho_2Ge_xTi_{2-x}O_7$ system [2]. A series of phase-pure samples were synthesized across the compositional range. Structural analysis shows that the titanate and germanate end members crystallize in the Fd-3m and $P4_12_12$ space groups, respectively, indicating composition dependent modification of the Ho^{3+} ligand environment. Magnetic measurements on $Ho_2Ge_2O_7$ and $Ho_2Ti_{0.1}Ge_{1.9}O_7$ reveal characteristic classical spin-ice correlations below ~2 K. Low-temperature synchrotron X-ray diffraction shows an anomalous lattice-volume behavior below 30 K, providing evidence of crystal-field phonon coupling in $Ho_2Ti_2O_7$ [3]. Curie-Weiss analysis of $Ho_2Ge_xTi_{2-x}O_7$ ($x \leq 0.25$) reveals a reduction in θ_{CW} with increasing chemical pressure, indicating enhanced antiferromagnetic exchange. The robustness of spin-ice freezing highlights this system as a promising quantum spin-ice platform.

Keywords: chemical-pressure, magnetically frustrated systems, pyrochlores, spin-ice.

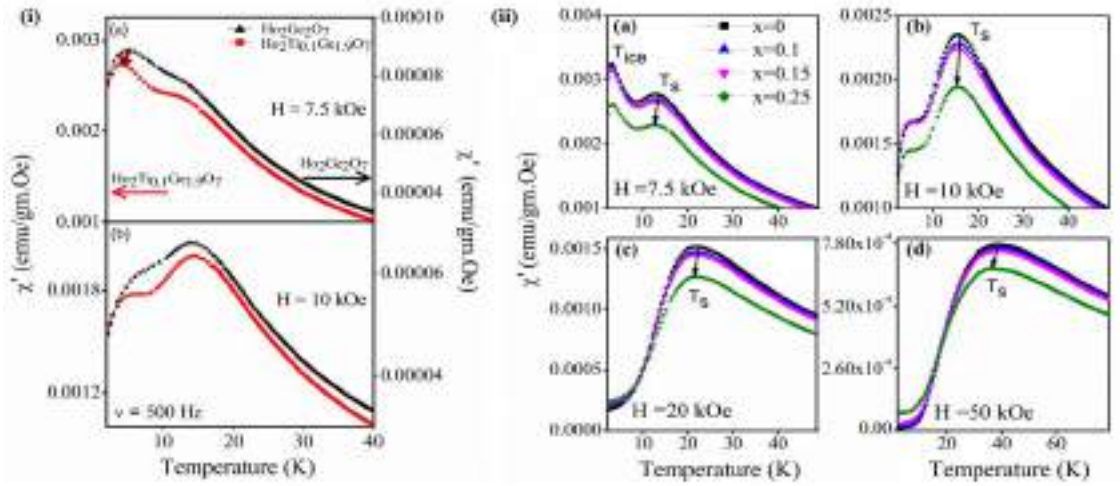


Fig. 1: (i) The ac-susceptibility plot of $Ho_2Ge_2O_7$ and $Ho_2Ti_{0.1}Ge_{1.9}O_7$ at an applied magnetic field of (a) H = 5 kOe (b) H = 10 kOe; (ii) Variation of ac susceptibility with temperature for $Ho_2Ti_{2-x}Ge_xO_7$ (x = 0, 0.1, 0.15 and 0.25) for an applied field of (a) H = 7.5 kOe (b) H = 10 kOe (c) H = 20 kOe (d) H = 50 kOe at 500 Hz.

References:

[1] M.J.P. Gingras and P.A. McClarty, Reports Prog. Phys. **77**, 1 (2014).
[2] Tomasello, C. Castelnovo, R. Moessner, and J. Quintanilla, Phys. Rev. B **92**, 1 (2015).
[3] M. Shukla, R. Upadhyay, M. Tolkiehn, and C. Upadhyay, J. Phys. Condens. Matter **32**, 1 (2020).

Abstract ID: 122

UNRAVELING THE EXCHANGE BIAS EFFECT IN Mn-DOPED ZnO NANOCRYSTALS: ROLE OF ZnO/$ZnMn_2O_4$/Zn_2MnO_4 WURTZITE-SPINEL HETEROSTRUCTURES

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Abstract: Dilute magnetic semiconductors (DMS) are of significant interest for spintronic applications because they integrate semiconducting behavior with magnetic ordering [1]. ZnO is an attractive host due to its wide band gap and chemical stability, while Mn is a suitable dopant because of its half-filled $3d^5$ configuration that provides a high magnetic moment without major lattice distortion [2,3]. However, exchange bias (EB) effect is rarely reported in Mn-doped ZnO and other oxide-based DMS systems. In this work, $Zn_{1-x}Mn_xO$ (X=1, 3, 5, 7 & 10 % Mn) nanocrystals were systematically investigated via co-precipitation method to understand how different Mn concentrations affect their structural and magnetic properties. X-ray diffraction and Raman analysis confirm the formation of secondary spinel phases, namely $ZnMn_2O_4$ and Zn_2MnO_4, in addition to the primary hexagonal $Zn_{1-x}Mn_xO$ matrix. Field emission scanning electron microscopy and high-resolution transmission electron microscopy showed agglomerated, polygonal nanostructures with distorted hexagonal morphologies. X-ray photoelectron spectroscopy reveals mixed valence states of $Mn^{2+}/Mn^{3+}/Mn^{4+}$, further confirming heterostructure formation [1]. These coexisting phases significantly influence the material's magnetic behaviour. Magnetic measurements show notable clear asymmetry in hysteresis loop and increased coercivity, confirming the presence of EB effect, which is found to have enhancement with increasing Mn content, likely due to interfacial coupling between ferromagnetic, antiferromagnetic, and spin-glass-like regions originating from different phases. To our knowledge, this is the first report of EB behaviour in Mn-doped ZnO nanocrystals featuring coexisting hexagonal and spinel structures [4]. These results highlight the role of phase evolution in designing ZnO-based nanomaterials for spintronic applications.

Keywords: $Zn_{1-x}Mn_xO$, $ZnMn_2O_4$, Zn_2MnO_4, Heterostructures, Exchange bias.

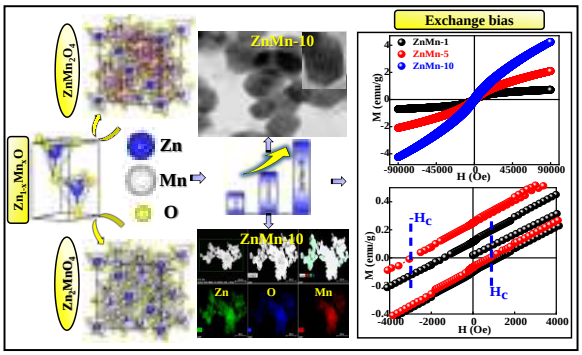


Fig. 1: Phase evolution in Mn-doped ZnO nanocrystals leading to exchange bias effect.

References:

[1] P. Bhardwaj, J. Singh, V. Verma, R. Kumar, Physica B: Condens. Matter 696 (2025) 416596.
[2] Ü. Özgür, Y. I. Alivov, C. Liu, A. Teke, M. A. Reshchikov, et al., J. Appl. Phys. 98 (2005) 041301.
[3] T. Dietl, H. Ohno, F. Matsukura, J. Cibert, D. Ferrand, Science 287 (2000) 1019–1022.
[4] S. K. Koroth, M. Vasundhara, Mater. Chem. Phys. (2025) 131946.

Abstract ID: 123

VACUUM – INDUCED CATION REDISTRIBUTION AND MAGNETIC ORDERING IN MANGANESE FERRITE NANOPARTICLES

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Abstract: $MnFe_2O_4$ (MFO) nanoparticles were synthesized via simple coprecipitation method and vacuum annealed upto 1000 °C. XRD analysis of pristine MFO (MFO-P) and vacuum annealed samples (MFO-V) shows a single phase of spinel structure. Raman analysis reveals a slight red shift of the A_{1g} mode along with pronounced blue shifts and evolution of T_{2g} and E_g modes upon vacuum annealing. The weakening of tetrahedral Fe-O vibrations and simultaneous strengthening of octahedral modes indicate redistribution of Fe^{3+} from A to B sites. Mössbauer spectroscopy of MFO-V reveals the disappearance of the paramagnetic doublet, coupled with well-resolved magnetic sextets, confirms the stabilization of long-range ferrimagnetic ordering. The inversion parameter decreases from 0.45 (MFO-P) to 0.34 (MFO-V), indicating reduction of Fe^{3+} ions at tetrahedral (A) sites and an increase of Fe^{3+} ion in octahedral (B) sites. Such migration upon annealing indicates cation redistribution towards normal spinel configuration [1,2]. The increase in saturation magnetization from 58 to 66 emu g^{-1} after vacuum annealing is attributed to oxygen-vacancy-induced cation redistribution.

Keywords: Cation distribution, Mössbauer spectroscopy, Vacuum annealing, Oxygen vacancy, Ferrimagnetic ordering

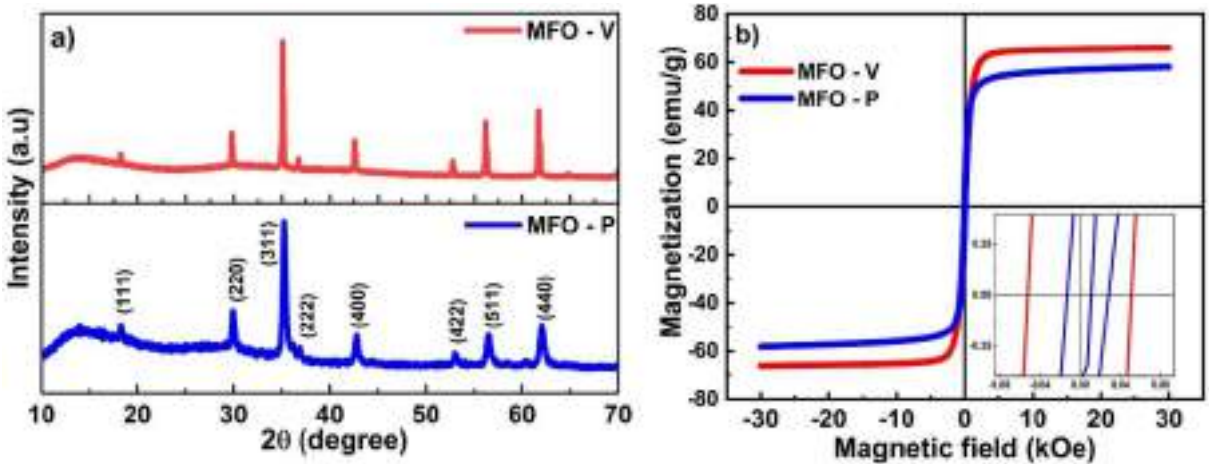


Fig. 1: a) XRD pattern and b) RT M-H loops of MFO- pristine and vacuum annealed upto 1000°C

References:

[1] Chandramohan, P., Srinivasan, M. P., Velmurugan, S., & Narasimhan, S. V. Journal of Solid State Chemistry, 184(1) (2011) 89-96

[2] Chinnasamy, C. N., Narayanasamy, A., Ponpandian, N., Chattopadhyay, K., Shinoda, K., Jeyadevan, B. & Nakatani, I. Physical Review B, 63(18) (2001) 184108

Abstract ID:124

MAGNETOSTRICTRONICS: EXCHANGE BETWEEN MAGNETIC ANISOTROPY AND ELASTIC ENERGIES FROM FIRST-PRINCIPLES CALCULATIONS

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Abstract: The outcome of strain while magnetized was observed by J. P. Joule (1842), and now-a-days it is exploited with computational first-principles modelling and calculations [1]. Harvesting and then utilizing these total internal *quantum mechanical energy* of a hard magnetic solid is sustainable approach by exploring its microscopic origin of crystalline spin-anisotropy perturbed with crystal orbital-field effect [2]. Novelties are thus raised due to its phenomenological implementation and possible future applications of such fundamentals which would be guided by the bi-directional energy exchange between the elastic and magnetic anisotropic energies in hard magnetic solids [3]. Hence, modulating the device transport property without external electric and or magnetic-field has become a pioneering domain of research, in the recent quantum materials research to explore these *quantum & mechanical energies* [2-3]. Here, modelling and quantification of magnetocrystalline anisotropic energy (MCAE) and its correlation with associated magneto-elastic stress-strains are key to the next generation magnetostrictive applications – pioneering to the domain *magnetostrictronics* [3]. An accurate first-principles calculations in the scarcity of the computational limitations of first-principles calculations and numerical instabilities at the few meV of energy scale limits this exploration of microscopic origin [2-3]. This has been now re-investigated in the available limit of the numerical stability and accuracy of the density functional theory (DFT) calculations for these two $L1_0$-*A*Pt order alloys (*A*= Fe, Mn) with some future notes about the reliability of plane-wave DFT codes [1-3]. Thus, in the presentation I will discuss this novel route to the bi-directional energy *exchange* via *magnetostrictronics* (Figure 1).

Keywords: Magetostrcictonics, First-principles calculations, DFT+*U*, Spin-orbit coupling, Elastic-tensor

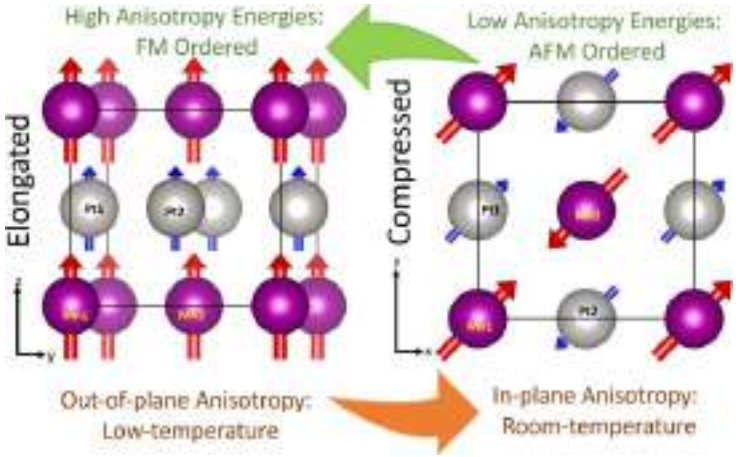


Fig. 1: Spin-anisotropic and associated lattice distortion schematics.

References:

[1] P. Nieves et al., Comput. Phys. Commun. 271 (2022) 108197.
[2] T. Das, P. Nieves, and D. Legut, J. Phys. D: Appl. Phys. 58 (2025) 035004.
[3] T. Das and A. K. Das, J. Mater. Chem. C 14 (2026) 1466.

Abstract ID: 125

TAILORING MAGNETIC TRANSITIONS AND MAGNETOCALORIC PROPERTIES TOWARDS ROOM TEMPERATURE IN $La_{0.67-x}Bi_xSr_{0.33}MnO_3$ (x=0.05-0.25) MANGANITES

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Abstract: Magnetic refrigeration has emerged as an energy-efficient and eco-friendly alternative to conventional vapor-cycle cooling. Perovskite manganites has found to be promising candidates due to their tuneable magnetocaloric properties [1]. This study investigates the influence of Bi^{3+} substitution on the structural, magnetic, and magnetocaloric properties of $La_{0.67-x}Bi_xSr_{0.33}MnO_3$ (x = 0.05-0.25) manganites, synthesized via the solid-state method. Rietveld refinement of X-ray diffraction patterns confirmed a dual-phase structure comprising a primary rhombohedral phase (R-3c) and a secondary tetragonal Mn_3O_4 phase (I41/amd), with the secondary phase fraction increasing progressively with rising Bi content. Scanning electron microscopy revealed uniform polygonal morphology, while X-ray photoelectron spectroscopy confirmed mixed Mn^{3+}/Mn^{4+} valence states with Mn^{3+} content decreasing systematically, indicating weakened double exchange interactions. Magnetization measurements demonstrated a ferromagnetic to paramagnetic second order transition in all samples, with the Curie temperature declining from 365 K to 335 K with increasing Bi content. A ferrimagnetic nature below 50 K, which is attributed to the Mn_3O_4 secondary phase, increased with higher doping. Magnetocaloric calculation was done using the Maxwell relation which yielded maximum isothermal magnetic entropy changes (ΔS_M) of 4.23 and 3.15 J kg^{-1} K^{-1} under 5 T for x = 0.05 and x = 0.25, respectively. Direct adiabatic temperature change (ΔT_{ad}) measurements supported these results. The systematic tunability of transition temperatures near room temperature, combined with appreciable magnetocaloric properties, establishes Bi-doped $La_{0.67}Sr_{0.33}MnO_3$ as a promising material for solid-state magnetic refrigeration applications.

Keywords: Manganites, Isothermal entropy change, Adiabatic temperature change, Magnetocaloric effect

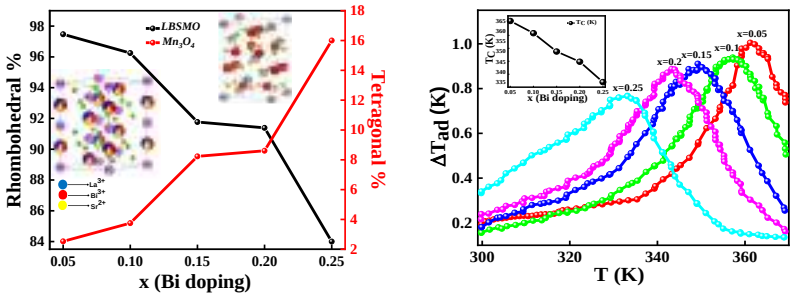


Fig. 1: Structural and Magnetic Data

References:

[1] Li, X., Zheng, X., Luo, X., Chen, D., Marchenkov, V. V., & Gao, T. (2022). Journal of Magnetism and Magnetic Materials, 560, 169625.

Abstract ID: 126

TOPOLOGICAL PHONON NODAL LINES AND HOURGLASS DISPERSIONS IN FERROMAGNETIC RARE EARTH HEXABORIDES, EuB_6

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Abstract: In this work, we investigate the phonon behaviour of the rare-earth ferromagnet europium hexaboride (EuB_6) using first-principles calculations, with a particular focus on how crystal symmetry influences its vibrational properties. EuB_6 crystallises in the relatively uncommon cubic *Pm-3m* structure (space group No. 221), making it an intriguing platform for realising symmetry-driven topological phonon states. Our phonon dispersion calculations reveal a surprisingly rich set of features. These include hourglass-like dispersions in the $k_z=\pi$ plane, as well as triple points and quadratic contact triple points (QCTP) appearing at the Γ and R high symmetry points. We also find an elaborate network of nodal lines spanning type-I, type-II, and hybrid varieties in the $k_z=0$ plane. In addition, quadratic nodal lines emerge along the Γ–X direction on the k_x axis ($k_y=0$, $k_z=0$). All of these features can be directly traced back to the symmorphic crystal symmetry and the constraints it imposes on the phonon bands. Looking beyond the bulk, we identify distinctive surface phonon modes, including drumhead-like states and square-shaped nodal line phonon features, which should be accessible in future experiments. Overall, this study provides the first comprehensive first-principles investigation of a magnetic material crystallising in space group 221. Our results uncover an exceptional diversity of topological phonon states and point toward new possibilities for studying topological lattice dynamics in magnetic crystals.

Keywords: Rare earth hexaborides, phonon dispersion, nodal lines, hourglass dispersion, triple points, quadratic contact triple points (QCTP).

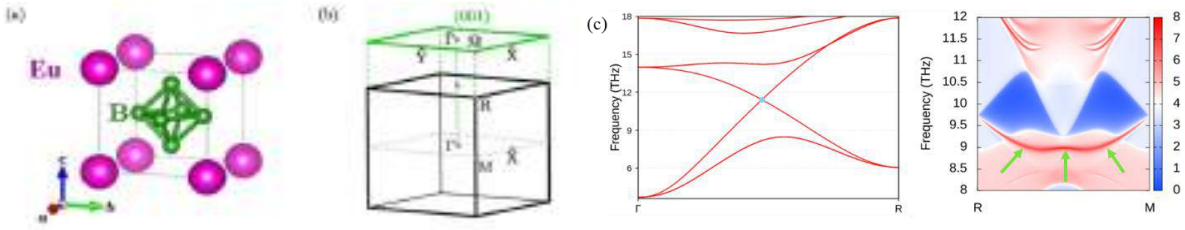


Fig. 1: (a) and (b) represent the crystal structure, and the corresponding Brillouin zone (c) shows hourglass-like features, Γ-R [$1\bar{1}0$] and drumhead surface states along R-M (8–9.5 THz) in EuB_6.

References:

[1] C.-K. Chiu, J. C. Teo, A. P. Schnyder, and S. Ryu, Classification of topological quantum matter with symmetries, Rev. Mod. Phys. 88, 035005 (2016).
[2] S. Park, Y. Hwang, H. C. Choi, and B.-J. Yang, Topological acoustic triple point, Nature Commun. 12, 6781 (2021).
[3] G. Ding, F. Zhou, Z. Zhang, Z.-M. Yu, and X. Wang, Charge-two Weyl phonons with type-III dispersion, Phys. Rev. B 105, 134303 (2022).
[4] S. Singh, Q. Wu, C. Yue, A. H. Romero, and A. A. Soluyanov, Topological phonons and thermoelectricity in triple-point metals, Phys. Rev. Materials 2, 114204 (2018).

Abstract ID: 127

CRYOGENIC MAGNETOCALORIC EFFECT IN COBALT HYDROXIDE NANOSHEETS SYNTHESIZED BY HYDROTHERMAL METHOD

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Abstract: Magnetic refrigeration based on the magnetocaloric effect (MCE) is a promising solid-state cooling technology, offering high energy efficiency and environmental sustainability compared to conventional gas-compression systems. Magnetocaloric materials that are earth abundant, having large surface-to-volume ratios, low thermal and magnetic hysteresis and maintaining a higher magnetocaloric response are particularly attractive for practical applications [1]. In this context, cobalt hydroxide emerges as a promising candidate for low temperature magnetic refrigeration. In this study, we prepared β-$Co(OH)_2$ nanosheets via a simple hydrothermal method at a relatively low temperature of 180ºC. X-ray diffraction combined with Rietveld refinement showed the formation of phase pure cobalt hydroxide without any detectable impurity phases. Transmission electron microscopy revealed the formation of hexagonal nanosheets of β-$Co(OH)_2$. Magnetic measurements carried out using vibrating sample magnetometer indicate a paramagnetic to antiferromagnetic transition with a Néel temperature of 9.6 K. A magnetization value of 149 $emug^{-1}$ was obtained at 5 K for an applied magnetic field of 50 kOe. Remarkably, the as-prepared β-$Co(OH)_2$ nanosheets, exhibits a $-\Delta S_M$ value of 23 $Jkg^{-1}K^{-1}$ at 12.5 K for $\Delta H = 5T$ (see Fig.1). Furthermore, at higher applied magnetic fields of 5 T, the $-\Delta S_M$ values of β-$Co(OH)_2$ nanosheets surpass those of other rare-earth-free materials in cryogenic refrigeration and are even comparable to the giant MCE observed in benchmark systems such as Gd, $Gd_5(Si_2Ge_2)$, La-Fe-Si, and MnFePAs alloys [2].

Keywords: Magnetocaloric Effect, Cryogenic Magnetic Refrigeration, Cobalt Hydroxide, Rare-Earth Free Materials.

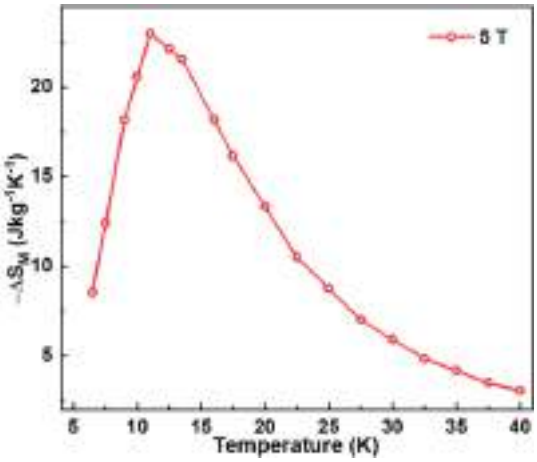


Fig. 1: Magnetic entropy change of as-prepared cobalt hydroxide nanosheets as a function of temperature for an applied magnetic field of 5T.

References:

[1] X. H. Liu, W. Liu, W. J. Hu, S. Guo, X. K. Lv, W. B. Cui, X. G. Zhao, and Z. D. Zhang, Appl. Phys. Lett. 93 (2008) 202502.

[2] N. T. M. Duc, H. Srikanth, and M.-H. Phan, Sci. Technol. Adv. Mater. 26 (2025) 1.

Abstract ID: 128

SINGLE CRYSTAL GROWTH, MAGNETIC AND ELECTRIC PROPERTIES OF $Eu_5Sn_2As_6$

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Abstract: High-quality single crystals of $Eu_5Sn_2As_6$ were successfully synthesized using the self-flux method, crystallizing in a well-ordered orthorhombic structure. Temperature-dependent magnetic susceptibility $\chi(T)$ measurements identify it as an antiferromagnet with canted spin below 10.04 K. Both $\chi(T)$ and specific heat capacity $C_P(T)$ clearly reveal two distinct low temperatures phase transitions for magnetic fields (H) applied along H ∥ ac and H ∥ b. The inverse susceptibility $\chi(T)^{-1}$ follows Curie-Weiss law in the high-temperature paramagnetic regime, yielding a positive Weiss temperature that indicate dominate ferromagnetic exchange interactions. The entropy and associated magnetic contribution were quantified from $C_P(T)$ data. Electrical resistivity $\rho(T)$ measurement show a metal-to-semiconductor crossover just below room temperature, with a narrow activation energy of 66.2 meV. The low-temperature transport behaviour can be well described by the combine effect of weak localization and kondo scattering. Hall effect measurement reveals an n- to p-type carrier crossover at elevated temperature, and together with the transport results, establish the semi-metallic nature of the compound. Further studies, including neutron scattering, magnetoresistance are suggested to examine the behavior of this complex two-phase magnetic system in greater detail.

Keywords: Single crystal, antiferromagnet, semi-mettalic, magnetoresistance.

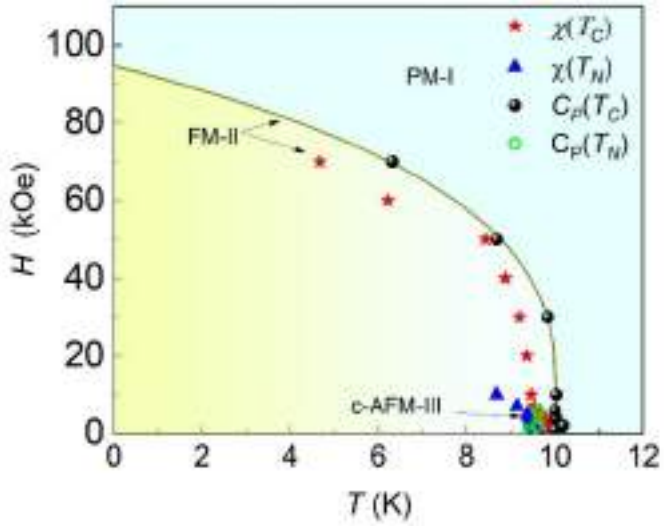


Fig. 1: Magnetic phase diagram for transition, fitted using the power law.

References:

[1] J. Wang, S. Q. Xia, and X. T. Tao, Inorg. Chem. (2012) 5771–5778.
[2] K. P. Devlin, B. Gomez, and S. M. Kauzlarich, *Z.* Anorg. Allg. Chem. (2022) e202100386.
[3] R. P. Day, K. Yamakawa, L. P. Cairns, and J. Singleton, Phys. Rev. B (2025) 054406.

Abstract ID: 129

STRAIN INDUCED EXCHANGE BIAS EFFECT IN THE HETEROSTRUCTURE THIN FILM OF $LaCoO_3$ AND $BaFeO_3$

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Abstract: The type of strain applied to the first layer of heterostructure oxides induces novel magnetic functionalities into the system by reorganizing spin, charge, orbital degrees of freedom at the interfacial region but the microscopic origin behind such occurrence still causing interests in the scientific arena for their potential applications in the spintronic. Here we have grown bilayer thin film of $LaCoO_3$ (LCO)/ $BaFeO_3$ (BFO) on two different substrate $SrTiO_3$ (001) and MgO (001) in order to produce compressive and tensile strain to the BFO layer. The X-ray diffraction confirms two opposite type of strain along the out of plane direction of BFO layer and reflection high energy electron diffraction (RHEED) measurement reflects epitaxial layer by layer growth of the bilayer thin film. The magnetization of the heterostructure with the varying temperature reveals two transition: one is ferromagnetic to paramagnetic transition around 75 K and the another one is for the ferromagnetic to paramagnetic transition of BFO around 130 K. The field cooled (FC) magnetization (M) measurement following both positive and negative cycle of varying field (H) shows exchange bias behaviour for the bilayer film grown on STO substrate. Certainly, this exchange bias behaviour remain absent in the bilayer film grown on MgO substrate. The measured value of exchange bias field is 330 Oe.

Keywords: Exchange bias effect, x-ray diffraction, reflection high energy electron diffraction, spintronic.

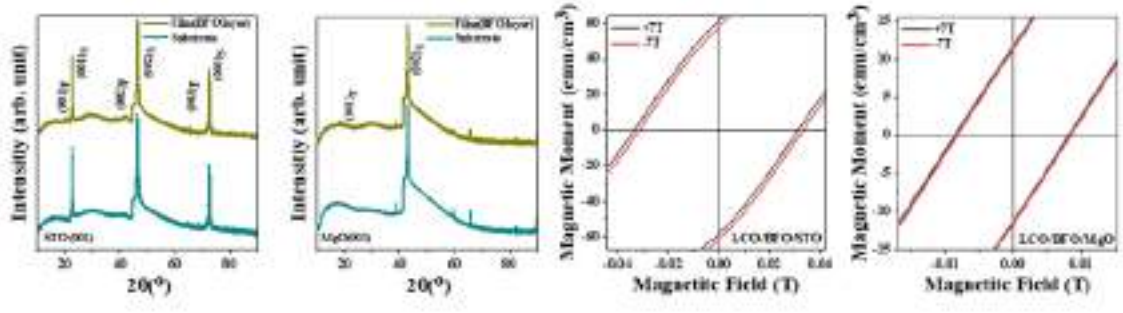


Fig. 1: XRD pattern and M-H plot taken at FC cycles at a temperature of 5 K for of bilayer thin film of LCO/BFO on STO (001) and MgO (001) substrate respectively.

References:

[1] S. Thota, K. Roychowdhury, V. Thakare, S. C. Ganguli, Z. H. Chen, E. J. Guo, and S. Das. Appl. Phys. Lett. 113, 122405 (2018).

[2] Feng, M., Ahlm, N. J., Kane, A. M., Chiu, I., Sasaki, D. Y., Shafer, P., Takamura, Y. (2022). Journal of Applied Physics, 132(19).

Abstract ID: 130

EFFECT OF RARE EARTH SOLUBILITY IN NICKEL FERRITES ON ALTERATION OF MICROSTRAIN AND MAGNETIC PROPERTIES

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Abstract: Europium substituted nickel ferrite nanoparticles ($Eu_xNiFe_{2-x}O_4$, $0.00 \leq x \leq 0.14$) were synthesized via sol-gel auto-combustion method to investigate the correlation between material structure and magnetic properties. FESEM of the samples confirmed globular, agglomerated morphology with 30 nm and 25 nm mean sizes for x = 0.00 and x = 0.06, respectively. XRD studies, utilizing Nelson-Riley extrapolation and Williamson-Hall (W-H) models, revealed a highly non-linear magnetostructural evolution dictated by a critical solubility limit at x = 0.04 [1]. Initial substitution of Eu^{3+} expanded the lattice parameter from 8.336 Å to 8.344 Å, inducing massive internal microstrain and drastically reducing the true W-H crystallite size from ~161 nm to ~21 nm. Beyond x = 0.04, the lattice strain reduced, showing crystallite size growth up to ~181 nm at x = 0.14. VSM analysis demonstrates that Eu^{3+} integration systematically dilutes the primary A-B super-exchange interactions in AB_2O_4 spinel, steadily but drastically reducing saturation magnetization (M_s) from 43.91 emu/g to 30.74 emu/g. Crucially, the magnetocrystalline anisotropy constant (K_1), derived via the Law of Approach to Saturation [2], mirrors the structural strain. K_1 exhibits an anomalous peak at 2.37×10^6 erg/cm^3 for the highly strained x = 0.04 composition before relaxing to a minimum of 1.81×10^6 erg/cm^3 for the value of x = 0.14. These findings demonstrate that strategically driving spinel ferrites to their rare-earth solubility limit provides a robust mechanism to tune internal microstrain and magnetic anisotropy, thereby resulting in suitable magnetic parameters for advanced high-frequency soft magnetic applications.

Keywords: Europium substituted nickel ferrite, X-ray diffraction, Magnetic anisotropy, Saturation magnetization, Nanomagnetism.

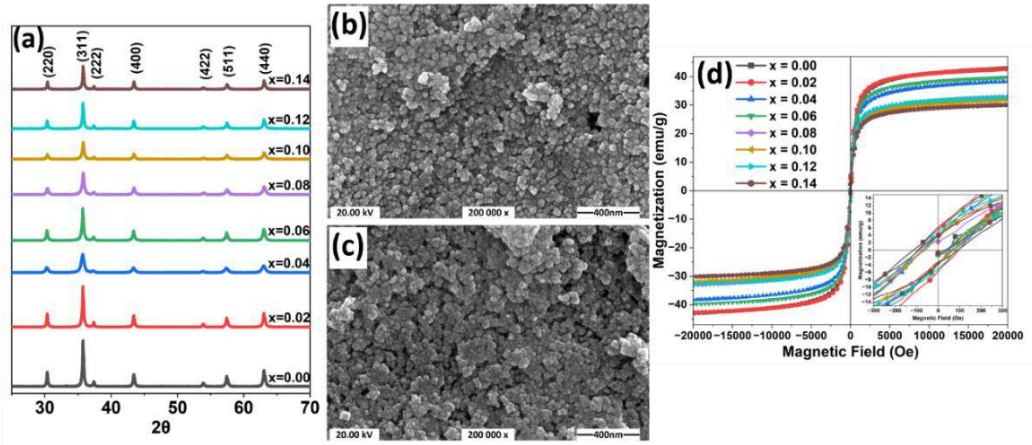


Fig. 1: (a) XRD patterns of $Eu_xNiFe_{2-x}O_4$ nanoparticles. FESEM micrographs of (b) x = 0.0 and (c) x = 0.06 compositions. (d) Hysterisis loops with inset (Zoom-in plot) showing H_c values.

References:

[1] N. Kumar, Archana, R. Kr. Singh, et al., J. Mater. Sci.: Mater. Electron. (2022) 33: 6131–6149.
[2] P. Sivaprakash, S. Divya, S. E. Muthu, A. Ali, et al., J. Mater. Sci. Eng. B, 301 (2024) 117200.

Abstract ID: 131

A MICROMAGNETIC STUDY OF SKYRMIONS IN NANOTUBES WITH INTRINSIC DMI

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Abstract: Magnetic skyrmions are topologically protected swirling spin configurations stabilized in materials with Dzyaloshinskii–Moriya interaction (DMI). Iron Monogermanide (FeGe) is a non-centrosymmetric helimagnet due to which the DMI in the system stabilizes chiral spin textures such as skyrmions and helical states. Magnetic nanotubes are a class of magnetic systems where geometry leads to chirality breaking [1]. The variation in Fe–Ge composition alters the intrinsic DMI, thereby affecting the stability and characteristics of skyrmions. Breaking the cylindrical symmetry by introducing bends offers an additional tunable degree of freedom for controlling skyrmion properties [2]. The magnetization reversal along the direction of bending plays a crucial role in determining the number of skyrmions and their annihilation field. The interplay between intrinsic DMI and curvature enables control over skyrmions. In summary, this work highlights the behavior of skyrmions in FeGe straight and bent nanotubes employing micromagnetic simulations.

Keywords: Skyrmions, Micromagentic simulations, Nanotubes, Magnetization reversal

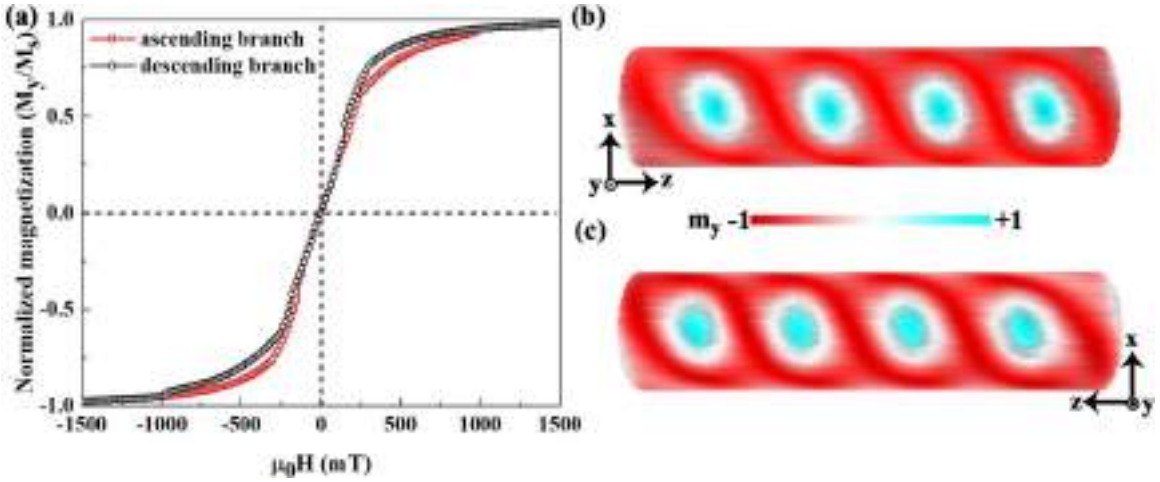


Fig. 1: (a) Normalized M-H loop of an FeGe nanotube. The magnetization reversal images showing the stabilization of skyrmions in FeGe nanotube along **(b)** +y direction and **(c)** -y direction.

References:

[1] Y. Liu, N. Cai, X. Yu, S. Xuan, Sci. Rep. 10 (2020) 21717.

[2] M.A. Garrido-Tamayo, E. Saavedra, C. Saji, U. Guevara, L.M. Pérez, L. Pedraja-Rejas, P. Díaz, D. Laroze, Nanomaterials 14 (2024) 1468.

Abstract ID: 132

EMERGENCE OF GRIFFITHS-LIKE PHASE AND GLASSY MAGNETIC STATE ALONG WITH EXCHANGE BIAS EFFECT IN HOLE-DOPED DOUBLE PEROVSKITE $Sm_{1.5}Ba_{0.5}CoMnO_6$

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Abstract: Substitution of a dopant ion (A′) at the A-site in $A_2BB'O_6$ double perovskites strongly influences the ordering of B and B′ cations [1]. Such substitution promotes the formation of B-site antisite ordering patterns that enhance thermodynamic stability and give rise to diverse functional properties. In particular, it generates multiple magnetic exchange pathways—namely $B-O-B-O-B'$, $B'-O-B'-O-B$, and $B-O-B'-O-B$ linkages—which drive complex magnetic interactions and stabilize various magnetic phases [2]. Herein, we present a systematic study of the structural characteristics and magnetic phase complexity of the hole-doped Sm-based double perovskite $Sm_{1.5}Ba_{0.5}CoMnO_6$ prepared via a conventional sol-gel synthesis route. A Griffiths-like phase is identified in the system near 140 K from deviations in dc susceptibility above the long-range ordering ($T_C = 127$ K). Dc and ac magnetization measurements reveal a glassy state around 119 K. The existence of such multiple magnetic phases leads to the occurrence of the exchange bias effect (EB) at lower temperature. Isothermal magnetization measurements confirm the presence of conventional exchange bias effect arising from interfacial coupling induced by disorder. Owing to its large exchange bias effect and the coexistence of multiple magnetic phases, this compound emerges as a promising candidate for advanced magnetic and spintronic applications [3].

Keywords: Double perovskite, Griffith-like phase, Exchange bias effect, Sol-gel synthesis route, Glassy state.

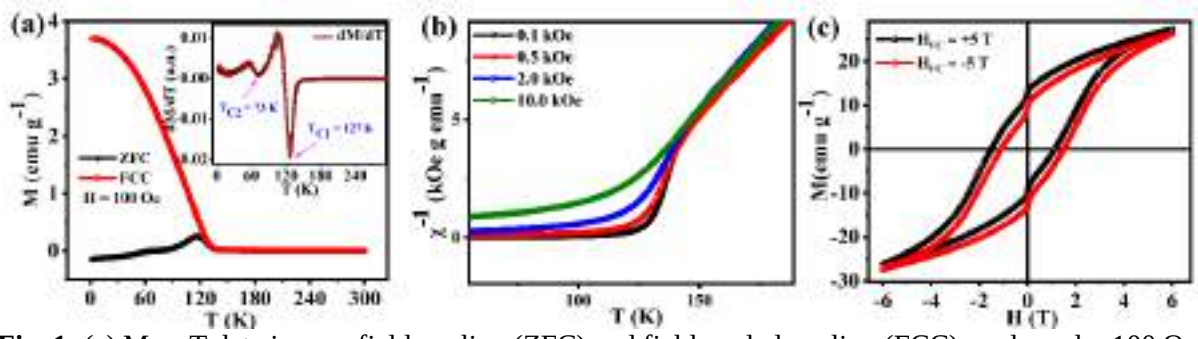


Fig. 1: (a) M vs T data in zero field cooling (ZFC) and field cooled cooling (FCC) mode under 100 Oe magnetic field. Inset shows thye corresponding dM/dT vs T data. (b) χ^{-1} vs T data for different applied magnetic fields. (c) Field cooled M vs H loop at 1.8 K.

References:

[1] A. Shit, T. Das, S. D. Das, T. K. Nath, J. Alloys Compd. 1008 (2024) 176547.
[2] R. C. Sahoo, Y. Takeuchi, A. Ohtomo, Z. Hossain, Phys. Rev. B 100 (2019) 214436.
[3] A. Shit, S. D. Das, T. K. Nath, J. Alloys Compd. 1033 (2025) 181197.

Abstract ID: 133

JAHN-TELLER DISTORTION AND ANTISITE DISORDER DRIVEN GRIFFITH PHASE SINGULARITY IN $Ho_2Ni_{1-x}Mn_{1+x}O_6$ $(x = 0.00, 0.25, 0.50)$ DOUBLE PEROVSKITES OXIDES

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Abstract: In this study, the magnetic properties of $Ho_2Ni_{1-x}Mn_{1+x}O_6$ (x = 0.00,0.25,0.50) samples were investigated by changing the Mn content. Structural analysis confirms the formation of polycrystalline monoclinic double perovskites with $P2_1/n$ space group synthesized using the solid-state reaction route. A thorough analysis of Jahn-Teller (JT) distortion and polyhedral distortion has been conducted and explained as a consequence of variations in the spin structure of Ni and Mn ions with extra Mn content. XPS analysis confirms mixed valence states, showing systematic changes in Mn^{3+}/Mn^{4+} and Ni^{2+}/Ni^{3+} ratios with increasing Mn content. Both high-spin (HS) and low-spin (LS) states of Mn^{3+} (HS:$t_{2g}^3e_g^1$; LS: $t_{2g}^4e_g^0$) and Ni^{3+} (HS: $t_{2g}^5e_g^2$; LS: $t_{2g}^6e_g^1$) are JT active, whereas Mn^{4+} ($t_{2g}^3e_g^0$) and Ni^{2+} ($t_{2g}^6e_g^2$) are JT inactive. All the samples show phase transition at around 83 K while a short-range ferromagnetic correlation has been seen to start much above T_C, which is a sign of Griffiths phase in the system. The magnetic ground state is governed by canted Ni/Mn spin arrangements and their interaction with the Ho sublattice. Saturation magnetization (M_S) measured at 1.8 K shows deviations from theoretical values, attributed to increasing anti-site disorder with higher Mn content.

Keywords: Double perovskite, Jahn-Teller (JT) distortion, Antisite disorder, Magnetic properties, Griffith phase.

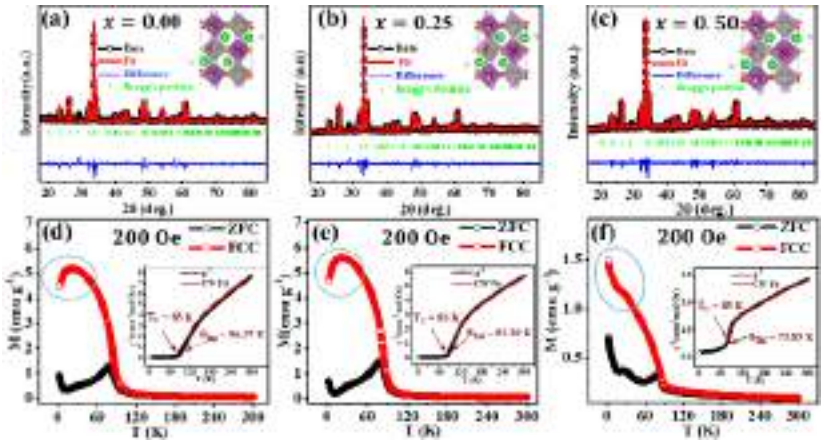


Fig. 1: (a-c) X-ray Diffraction and (d-f) M-T (ZFC and FCC) Plot of $Ho_2Ni_{1-x}Mn_{1+x}O_6$ (x = 0.00,0.25,0.50) samples.

References:

[1] T. Saha-Dasgupta, Double perovskites with 3d and 4d/5d transition metals: Compounds with promises, Mater Res Express 7 (2019) 014003. https://doi.org/10.1088/2053 1591/ab6293.

Abstract ID: 134

TUNING MAGNETIC FRUSTRATION AND SLOW SPIN DYNAMICS VIA SITE-SPECIFIC Ga DILUTION IN CO_3O_4 SPINELS

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Abstract: Magnetic frustration induced by controlled substitution of non-magnetic elements in magnetic spinels is a subject of intense research for a few decades. Focusing on this aspect in this work, we investigate the influence of Ga dilution on the electronic structure and magnetic properties of antiferromagnetic (AFM) Co_3O_4, aiming to understand its non-trivial magnetic ground states through combined experimental and density functional theory (DFT+U) studies. Experimental results on the bulk grain size (1.6-2.0 µm) samples of Ga_2CoO_4 confirm the cubic $Fd\bar{3}m$ structure ($F^4_{1/d}\bar{3}_{2/m}O^7_h$; No. 227) without any detectable structural distortion or spurious secondary phases. *X*-ray photoelectron spectroscopy and first-principles calculations reveal distinct cationic distributions and electronic states, leading to modified Co–O hybridization and an enhanced electronic band-gap relative to pristine Co_3O_4. Magnetization measurements show complete suppression of the long-range AFM ordering of Co_3O_4 ($T_N \approx$ 29.9 K) and emergence of a low-temperature spin-glass (SG) state with freezing temperature, $T_{SG} \approx 8$ K. Frequency-dependent AC magnetic susceptibility (χ_{ac}) data reveal pronounced dispersion in its peak maximum, resulting in Mydosh parameter, $\Omega \sim 0.02$, confirming the presence cluster SG state in the system [2]. Dynamical scaling analysis using power-law and Vogel–Fulcher law yields spin relaxation times ~ 10^{-12}–10^{-15} sec and the critical exponent ($z\nu$~11) consistent with the cooperative spin freezing phenomena (as shown in fig. 1(a)). The field dependence of T_{SG} follows the Almeida–Thouless relation with crossover exponent, $\Phi \sim$ 3.2, indicating random anisotropy prevalent in the system (fig. 1(b)). Thermoremanent magnetization confirms slow magnetic relaxation below T_{SG} where initial magnetization and magnetic viscosity decrease monotonically and vanish near the transition (fig. 1(c)). Magnetic hysteresis loops exhibit exponential reduction of coercivity and remanence with fitting exponents $\alpha_H = (0.25 \pm 0.01)$ and $\alpha_M = (0.125 \pm 0.001)$, further supporting the spin-glass state present in the system. These results demonstrate that Ga-induced magnetic dilution disrupts competing superexchange interactions, enhances frustration, and stabilizes the cluster spin-glass state, emphasizing the interplay between cation disorder and emergent magnetic dynamics in spinel oxides.

Keywords: Antiferromagnetism, Spin Glass, Mydosh parameter, remanent magnetization

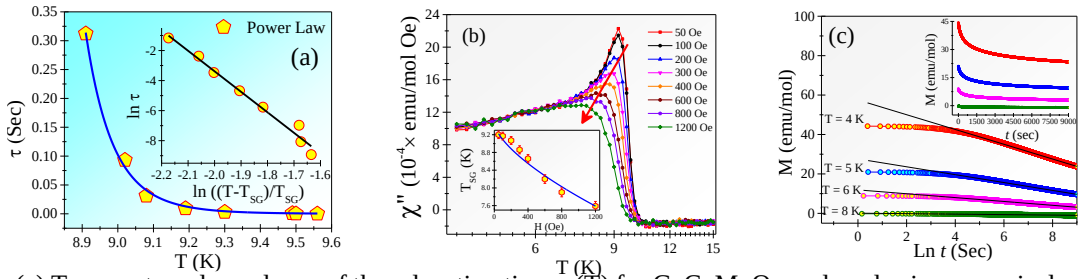


Fig. 1: (a) Temperature dependence of the relaxation time τ (T) for $GaCoMnO_4$ analyzed using emperical power-law analysis. (b) Field dependent imaginary component of the ac susceptibility, χ′′(T), with the non–mean-field Almeida–Thouless (AT) fit shown in the inset. (c) Thermoremanent magnetization measured under H_{DC} = 90 kOe at T= 4 – 8 K; solid lines denote fits to the Kohlrausch stretched-exponential relaxation model.

Abstract ID: 135

TEMPERATURE-DEPENDENT PAULI SUSCEPTIBILITY OF AN ALTERMAGNET CANDIDATE RuO_2

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Abstract: Altermagnets are a recently identified class of antiferromagnets with symmetry-driven magnetic responses. Following the 2019 pioneering studies and the review by Šmejkal [1], RuO_2 has become a key candidate, sparking extensive investigations since 2020. However, its magnetic ground state—paramagnetic or altermagnetic—remains unresolved, largely due to limitations in crystal quality (RRR = 12–160) used in earlier studies. In this work, we report the growth of ultra-clean RuO_2 single crystals exhibiting RRR values above 1200 [2]. Depending on the growth conditions, the crystals form either bulk-like or needle-like morphologies as shown in figure [2]. Low-temperature DC susceptibility measurements reveal an upturn attributable to trace paramagnetic impurities at the level of only a few tens of ppm [1,2]. Curie–Weiss analysis yields Curie constants of 1.8×10^{-5} emu·K/mol for RRR = 400 and 7.7×10^{-6} emu·K/mol for RRR = 1200, corresponding to impurity concentrations of approximately 36 ppm and 15 ppm, respectively [3]. The exceptionally high RRR of our ultra-clean crystals allows us to conclude that bulk RuO_2 is intrinsically paramagnetic [2-5]. Nevertheless, the temperature-dependent susceptibility is accurately described by a logarithmic $T^2\ln T$ contribution, while the field dependence follows an $H^2\ln H$ scaling, characteristic of Fermi-liquid behaviour [3]. The electronic specific heat, magnetic susceptibility, and T^2 resistivity demonstrate that RuO_2 behaves as a weakly correlated three-dimensional Fermi liquid, in agreement with the Wilson and Kadowaki–Woods ratios [3].

Keywords: Altermagnet candidate, Ultra-clean oxide single crystal, Resistivity, Magnetisation, Specific heat, Wilson and Kadowaki–Woods ratios.



Fig. 1: Optical images of the ‘‘zoo’’ of RuO_2 crystals in various morphologies.

References:

[1] L. Šmejkal et. al., Physical Review X 12, 040501 (2022)
[2] S. Paul et. al., Journal of Crystal Growth 673, 128405 (2025).
[3] S.Paul et. al., arXiv:2512.03108 (2025)
[4] Z. Wu, S.Paul et. al., Physical Review X 15, 031044 (2025)
[5] T. Osumi, S.Paul et. al., Physical Review 113, 085116 (2026)

Abstract ID: 136

$Fe_{1-x}Cr_xNbO_4$ (x = 0.0 - 1.0): STABILIZATION OF RUTILE STRUCTURE AND MAGNETIC SPIN GLASS BEHAVIOUR

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Abstract: Iron niobium oxide ($FeNbO_4$) exists in three different polymorphs [1]. The wolframite structure with monoclinic symmetry is stable below 1085 ℃. The ixiolite structure with an orthorhombic symmetry is stable between 1085 and 1380 ℃, above which it transforms to rutile-type tetragonal symmetry between 1380 and 1450 ℃. This high-temperature rutile structure can be effectively stabilized by a systematic substitution of Fe^{3+} with Cr^{3+}, which reduces the low-temperature rutile structure instability as found in the pure $FeNbO_4$ compound, as confirmed by powder X-ray diffraction analysis. There is a substantial variation in the lattice parameters with the progressive addition of Cr, indicating a continuous structural variation throughout the series. Magnetic measurements indicate a transition from long-range antiferromagnetic ordering in $FeNbO_4$ to a spin glass-like state at an intermediate concentration of Cr, once the phase is stabilized. This is due to the spin-glass behaviour arising from cation disorder in rutile-type $CrNbO_4$ [2]. A composition-dependent magnetic entropy change, as indicated by the observed magnetic phase transitions, has been identified by analyzing the magnetocaloric effect through isothermal magnetization analysis. These findings indicate the effectiveness of Cr substitution in varying the structural stability and functional properties of $FeNbO_4$, making $Fe_{1-x}Cr_xNbO_4$ (x =0.0-1.0) a potential candidate for magnetically active material applications.

Keywords: Rutile structure stabilization; Antiferromagnetism; Magnetic frustration; Spin glass State; Memory effect; Magnetic Entropy; Magnetocaloric effect; Magnetic Refrigeration.

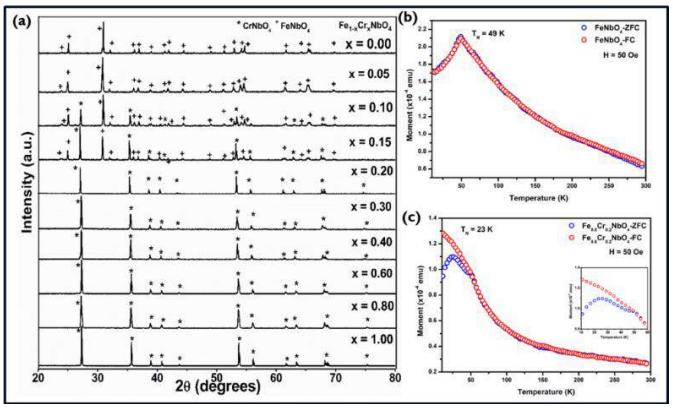


Fig. 1: (a) Powder XRD patterns of $Fe_{1-x}Cr_xNbO_4$ revealing the phase transformation; Temperature-dependent magnetization curves under ZFC and FC conditions of (b) wolframite $FeNbO_4$ and (c) rutile $Fe_{0.8}Cr_{0.2}NbO_4$, the latter exhibiting spin glass behaviour.

References

[1] N. Lakshminarasimhan et al., Progress in Solid State Chemistry 54 (2019) 20-30.
[2] N. Lakshminarasimhan, Materials Research Bulletin 142 (2021) 111440.

Abstract ID: 137

ROLE OF (Fe,Cu)O_5 POLYHEDRON DISTORTIONS IN TUNING THE MAGNETISM OF TYPE-II MULTIFERROIC YBaCuFeO_5

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Abstract: Recently magnetism-driven ferroelectricity has been reported for a number of frustrated magnets featuring ordered spiral magnetic phases [1]. Such materials are interested due to their potential for spintronics and low-power magnetoelectric devices. In this context, spiral magnet YBaCuFeO_5 (YBCFO) has highest critical temperatures, which exhibits a particular type of chemical disorder (between Fe and Cu) providing the possibility of tuning magnetism with either substitution, preparation conditions etc [1, 2]. The present work reports the study of Zn substitution effects at Cu site in YBCFO, with complimentary experimental methods to understand the role of Fe/Cu positional disorder and/or (Fe,Cu)O_5 polyhedron distortions in tuning its magnetic transition temperatures. Synchrotron X-ray diffraction reveals systematic modifications at (Cu,Fe)O_5 polyhedron with Zn substitution. Unambiguous signatures of increasing distortion in FeO_5 polyhedron are obtained from ^{57}Fe Mössbauer measurements that are carried out in the paramagnetic region. From detailed temperature dependent magnetization and ^{57}Fe Mössbauer measurements, magnetic transition temperatures of para to collinear anti-ferromagnetism (T_{N1}), collinear anti-ferromagnetism to spiral magnetism (T_{N2}) are determined. Employing ^{57}Fe Mössbauer and anomalous X-ray diffraction it is shown that Fe (Cu) occupy $1b_1$ ($1b_2$) site with Zn substitution similar to that of parent composition [2] implying that the distortion in (Fe,Cu)O_5 polyhedron are dominant over the Fe/Cu site-disorder in tuning magnetic transition temperatures.

References:

[1] M. Morin et al., Nat Commun., 7 (2016) 13758.
[2] Saurabh Gupta et al., Phys. Rev. Mater. 8 (2024) 114414.

Abstract ID: 138

INFLUENCE OF NON-MAGNETIC ION ON THE PHYSICAL PROPERTIES OF $Sm_3Fe_{5-x}Mn_xO_{12}$ FOR RESONATOR ANTENNA

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Abstract: Nowadays magnetic materials are highly in demand for high frequency applications such as telecommunications and radar systems. Samarium-iron garnet ($Sm_3Fe_5O_{12}$: SmIG) is a potential candidate for broad microwave applications [1]. This work unfolds the investigation of structural and magnetic properties of Mn doped Samarium Iron Garnet ($Sm_3Fe_{5-x}Mn_xO_{12}$: x =0, 0.15 and 0.25 wt%). The synthesized samples exhibits cubic crystalline nature with space group Ia-3d. The crystallite size was estimated through the Williamson-Hall plot analysis and found to reduced from 70.577 nm to 60.714 nm. The room temperature saturation magnetization value was enhanced from 16.3 emu/g to 23.5 emu/g. These materials exhibits a ferrimagnetic (FIM) to paramagnetic (FIM) phase transition at high temperature rose from 557 K to 545 K which is attributed to the lesser superexchange interaction between Fe^{3+} ions. . The FIM T_c were determined from dM/dT versus T plot as shown in inset of Fig 1 (a & b). The synthesized samples shows soft ferrimagnetic behavior. The stable crystal structure, soft ferrimagnetic nature and high transition temperature make these material suitable for ferrite resonator antenna a new technology towards 5G applications.

Keywords: Cubic Crystal, Soft Magnetic Materials, Ferrimagnet, Antenna.

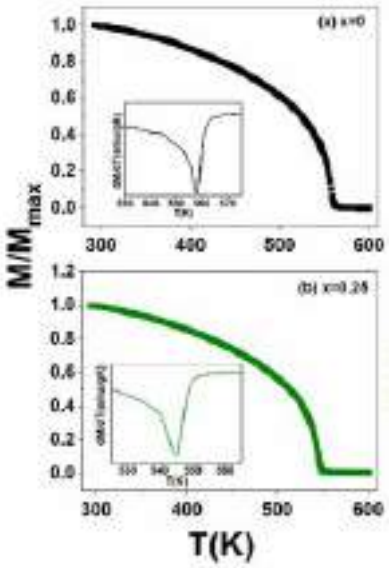


Fig. 1: (a & b) Ferrimagnetic to paramagnetic transition curve for x = 0 and 0.25 wt% of $Sm_3Fe_{5-x}Mn_xO_{12}$.

References:

[1] S. Yadav, M. Sharma, & B. K. Kuanr. "Fabrication of compact circular ring antenna loaded with Gd-YIG ferrites: Photon–magnon interaction" *AIP Advances*, *14*(1) (2024) 015224.

Abstract ID: 139

INTERPLAY OF MAGNETIC ORDERING AND DIELECTRIC RESPONSE IN $0.9Bi_2Fe_4O_9/0.1CoFe_2O_4$ COMPOSITE

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Abstract: The sol–gel auto-combustion method was used to synthesize the composite $0.9Bi_2Fe_4O_9/0.1CoFe_2O_4$, and its structural, magnetic, and dielectric properties were systematically studied in the present work. Rietveld refinement of room-temperature (RT) X-ray diffraction (XRD) patterns confirmed the composite's biphasic nature. The zero-field-cooled and field-cooled magnetization data show strong magnetic irreversibility in the composite below 200 K, and the openings of M–H hysteresis loops at 10 K and 150 K confirm the onset of weak ferromagnetism with magnetic glass–like characteristics in the composite 0.9BFO/0.1CFO [1]. An anomaly is observed near the magnetic transition temperature in ε', and the contrasting nature of tanδ below and above the transition temperature was observed over the same temperature range. These features suggest a possible coupling between the magnetic and electric order parameters [2]. The presence of magnetodielectric (MD) coupling enhances the composite's potential for multifunctional applications, such as memory devices, sensors, and actuators [3].

Keywords: sol-gel auto combustion, magnetic irreversibility, ferromagnetism, magnetodielectric coupling.

References:

[1] S. R. Mohapatra, P. N. Vishwakarma, S. D. Kaushik, R. J. Choudhary, N. Mohapatra, and A. K. Singh, J. Appl. Phys. 121 (2017) 124101.

[2] S. Kumari, D. K. Pradhan, P. T. Das, N. Ortega, K. Pradhan, J. F. Scott, *J. Appl. Phys.* 122 (2017), 144102

[3] J. Zhao, T. Liu, Y. Xu, Y. He, W. Chen, Synthesis and characterization of $Bi_2Fe_4O_9$ powders, Mater. Chem. Phys. 128 (2011) 388.

Abstract ID: 140

DESIGN AND DEVELOPMENT OF PERIODIC MAGNETIC FOCUSING STRUCTURE FOR MM-WAVE TWT

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Abstract: The current paper deals with design and development of a periodic magnetic focusing magnetic structure for a mm-wave Traveling Wave Tube (TWT).The size of mm-wave TWT falls drastically when compared to lower freqeuncy TWTs. The decrease in size of the TWT throws a challenge in design and development of the magnetic focusing structure.A magnetic flux density of 3500G was required to focus the electron beam with 0.65A at 20kV specifications.Magnetic field in the slow wave structure with diameter 1.4mm has to be generated to focus and transport the electron beam over a length of 130mm.A Periodic Permament Magnetic (PPM) focusing structure was tried. It has a chain of pole piece and spacers arranged alternatively , where the pole piece is magnetic conductor and spacer is a non-magnetic material.Circular magnets with slits are integrated with the spacers and pole piece as shown in the fig:01. The PPM structure is simulated in CST and also with EGUN code.The structure is developed by integrating pole pieces, spacers and magnets.Samarium cobalt based magnets were used to integrate with the stack. The desired on axis field was generated by 15-20% lower than desired. NdFeB magnets,which have high energy product than samarium cobalt ,was used to overcome the problem. Thus developed structure resulted in desired on axis field. Thus developed focusing structure was integarted with the TWT for performance check and the results were as desired.

Keywords: TWT, Magnet,field.

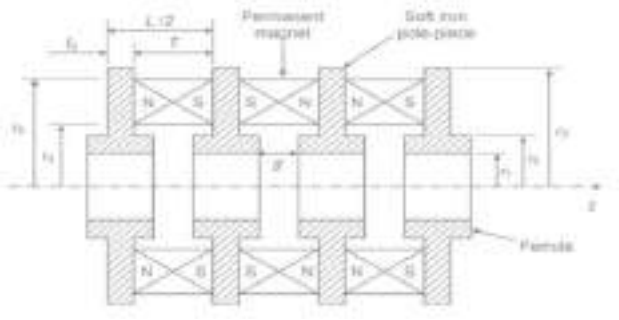


Fig. 1: Schematic of PPM focusing structure

References:

[1] M. Santra, L. Kumar, and J. Balakrishnan, “An analytical approach for obtaining user defined axial magnetic field profile of a PPM focusing structure,” IEEE Trans. Electron Devices, vol. 58, no. 11, pp. 4087–4092, Nov. 2011.

Abstract ID: 141

SURFACTANT-ASSISTED SYNTHESIS OF HIGH ANISOTROPIC STRONTIUM HEXAFERRITE ($SrFe_{12}O_{19}$) FOR BONDED MAGNET APPLICATIONS

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Abstract: Precise regulation of particle size and suspension stability is essential for advanced nanomaterial processing. In this context, surfactant-assisted milling provides an effective and adaptable route to enhance milling efficiency and control interfacial interactions during wet pulverization. Ovtar et al.[1] investigated the stability of dodecylbenzene sulfonic acid (DBSA)-capped $BaFe_{12}O_{19}$ particles and demonstrated that the formation of a second DBSA layer significantly enhanced the colloidal stability of the system. In this study, Strontium Hexaferrite (SHF) synthesized via a conventional solid-state route was wet-milled in water with the addition of cetyltrimethylammonium bromide (CTAB) following calcination, across a pH range of 4–14. The influence of the surfactant on particle stability, structural integrity, morphology, and magnetic properties of the milled and subsequently annealed powders was systematically evaluated and optimized by analysing the microstructural and magnetic properties. Increasing NaOH concentration, the SHF particle surfaces progressively deprotonated, resulting in a negatively charged surface. The most stable suspension was achieved at pH 12, exhibiting a high magnetic squareness ratio of 92%. To mitigate the degradation of the coating caused by carbonization during post-stress relieving annealing, a subsequent surface treatment with CTAB was imperative. The efficacy of this intervention was confirmed by the complete restoration of magnetic properties, highlighting the essential function of surfactant-mediated surface modification in optimizing the suitability of SHF particles for permanent magnet applications.

Keywords: Strontium Hexaferrites, CTAB, Zeta potential, pH, post-annealing, surface treatment

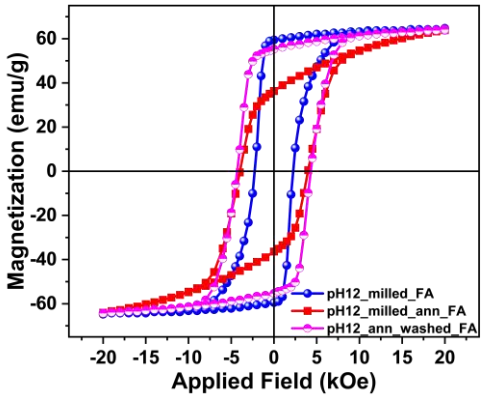


Fig. 1: Room temperature magnetic hysteresis curves recovery of high squareness and coercivity with suitable treatment of surfactant.

References:

[1] Ovtar S., Lisjak D., Drofenik M. J., Surface and Interface Analysis. *42* (2010) 1217–1221.

Abstract ID: 142

UNIFYING GHz-THz SPINTRONICS THROUGH THE CALCULATION OF SPIN DIFFUSION LENGTHS IN HEAVY METALS.\

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Abstract: The advent of out-of-equilibrium excitation in ferromagnet(FM)/heavy metal(HM) heterostructures has transformed spintronics by enabling the generation of ultrafast spin currents that extend into the terahertz regime [1]. Unlike spin currents driven near equilibrium through ferromagnetic resonance [2], these ultrafast currents are triggered by femtosecond laser excitation and follow distinct dynamical pathways. In this work, we experimentally demonstrate a direct link between the spin diffusion lengths associated with spin currents generated at gigahertz and terahertz frequencies. Henceforth, we measured the spin diffusion lengths of three different heavy metals, platinum, tungsten, and tantalum, from the THz emission data of the bilayer structure comprising these metals and the ferromagnet NiFe, one by one. Complementing the experiments, we introduce analytical models that connect the microscopic mechanisms, allowing for a quantitative determination of spin diffusion lengths [2] in heavy metals such as Pt, W, and Ta. Our study provides new insights into ultrafast spin transport, offering a contactless and non-invasive optical route to probe spin properties. By bridging GHz and THz spin dynamics, these results not only deepen the fundamental understanding of spin transport but also support the advancement of next-generation memory devices.

Keywords: GHz-THz spintronics, Spin diffusion lengths, THz emission, Spin transport.

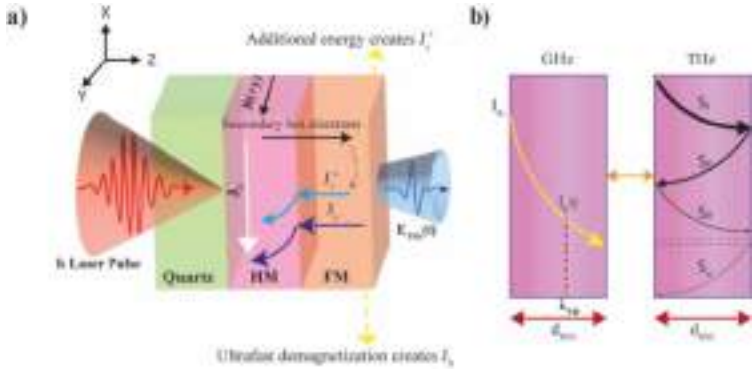


Fig. 2: (a) THz emission by a fs laser pulse from FM/HM bilayer;(b) Variation in spin dynamics in GHz and THz frequencies.

References:

[1] Seifert, Tom, S. Jaiswal, U. Martens, J. Hannegan, Lukas Braun, Pablo Maldonado, F. Freimuth. *Nature Photonics* 10, no. 7 (2016): 483-488.

[2] Berger, A. J., Edwards, E. R., Nembach, H. T., Karis, O., Weiler, M., & Silva, T. J., *Physical Review B 98*(2) (2018), 024402.

Abstract ID: 143

EFFICIENT SPIN-TO-CHARGE CONVERSION IN Bi_2Se_3/NiFe HETEROSTRUCTURE THROUGH Ti SPACER LAYER

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Abstract: Topological insulator–ferromagnet heterostructures provide an efficient platform for spin–charge interconversion due to strong spin–orbit coupling and spin–momentum locking of topological surface states [1]. However, the efficiency of spin-to-charge conversion critically depends on interface quality, as atomic interdiffusion can degrade these surface states. In this work, we investigate the role of interfacial engineering in enhancing spin-to-charge conversion in Bi_2Se_3/NiFe heterostructures. Crystalline Bi_2Se_3 thin films were deposited on Si (100) substrates using magnetron sputtering, followed by NiFe as the ferromagnetic layer. Spin pumping and spin-to-charge conversion were examined using ferromagnetic resonance (FMR) spectroscopy combined with inverse spin Hall effect (ISHE) measurements. To suppress interfacial diffusion, a thin Ti spacer layer was inserted between Bi_2Se_3 and NiFe. The Ti spacer led to a significant enhancement in spin-to-charge conversion, with the effective spin Hall angle increasing from 0.18 ± 0.06 to 1.79 ± 0.03. This improvement is attributed to reduced Fe diffusion into Bi_2Se_3, which otherwise causes chemical interaction with Se and degradation of topological surface states [2]. The Ti layer preserves interface integrity, enabling efficient transmission of spin currents. These findings emphasize the importance of interface engineering for optimizing spin–orbitronic device performance.

Keywords: Topological Insulator, Spin Hall Angle, Bismuth Selenide, Ferromagnetic Resonance, Inverse Spin Hall Effect

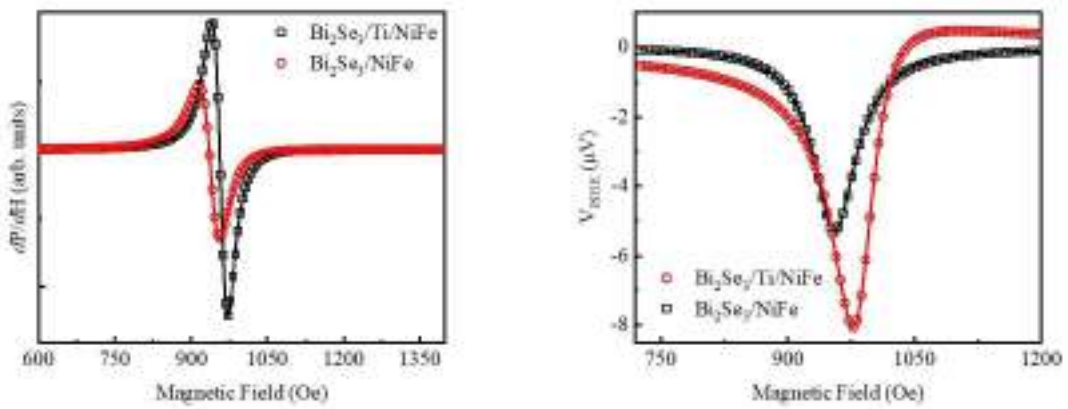


Fig. 1: (a), (b) FMR spectra and ISHE voltage drop Bi_2Se_3/NiFe heterostructure with and without the Ti spacer layer, respectively.

References:

[1] A.R. Mellnik, J.S. Lee, A. Richardella, J.L. Grab, P.J. Mintun, M.H. Fischer, A. Vaezi, A. Manchon, E.-A. Kim, N. Samarth, D.C. Ralph, Nature 511 (2014) 449–451.

[2] H.T. He, G. Wang, T. Zhang, I.K. Sou, G.K.L. Wong, J.N. Wang, H.Z. Lu, S.Q. Shen, F.C. Zhang, Phys. Rev. Lett. 106 (2011) 166805.

Abstract ID: 144

A STUDY ON MATERIAL VARIATION ON PERFORMANCE OF PCB MOTOR

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Abstract: Printed circuit board (PCB) motors are emerging as compact and high-speed electromechanical solutions for electric mobility, robotics, and aerospace applications. Unlike conventional laminated stator machines, PCB motors depend more on material properties due to their slotless topology and multilayer copper windings. This study investigates the effect of varying magnetic, conductive, and substrate materials on the electromagnetic, thermal, and efficiency characteristics of an axial-flux PCB motor.A comparative analysis is performed by varying permanent magnet grades , rotor back-iron materials , and stator substrate materials . A coupled electromagnetic–thermal finite element model is developed to evaluate air-gap flux density, torque density, core losses, eddy current losses, and temperature rise under identical operating conditions. The influence of material parameters such as saturation flux density, coercivity, electrical resistivity, and thermal conductivity on overall motor performance is systematically quantified.The results demonstrate that material substitution significantly impacts torque production, loss distribution, and steady-state temperature rise, highlighting critical trade-offs between magnetic performance and thermal stability. The study provides design guidelines for optimal material selection in high-speed PCB motors and establishes a framework for electromagnetic–thermal co-optimization of next-generation compact electric drive systems.

Keywords: Core loss, Eddy lossElectromagnetic Effect, Printed Circuit Boartd, Magnetic Flux Density.

References:

[1] H. Wu, C. Zhi, H. Gao, L. Xu and Y. Mao, "Design and Evaluation of a Flat PCB Based Axial Flux Motor," 2024 27th International Conference on Electrical Machines and Systems (ICEMS), Fukuoka, Japan, 2024, pp. 543-546, doi: 10.23919/ICEMS60997.2024.10921003.

[2] B. Anvari, P. Guedes-Pinto and R. Lee, "Dual Rotor Axial Flux Permanent Magnet Motor using PCB Stator," 2021 IEEE International Electric Machines & Drives Conference (IEMDC), Hartford, CT, USA, 2021, pp. 1-7, doi: 10.1109/IEMDC47953.2021.9449506.

Abstract ID: 146

SINTERING-CONTROLLED DEFECT ENGINEERING IN BULK BISMUTH DOPED YIG: INTERPLAY BETWEEN MICROSTRUCTURE, MAGNETO-DIELECTRIC RESPONSE, OPTICAL BAND STRUCTURE, AND CHARGE TRANSPORT

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Abstract: Engineering intrinsic material parameters rather than external device geometry offers a fundamentally scalable pathway for tuning photon-magnon interactions in microwave systems. In this study, we demonstrate a sintering-controlled defect-engineering strategy to optimize bulk $Bi_{0.6}Y_{2.4}Fe_5O_{12}$ (Bi–YIG) as a multifunctional magneto-dielectric platform. The Bi concentration (x = 0.6) was deliberately selected to enhance magneto-optical response and modulate saturation magnetization while preserving single-phase garnet stability. Samples synthesized via citrate–nitrate sol–gel auto-combustion were sintered at 850 °C, 950 °C, and 1050 °C to establish correlations between microstructure, electrical transport, dielectric relaxation, optical band structure, and magnetic ordering. Rietveld refinement confirms single-phase cubic $Ia\bar{3}d$ symmetry [1] with lattice expansion (a ≈ 12.397 Å) due to Bi^{3+} substitution. FESEM analysis reveals progressive grain growth, with the 950 °C sample exhibiting optimal densification and minimal porosity. Temperature-dependent resistivity follows thermally activated small-polaron hopping between Fe^{2+}/Fe^{3+} ions, while dielectric measurements indicate Maxwell–Wagner interfacial polarization [2]. The 950 °C specimen shows highest resistivity and lowest dielectric loss, reflecting suppressed oxygen-vacancy–mediated relaxation. UV-Vis spectroscopy confirms a direct allowed band gap (~2.2 eV) arising from Bi-induced Fe-O hybridization modification [3]. Magnetic measurements reveal enhanced room-temperature saturation magnetization (~26 emu/g) and the highest Curie temperature (~556 K) for the 950 °C sample, indicating strengthened superexchange and reduced spin disorder. The balanced crystallinity and defect suppression at 950 °C define an optimal processing window for low-dissipation magnonic and reconfigurable microwave applications.

Keywords: Defect-engineering, Magneto-dielectric, Sol-gel auto-combustion, UV-Vis spectroscopy, Maxwell–Wagner interfacial polarization.

References:

[1] N. Askarzadeh and H. Shokrollahi, J. Mater. Sci.: Mater. Electron. 36 (2025) 2009
[2] Y. Bai, Y. Chen, L. Zhang, J. Wang, J. Chen, and S. Zhao, J. Appl. Phys. 132 (2022) 224106
[3] R. Hazam, M. Maity, S. Verma, R. Singh, and B. Bhoi, Chem. Phys. Impact 9 (2024) 100671

Abstract ID: 147

INTERFACE-INDUCED ENHANCED MAGNETIC ANISOTROPY AND OBSERVATION OF DUAL MAGNETORESISTANCE IN LSMO THIN FILMS ON (001) Si SUBSTRATE

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Abstract: Magnetic oxide thin films with strong anisotropy and tunable magnetotransport properties are crucial for next-generation spintronic devices. One effective strategy for manipulating these properties is to use interfaces in correlated oxide systems. The interface is created by growing a series of $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) films on (001) oriented silicon substrates using pulsed plasma deposition techniques. The LSMO thin films with varying thicknesses ($\leq$ 20 nm) demonstrate a strong magnetic anisotropy on the order of 10^6 erg/cm^3, surpassing many reported heterostructures and comparable to state-of-the-art oxide thin films and metal/oxide interfaces[1]. Analysis using the Stoner-Wohlfarth model and density functional theory (DFT) reveals that the observed anisotropy predominantly arises from shape effects and interfacial spin reordering, modulated by charge transfer at the Si–O–Mn interface, which induces non-collinear antiferromagnetic ordering of Mn ions. These highly oriented LSMO films exhibit both positive and negative magnetoresistance (MR), in contrast to the typical colossal negative MR observed in bulk LSMO. Low-field, in-plane positive MR reaches a maximum of ~7% for 12.4 nm films and ~12% for 20.0 nm films, while out-of-plane MR variation is limited to ±0.8%. The in-plane MR switching field occurs at ±0.2 kG (coercive field), whereas the out-of-plane MR switching field is much higher (up to ±5 kG), indicating strong anisotropy modulated by interfacial exchange coupling strength[1].The unique dual-sign MR, strong tunability, and anisotropic switching behaviour observed in these Si/LSMO films reveal new opportunities for the design of advanced magnetic sensors and memory devices compatible with silicon technology [1].

Keywords: Magnetic Anisotropy, Stoner-Wohlfarth Model, Density Functional Theory, Thin Films

References:

[1] U. K. Sinha, A. Sahoo, P. Padhan, J. Alloys Compd. 952 (2023) 170037.

Abstract ID: 148

THERMALLY ROBUST BiSb(Ge) TOPOLOGICAL HETEROSTRUCTURES ENGINEERED FOR ADVANCED SPIN-ORBIT TORQUE TECHNOLOGIES

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Abstract: Topological insulators(TIs) such as BiSb have attracted significant attention for spin-orbit torque(SOT) applications because of their gapless surface states and strong spin-orbit coupling[1, 2]. Despite the large SOT efficiencies reported in BiSb-based heterostructures, their limited thermal stability and poor film uniformity on amorphous SiO_2 substrates remain major obstacles to device integration. In this work, we address these challenges by combining buffer-layer optimization, controlled Ge incorporation, and interfacial engineering to achieve thermally robust, uniform BiSb-based topological heterostructures on amorphous SiO_2 substrates. A NiFeGe buffer layer is introduced to promote homogeneous BiSb growth on amorphous SiO_2 substrates, and Ge is alloyed into BiSb through a lamination strategy with a Ge concentration below 10% to preserve intrinsic topological properties. The optimized BiSb(Ge) heterostructures exhibit a dominant (012) texture, reduced surface roughness, and improved thermal stability up to 250°C. X-ray reflectivity analysis reveals interfacial oxidation at the SiO_2/NiFeGe interface, which is effectively suppressed by inserting a thin TiN_x underlayer in the stack, as shown in Fig.1(a). This interfacial modification further enhances thermal robustness up to 250°C and smoothens the heterostructure, as confirmed by morphological and structural characterizations shown in Figs.1(b)&(c). SOT performance is evaluated using spin-torque ferromagnetic resonance measurements on micro-patterned devices. The TiN_x-engineered stacks maintain a high SOT efficiency of 0.35 after annealing at 250°C, compared with 0.2 in reference samples without TiN_x. These results demonstrate that synergistic alloying and interfacial engineering provide an effective pathway to thermally stable BiSb-based SOT devices, highlighting the potential of BiSb(Ge) heterostructures for practical spintronic applications.

Keywords: Topological insulator; BiSb; Ge alloying; TiN_x underlayer; Spin-orbit torque.

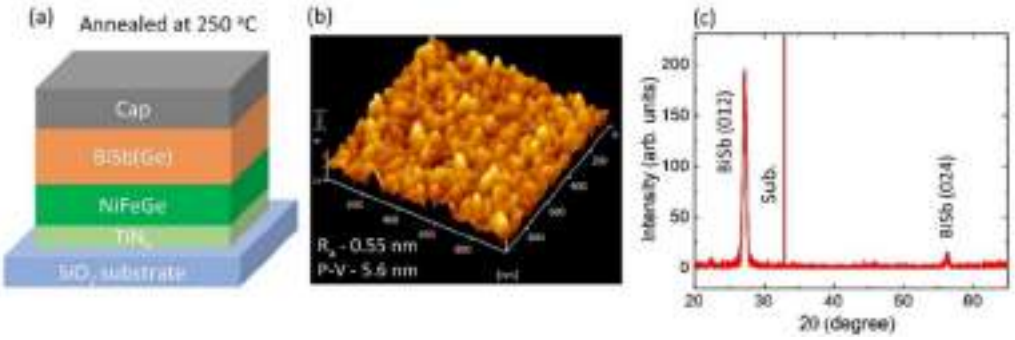


Fig. 1: (a) Stacking of the laminated structure. (b) atomic force microscopy image and (c) XRD profile of the optimized stack after annealing at 250 °C.

References:

[1] N. H. D. Khang, Y. Ueda, and P. N. Hai, *Nat. Mater.*, vol. 17, pp. 808–813, Jul. 2018.
[2] T. Manoj *et al.*, *ACS Appl. Electron. Mater.*, vol. 6, no. 6, pp. 4269–4276, Jun. 2024.

Abstract ID: 149

FEASIBILITY STUDY ON CARDIAC SOURCE LOCALIZATION USING FLUXGATE VECTOR MAGNETOMETER

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Abstract: Magnetocardiography (MCG) is a non-invasive measurement of cardiac magnetic fields generated by the electrical activity of the heart. MCG offers distinct advantages, including the ability to accurately localize the underlying cardiac current sources compared to that possible with the conventional voltage-based measurements of the heart's activity, such as in electrocardiogram (ECG) [1]. Amongst the available sensitive magnetic detectors with a multitude of practical limitations and sensitivity ranges, the emergence of low-cost, portable, room-temperature magnetometers in recording MCG is gaining popularity in recent times[2]. However, exclusive evaluations on the suitability of such detectors for estimating cardiac sources are sparingly discussed. This study presents an experimental framework and methodology for validating magnetic source localization using a portable, room-temperature, three-axis fluxgate magnetometer, wherein the spatial distribution of magnetic fields generated by a simulated, test-coil-generated magnetic dipole source is measured and analysed for source reconstruction. A computational framework is formulated to solve the forward problem based on the lead field matrix construction, which governs the relationship between source locations and measured magnetic field and the same is used for the forward problem. For the inverse problem downhill simplex method is employed to estimate the source parameters. The localization performance is quantitatively evaluated in terms of spatial accuracy and robustness under different noise conditions. This study presents a systematic methodology for fluxgate-based magnetic source localization thereby highlighting the importance of cost-effective fluxgate-based magnetometery for potential use in real MCG measurements.

Keywords: Magnetocardiography, Fluxgate magnetometer, Source localization, Lead Field.

References:

[1] J. Li, Y. Shen, C. Shen, X. Ning, M. Xiang, Front Cardiovasc Med. (2025)
[2] G. Bison, N. Castagna , A. Hofer , P. Knowles , J. L.Schenker , M. Kasprzak , H. Saudan , A. Weis, Applied Physics Letters. 95(2009).

Abstract ID: 150

CRITICAL BEHAVIOUR AND UNIVERSALITY CLASS OF $Mn_2Fe_{0.8}Ti_{0.2}Sn$ HEUSLER LIKE ALLOY NEAR THE FERROMAGNETIC PHASE TRANSITION

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Abstract: Heusler alloys gained interest due to their highly tunable structure that enables diverse functional properties such as half-metallicity, high-temperature magnetism, shape memory effect, magnetocaloric effect, and topological electronic states. Multifunctionality in Heusler alloys arises from competing and tunable exchange interactions between localized and itinerant electrons in an ordered lattice. The microscopic interaction mechanism and nature of a phase transition can be revealed through critical exponent study. In this work, the critical behavior associated with the second-order ferromagnetic→paramagnetic phase transition in the half metallic Full Heusler like alloy(FHLA) $Mn_2Fe_{0.8}Ti_{0.2}Sn$ has been systematically investigated by bulk isothermal magnetization measurements [1,2]. Values of the Critical exponents, $\beta = 0.569\pm0.060$, $\gamma = 1.193\pm 0.011$ and $\delta = 3.065\pm0.001$ with a Curie temperature $T_c = 284$ K estimated from Modified Arrot Plot (MAP), Kouvel-Fisher method (KF) and critical isotherm (CI) analysis, fall in between Mean-Field and 3D-Ising Model. They do not belong to any single universality class which suggests the presence of complex magnetic interaction. The consistency of these exponents is also verified using Widom scaling relation and scaling equation of state, confirming the reliability of the analysis. The research on this system reveals long-range magnetic ordering with itinerant ferromagnetic behaviour. These findings provide important insight into the nature of magnetic interactions and phase transition behavior in Ti-substituted Mn-based Heusler alloys, which are promising candidates for spintronics and high magnetocaloric response applications [1].

Keywords: Critical Exponent, Heusler Alloy, Magnetocaloric, Spintronics, Modified Arrot Plot.

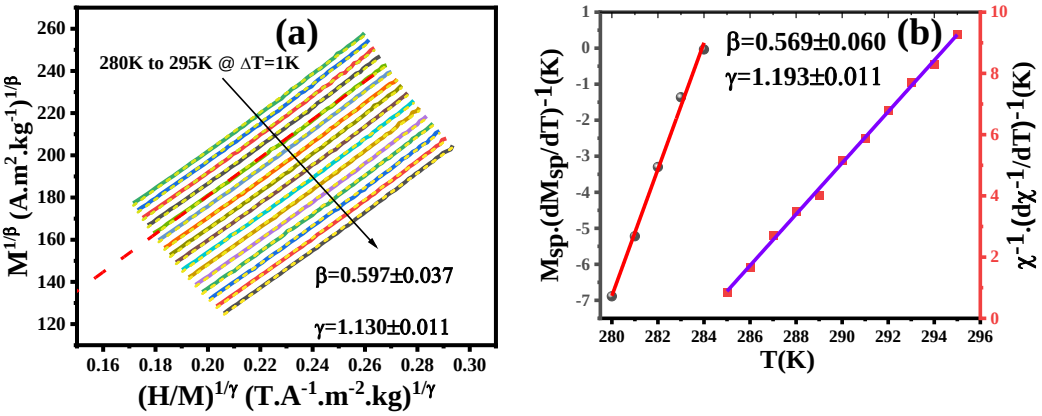


Fig. 1: (a) Modified Arrot Plot (b) Kouvel-Fisher Plot

References:

[1] S. Mandal, P. Nandi, and T. K. Nath, Materials Today Physics 58(2025): 101864.

[2] S. Mandal, P. Nandi, and T. K. Nath, physica status solidi (RRL) 20, no. 1 (2026): e202500343.

Abstract ID: 152

Fe, Co-DOPED $MnNi_2O_4$ NANO STRUCTURES FOR IMPROVED WATER SPLITTING; STRUCTURAL, AND MORPHOLOGICAL ANALYSIS

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Abstract: Earth-abundant, long-lasting, and efficient electrocatalysts for water splitting are critical components of a sustainable energy system. We make Fe, Co-doped MnNi2O4 nanoparticles that can be used for both parts of water splitting by using the sol-gel method. It's intriguing to note that Mo doping could effectively change the electrical structure of MnNi2O4, expanding the electroactive site. MnNi2O4 and Fe, Co-doped MnNi2O4 were found to have a face-centred cubic arrangement and a spinel structure with the space group Fd-3m. The density dropped while the size and lattice parameter of the crystallite grew [1]. We examined the surface structural morphology using TEM and SEM. Likewise, to completely increase the electrocatalytic activities for the oxygen evolution reaction, an electrochemical activation technique is suggested to create Fe, Co-doped MnNi2O4 . Because of its distinct freestanding structure and Co, Fe doping, Fe, Co-doped MnNi2O4 exhibits exceptional electrochemical performances that are competitive with those of other recent studies. When comparing pure MnNi2O4 to Fe, Co-doped MnNi2O4, the overpotential decreased by 120 mV, and the cell voltages were 1.81 V for the oxygen evolution reaction. These results show how Ni and Fe doping greatly improve the electrocatalytic efficiency of MnNi2O4, making it a strong potential candidate for green hydrogen production [2].

Keywords: $MnNi_2O_4$, Oxygen Evolution Reaction, Water Splitting, Electrocatalysis, green hydrogen.

References:

[1] Hosseini, S., Askari, M. B., & Beitollahi, H. (2023). MnNi2O4-MWCNTs as a nano-electrocatalyst for methanol oxidation reaction. International Journal of Hydrogen Energy, 48(55), 21240-21248.

[2] Medany, S.S., Hefnawy, M.A. & Kamal, S.M. High-performance spinel $NiMn_2O_4$ supported carbon felt for effective electrochemical conversion of ethylene glycol and hydrogen evolution applications. *Sci Rep* **14**, 471 (2024). https://doi.org/10.1038/s41598-023-50950-3

Abstract ID: 154

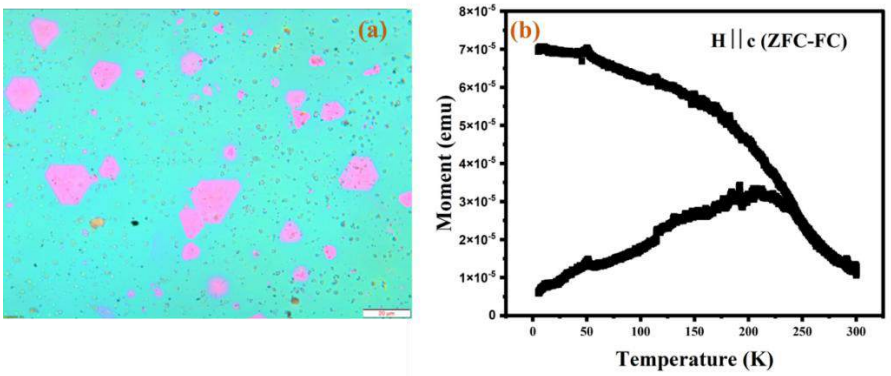
MAGNETIC AND ELECTRICAL TRANSPORT STUDIES OF CVD-GROWN FGT

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Abstract: Among Van der Waals two-dimensional materials, iron germanium telluride (Fe_3GeTe_2) has attracted significant interest due to its gate-tunable ferromagnetic ordering and its potential to tailor spin-based device properties and enable next-generation magnetic data storage devices.[1] The wafer-scale growth mechanism of 2D FGT ferromagnetic flakes remains a key challenge, particularly given their ternary nature and variable competitive stoichiometry.[2] However, we demonstrate the optimised chemical vapour deposition (CVD) technique- a reliable route for the growth mechanism of quasi 2D flakes on Si/SiO_2 substrates, controlling precursor flux balance and temperature gradients. Transmission electron microscopy reveals high crystalline quality, as evidenced by the SAED pattern, which shows a single set of 6-fold diffraction spots characteristic of a hexagonal symmetry lattice. A comparative study of magnetic behaviour between the bulk-like and reduced-dimensional regimes of ferromagnetism was conducted using magnetization measurements with a vibrating sample magnetometer, suggesting modified interlayer coupling in thin flakes. These results show pathways for 2D ferromagnetic spintronics.[3]

Keywords: Iron germanium telluride (FGT), Ferro-magnetism, Chemical vapour deposition (CVD), Vibrating sample magnetometer(VSM), Interlayer magnetic coupling, Spintronics.



Fig, 1: (a) Optical microscope image, (b) Out-of-plane magnetization vs Temperature curve.

References:

[1] S. Mondal, N. Khan, S.M. Mishra, B. Satpati, and P. Mandal, "Critical behavior in the van der Waals itinerant ferromagnet Fe4 $GeTe_2$," Phys. Rev. B 104(9), 1–9 (2021).

[2] Z. Fei, B. Huang, P. Malinowski, W. Wang, T. Song, J. Sanchez, W. Yao, D. Xiao, X. Zhu, A.F. May, W. Wu, D.H. Cobden, J.H. Chu, and X. Xu, "Two-dimensional itinerant ferromagnetism in atomically thin Fe_3GeTe_2," Nat. Mater. **17**(9), 778–782 (2018).

[3] G.K.R. Nair, Z. Zhang, F. Hou, A. Abdelaziem, X. Xu, S.W.Q. Yang, N. Zhang, W. Li, C. Zhu, Y. Wu, H. Weiling, L. Kang, T. Salim, J. Zhou, L. Ke, J. Lin, X. Li, W. Gao, and Z. Liu, "Phase-pure two-dimensional Fe_xGeTe_2 magnets with near-room-temperature T C," Nano Res. 15(1), 457–464 (2022).

Abstract ID: 155

SOC-INDUCED ANISOTROPY AND MAGNETIC MEMORY IN FRUSTRATED $Ca_3Co_2O_6$

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Abstract: Frustrated magnetic systems are of great interest due to their intrinsic non-equilibrium spin dynamics, magnetoelectric coupling, and potential applications in spintronic and thermal memory devices. Here, we conducted a comprehensive experimental and theoretical investigation of the quasi-one-dimensional spin-chain frustrated compound $Ca_3Co_2O_6$. The compound consists of alternating CoO_6 octahedra (Co I) and CoO_6 trigonal prisms (Co II) separated by Ca atoms, forming ferromagnetic chains along the c-axis and antiferromagnetically coupled chains arranged on a triangular lattice in the ab plane, giving rise to geometric frustration [1,2].

Polycrystalline samples were synthesized via the conventional solid-state reaction method, and Rietveld refinement of X-ray diffraction data confirms single-phase formation. DC magnetization measurements reveal a paramagnetic-to-disordered antiferromagnetic transition at $T_c \approx 25$ K, followed by a glassy magnetic phase below $T_g \approx 11$ K. The enhanced effective magnetic moment ($\mu_{eff} \approx 6.50\ \mu_B$) indicates a finite orbital contribution arising from spin-orbit coupling (SOC) as confirmed by DOS calculation (Fig.1(a)), which in turn significantly enhances the magnetic anisotropy energy (MAE) of the system. First-principles calculations identify the ferromagnetic configuration as the lowest-energy ground state. SOC-driven MAE calculations reveal a strong anisotropy with the easy axis tilted from the c-axis ($\theta = 30°$, $\varphi = 300°$), yielding a maximum energy barrier of ~20 meV/f.u., indicative of robust magnetization stability. Further interrupted field-cooled magnetisation measurements demonstrate a clear magnetic memory effect below 11 K (Fig.1(b)). These findings highlight $Ca_3Co_2O_6$ as a promising material for low-temperature magnetic memory applications.

Keywords: 1D spin-chain compound; Spin frustration; Low dimension; Spin dynamics; DFT.

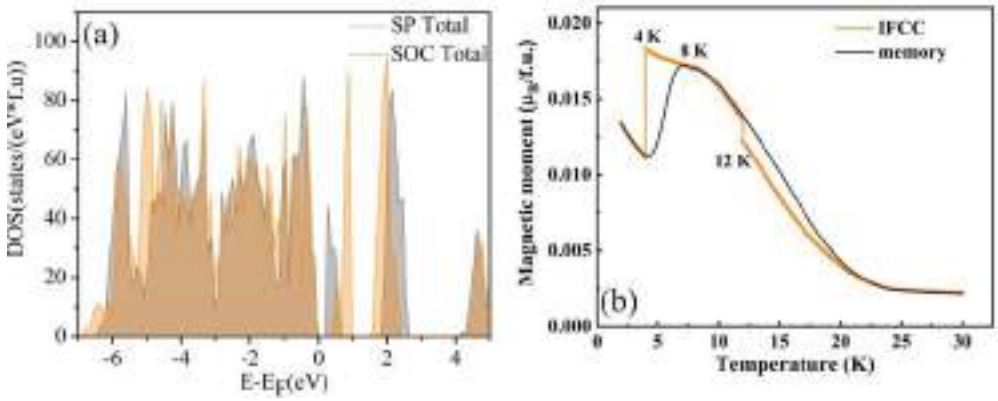


Fig. 1: (a) Total DOS of ferromagnetic with spin polarised (SP) and spin-orbit coupling (SOC), and (b) Memory effect curve at 100 Oe for $Ca_3Co_2O_6$.

References:

[1] Hardy V, et al, Phys. Rev. B 68 14424.
[2] Allodi G, et al, Phys. Rev. B. 83 104408

Abstract ID: 156

SINGLE-STEP SYNTHESIS OF DyF_3 FOR STRATEGIC APPLICATIONS

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Abstract: Rare-earth (RE) metals, particularly dysprosium (Dy), are essential for strategic, automotive, and medical applications, including high-performance NdFeB magnets via grain boundary diffusion processes. Dy is sourced from monazite/bastnaesite ores, processed into Dy oxide. Given the high thermodynamic stability of RE oxides, converting them to halides (Cl, F, or I) is favourable for subsequent metal reduction.

In this study, we successfully transformed indigenously sourced Dy oxide into DyF_3 via a novel single-step dry-state method. Unlike conventional approaches which rely on corrosive, toxic, hygroscopic agents like HF, F_2 gas, or NH_4F and often require multiple steps our method uses readily handled, less toxic, non-hygroscopic ammonium bifluoride as the fluorinating agent. An intimate mixture of Dy oxide and ammonium bifluoride was loaded into a tubular furnace under continuous inert gas flow, heated to 500 °C at varying rates, cooled, crushed, and analysed via XRD, SEM, ED-XRF, and ICP-OES for phase formation, morphology, and composition. Particle size distribution was assessed using a particle size analyzer. Results confirmed complete fluorination, yielding high-purity (99%) DyF_3 with 99.5% yield, suitable for Dy metal preparation and subsequent grain boundary diffusion in NdFeB magnets.

Keywords: Dysprosium Fluoride, NdFeB Magnets, Fluorination, Grain-boundary diffusion.

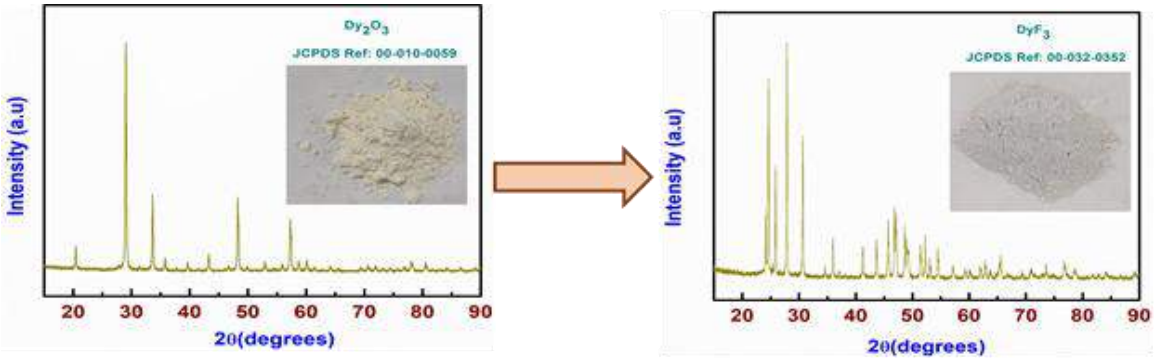


Fig. 1: X-ray diffraction pattern of the synthesized single-phase DyF_3 powder through the dry-route.

References:

[1] Sofronov, Vladimir, et al. Key Engineering Materials 683 (2016): 345-352, "Research of dysprosium, terbium and neodymium oxides fluoration."

[2] Swarovski, Alexander Y., et al. Advanced Materials Research 1084 (2015): 82-86, "Fluoride Technology of Processing Oxides of Rare Earth Elements.

Abstract ID: 157

METALLOTHERMIC REDUCTION OF MIXED (Nd-Pr) FLUORIDE: AN EFFICIENT PATHWAY FOR HIGH-PURITY Nd-Pr FOR NdFeB MAGNETS

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Abstract: Neodymium-Praseodymium (Nd-Pr) is a critical metal with widespread applications in green technologies [1]. This study focuses on producing high-purity Nd-Pr metal through a metallothermic reduction route [2]. The process begins with the conversion of Neodymium Praseodymium (Nd-Pr) oxide into Neodymium-Praseodymium fluoride ($NdPrF_3$). The resulting $NdPrF_3$ is subsequently reduced to metallic NdPr by metallothermic reduction under inert atmosphere. Optimal fluorination conditions were established to obtain high-purity $NdPrF_3$. The subsequent metallothermic reduction was systematically investigated to determine the ideal parameters for maximizing yield and purity. The produced NdPr metal was characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS) to evaluate its phase purity, surface morphology, and elemental composition. Following reduction, the metal was purified by high-temperature high vacuum melting and obtained NdPr metal with more than 99.3% purity. These results highlight the effectiveness of this approach in producing high-purity NdPr, making it highly suitable for NdFeB magnets production and other cutting-edge technologies.

Keywords: Metallothermic reduction, NdFeB magnets, Nd-Pr metal, vacuum melting, XRD.



Fig. 1: Preparation of NdPr metal from $NdPrF_3$ through the metallothermic reduction process.

References:

[1] Gupta, C.K., Krishnamurthy, N., 1992. Extractive metallurgy of rare earths. Int. Mater.Rev. 37, 197-248.

[2] Sahoo, Deepak Kumar, et al. "Study on the extraction of neodymium metal by calciothermic reduction process." Mineral Processing and Extractive Metallurgy 133.3 (2024): 101-108.

Abstract ID: 158

TOPOLOGY-DRIVEN MAGNETIC PHASES FOR RESERVOIR COMPUTING

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Abstract: The growing demand for energy-efficient artificial intelligence has accelerated the development of neuromorphic hardware based on spintronic systems. Although skyrmion fabrics have demonstrated promise for physical reservoir computing (RC) [1-3], the comparative computational roles of other non-trivial magnetic topologies remain insufficiently explored. Here, we systematically examine how different micromagnetic phases such as skyrmion arrays, domain stripes and labyrinthine domains affect RC performance. Using MuMax3 simulations, these phases are stabilized via energy minimization under the interplay of Dzyaloshinskii–Moriya interaction, exchange interaction, magnetocrystalline anisotropy and external magnetic field. The stabilized textures are then driven by time-varying external stimuli in the form of sinusoidal magnetic fields and spin-polarized current densities to induce nonlinear magnetization dynamics. The resulting time-dependent spin evolution is converted into computational outputs through dual electrical readouts based on anisotropic magnetoresistance (AMR) and anomalous Hall effect (AHE), derived directly from spatial magnetization components [3]. Reservoir performance is benchmarked on standard time-series prediction tasks using the Normalized Root Mean Square Error (NRMSE), complemented by evaluation of nonlinearity and short-term memory capacity. Early-stage analyses reveal topology-dependent variations in state-space dynamics between labyrinthine and skyrmion phases, the computational implications of which are currently under further investigation. These findings highlight the critical role of magnetic topology in shaping computational capacity and provide insight toward phase-engineered spintronic reservoirs for reservoir computing.

Keywords: Reservoir Computing, Skyrmions, Labyrinthine Domains, Micromagnetism

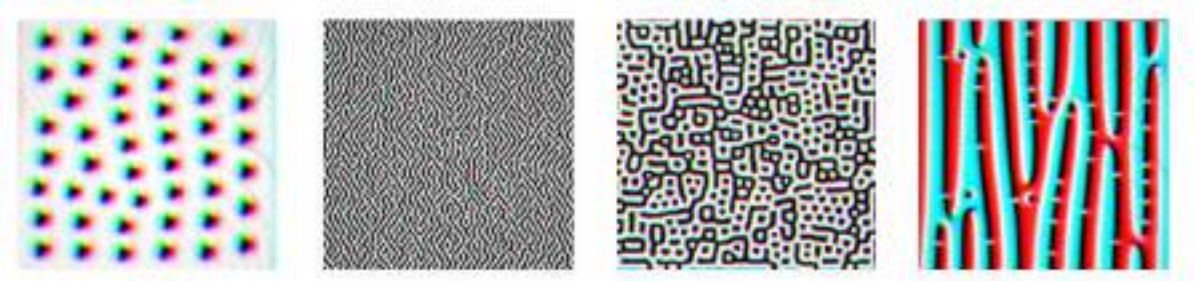


Fig. 1: Selected micromagnetic phases used as reservoirs: skyrmion arrays, dense chiral stripes, skyrmion fabric, and labyrinthine domains.

References:

[1] D. Prychynenko, M. Sitte, K. Litzius, et al. *Physical Review Applied* 9 (2018) 014034.
[2] Y. Sun, T. Lin, N. Lei, X. Chen, et al. *Nature Communications* 14 (2023) 3434.
[3] D. Pinna, G. Bourianoff, K. Everschor-Sitte et al. *Physical Review Applied* 14 (2020) 054020.

Abstract ID: 159

SHARP QUANTUM PHASE TRANSITION IN THE FRUSTRATED SPIN-1/2 ISING CHAIN ANTIFERROMAGNET: $CaCoV_2O_7$

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Abstract: In this work, we uncover magnetic field driven quantum criticality in the quasi one-dimensional spin-1/2 zigzag antiferromagnetic chain material $CaCoV_2O_7$. When no magnetic field is applied and the temperature is reduced below T_n = 3.3 K, neutron diffraction reveals that the system adopts an up–up–down–down spin arrangement, which appears to originate from an order-by-disorder mechanism. At the lowest temperatures, this long-range magnetic order collapses under an applied field, giving way to a quantum paramagnetic phase once the field reaches B_c = 3 T. Both ESR measurements and neutron scattering confirm this field-induced transition. Remarkably, the quantum phase transition is extremely sharp, characterized by a critical exponent $\phi = 0.164(3) \approx 1/6$, which is much smaller than values reported for typical uniform S - 1/2 chains. Such an unusually steep phase boundary likely results from the combined influence of strong spin–orbit coupling and the competing nearest (J_1) and next-nearest-neighbor (J_2) interactions inherent to the zigzag chain structure.

Keywords: Antiferrromagnetic, Quantum phase transition.

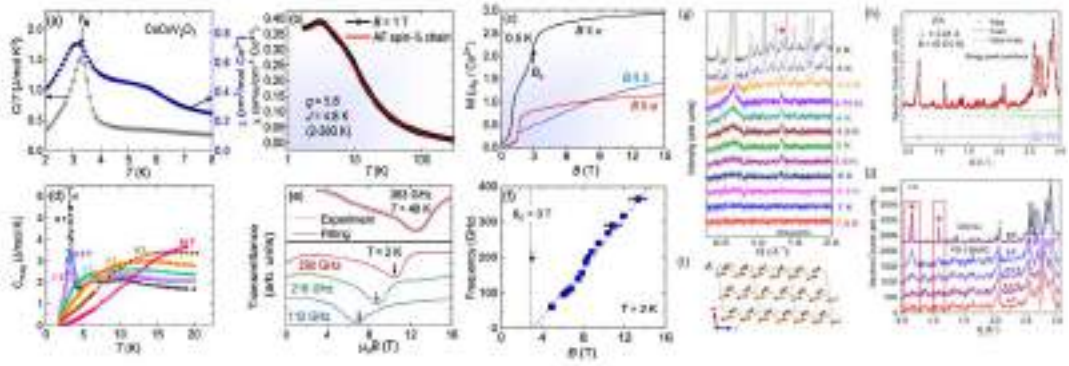


Figure 1: (a) The temperature dependent magnetic susceptibility χ at 0.1 T and zero field specific heat C curves of $CaCoV_2O_7$ over low temperatures below 8 K (b) 1 T fitted curve by an AFM spin-1/2 Bonner-Fisher model (c) Pulsed field magnetization of single-crystal shows anisotropic slope changes, with low-field transitions at 1 T (B ∥ c) and 1.5 T (B ∥ a, b) arising from a secondary phase (d) Magnetic specific heat (C_{mag}) of $CaCoV_2O_7$ obtained after subtracting the lattice contribution using $CaMgV_2O_7$ (e, f) ESR spectra at various frequencies show field-dependent magnetic excitations, with a 48 K spectrum fit (g_x=1.85, g_y=2.17, g_z=5.35) matching the effective spin Hamiltonian and a frequency–field diagram mapping absorption maxima at 2 K (g) Magnetic neutron diffraction of $CaCoV_2O_7$ (2–7.5 K) shows magnetic peaks after subtracting the 8 K nuclear background, with an extra peak near Q ≈ 1.4 $Å^{-1}$ from $Co_3V_2O_8$. (h) At 2 K, observed and calculated patterns for the four-phase model agree well. (i) The UUDD magnetic structure of $CaCoV_2O_7$. (j) At 2 K, magnetic peaks vanish above 3 T, with field-induced changes in nuclear peak intensities due to powder reorientation.

References:
[1] Isha et al. Phys. Rev. Research Lett. 6, (2024) L032010.

Abstract ID: 160

UNRAVELLING THE MAGNETIC GROUND STATE OF A HONEYCOMB LATTICE COMPOUND $Nd_2Te_4O_{11}$

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Abstract: Frustration-driven quantum fluctuations, along with spin-orbit coupling and crystal electric field (CEF) can give rise to exotic magnetic phenomena in rare-earth based quantum magnets [1-3]. We have investigated the structural properties of $Nd_2Te_4O_{11}$ through X-ray diffraction and Raman spectroscopy. It crystallises in a monoclinic crsytal structue, where magnetic ions are decorated on a distorted honeycomb lattice, without any disorder between their constitutents atoms. This structure induces significant magnetic frustration among Nd^{3+} spins and can results in exotic magnetic ground states. To explore magnetic behaviour, temperature and field dependent DC and AC magnetization measurements were performed on this compound. Our studies reveal the absence of long-range magnetic ordering and spin freezing down to 1.8 K. Further, analysis of magnetization data confirms that Nd^{3+} ions exhibit an effective spin (J_{eff}) = 1/2 state with weak antiferromagnetic interactions within the Kramers doublet ground state in the low temperature-regime. These findings are further supported by point-charge based calculations, which indicate substantial energy separation between the ground state and the first excited state (~ 9.5 meV). Thus, it confirms that at low temperature, magnetic properties are solely dependent on the ground state Kramers doublet, leading to low-energy J_{eff} = 1/2 state in $Nd_2Te_4O_{11}$. This compound can be a potential candidate to explore quantum magnetism in honeycomb geometry.

Keywords: Frustrated Magnetism, Honeycomb Lattice, Effective J = ½ state, crystal field excitations

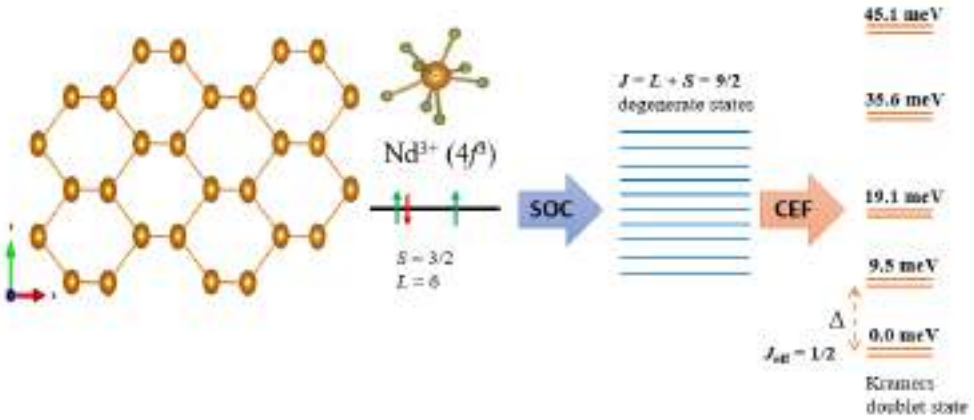


Fig. 1: (left) Magnetic Nd^{3+} ions forms distorted honeycomb like structure. (Right) Pictorial representation of CEF scheme and realization of J_{eff} = ½ state at low temperatures.

References:

[1] Y. Li, et al., Phys. Rev. Lett. **117**, (2016).

[2] J. B. Fouet, P. Sindzingre, and C. Lhuillier, Eur. Phys. J. B **20**, 241 (2001).

[3] S. A. Yang, H. Pan, and F. Zhang, RSC Adv. **5**, 83350 (2015).

Abstract ID: 161

THICKNESS AND ANNEALING-DRIVEN EVOLUTION OF STRUCTURE AND MAGNETISM IN FeMn/CoFeB/Cr TRILAYERS

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Abstract Interface-controlled magnetism in metallic heterostructures is central to the development of thermally stable spintronic devices. In this study, FeMn/CoFeB/Cr trilayer thin films were systematically designed to investigate the coupled effects of CoFeB thickness and post-deposition annealing on structural evolution and magnetic behaviour[1]. While the FeMn buffer and Cr capping layers were kept identical in all samples, only the CoFeB thickness was varied, enabling a controlled thickness-dependent study. X-ray reflectivity confirms the formation of well-defined multilayers with preserved interfacial quality, whereas grazing-incidence X-ray diffraction captures a clear thickness and temperature-driven structural transformation of the CoFeB layer. Magnetic properties were examined using magneto-optical Kerr effect and vibrating sample magnetometry measurements performed in both in-plane and out-of-plane geometries, revealing distinct magnetic responses governed by interfacial coupling, magnetic volume, and thermal history. The combined structural and geometry-dependent magnetic analysis highlights how thickness engineering and annealing jointly regulate anisotropy, coercive behaviour, and magnetization reversal mechanisms in FeMn/CoFeB/Cr heterostructures. These findings establish an effective framework for tuning magnetic functionality in metallic thin-film systems and provide design guidelines for robust spintronic architectures.

Keywords: Magnetic thin films, XRR, GIXRD, VSM, MOKE.

References:

[1] Y. Zhang, L. Wang, and J. Zhao, "Annealing-induced structural evolution and magnetic modification in CoFeB-based exchange biased heterostructures," *Applied Physics Letters*, vol. 118, 2021.

Abstract ID: 162

COMPOSITION-DEPENDENT STRUCTURAL AND MAGNETIC PROPERTIES OF Ni–Co NANOPARTICLES

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Abstract: Alloys of magnetic nanoparticles have gained significant attention due to their composition-dependent magnetic properties, which arise from nanoscale exchange interactions and electronic hybridization [1]. Unlike single-component nanoparticles, nanoalloys enable tuning of saturation magnetization, magnetic anisotropy, and spin dynamics through controlled alloying [2]. In this work, nickel - cobalt (Ni - Co) nanoparticle samples with varying nickel and cobalt compositions S1 (Ni:Co = 50:50), S2 (Ni:Co = 60:40), and S3 (Ni:Co = 70:30) were synthesized, and their magnetic, morphological, and structural properties were systematically investigated. FESEM images show differences in particle morphology and agglomeration among the Ni - Co nanoalloys with varying compositions as shown in Figure 1(a-c). Magnetic measurements reveal a strong dependence of saturation magnetization and coercivity on alloy composition as shown in Figure 1(d) highlighting the importance of compositional control in tuning magnetic properties. X-ray diffraction (XRD) analysis confirms the formation of a single-phase face-centered cubic (FCC) crystal structure for all compositions, indicating successful alloy formation without secondary phases. This study provides a simple and systematic understanding of the relationship between composition, structure, and magnetism in Ni - Co nanoparticles, making them promising materials for future magnetic and energy-related applications.

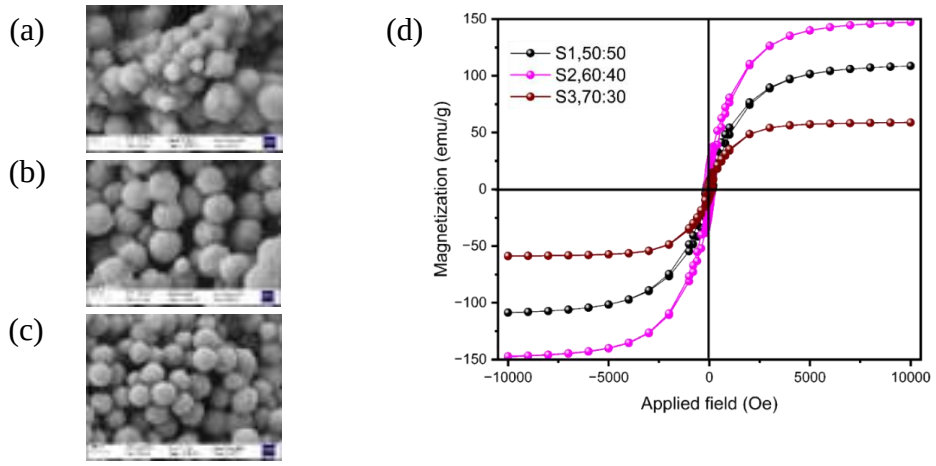


Fig. 1: (a) Room-temperature VSM hysteresis loops of Ni - Co nanoalloys with different compositions, FESEM image of (b) S1 (Ni:Co = 50:50), (c) S2 (Ni:Co = 60:40), and (d) S3 (Ni:Co,70:30).

References:

[1] S. Sun, C.B. Murray, J. Appl. Phys. 85 (1999) 4325–4330.
[2] A. Pandey, P. Jeevanandam, J. Alloys Compd. 735 (2018) 1968–1976

Abstract ID: 163

INFLUENCE OF MECHANICAL STRESSES ON ELECTRICAL STEEL CORE LOSSES AND ELECTRIC MOTOR PERFORMANCE

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Abstract: Electrical steel is the primary core material in electric motors, where its magnetic properties—permeability and core losses—directly determine motor efficiency. This study examines how mechanical deformation and stresses from manufacturing (punching, cutting, stacking) and operation (tensile, compressive, cyclic loading) affect non-oriented electrical steel performance in electric motors. The results show that plastic deformation and residual stresses increase hysteresis and eddy-current losses, often by tens to hundreds of percent in affected regions, while reducing permeability. These changes raise heat generation, lower motor efficiency by several percentage points, and reduce torque or increase required input power. Although compressive stress can occasionally reduce losses in narrow ranges, tensile and plastic deformation generally degrade performance, with stronger effects in high-speed and traction motors under cyclic loads. The study emphasizes the need for improved processing techniques and stress-relief methods to preserve magnetic quality and maximize electric motor efficiency.

References:

[1] H. A. Weiss et al., "Impact of Punching Parameter Variations on Magnetic Properties of Nongrain-Oriented Electrical Steel," IEEE Transactions on Magnetics, vol. 54, no. 11, pp. 1-5, Nov. 2018..

[2] U. J. Seo et al., "Mechanical Cutting Effect of Electrical Steel on the Performance of Induction Motors," Energies, vol. 13, no. 23, p. 6314, 2020..

Abstract ID: 164

STUDY OF MAGNON–MAGNON COUPLING IN MAGNETIC NANODISCS

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Abstract: In recent years, hybrid magnonic systems that explore interactions between magnons and various quantum excitations have attracted considerable attention. The development of strong and adjustable magnon–magnon interactions in confined nanomagnets is key to enabling chip-level hybrid quantum technologies. In this work, we perform micromagnetic simulations to study the evolution of magnon–magnon coupling (MMC) in isolated FeNi nanodiscs by varying its geometry from circular (a = b) to elliptical shapes with different axis ratio (a > b and a < b). The results show an anticrossing gap appears in the frequency-vs-field plots for all geometries, proving that the modes are interacting. A comprehensive theoretical framework is presented, which explains this anticrossing phenomenon as a result of MMC and provides estimates for the strength of the coupling. Furthermore, this intermodal coupling can be tuned from a strong coupling regime to a weak coupling regime by varying the direction of the external magnetic field. These results contribute to the growing field of quantum magnonics and deepen the understanding of magnon–magnon coupling in nanoscale systems.

Keywords: Hybrid magnonics, Magnon-magnon coupling, Quantum magnonics, nanodisc.

Abstract ID: 166

FIRST-PRINCIPLES STUDY OF NICKEL SUBSTITUTION ON Fe_2CuAl INVERSE-HEUSLER ALLOY

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Abstract: Since their discovery in 1903, Heusler alloys have been the focus of extensive research due to their importance in both fundamental science and applied technologies. Heusler alloys are primarily classified into half-Heusler (XYZ) and full-Heusler (X_2YZ) compounds, with the latter further divided into regular ($L2_1$) and inverse (XA) structures based on the arrangement of atoms. Among these, inverse Heusler alloy has a wide range of applications due to their structural stability and tunable magnetic properties, in addition, Fe_2CuAl offers a cost-effective and earth-abundant alternative. As a result in this study, we investigate the effect of Ni substitution on the electronic structure and magnetic properties of Fe_2CuAl based on Density Functional Theory (DFT). The results of the studies reveals that substitution of Ni enhances the saturation magnetization of the material. This is mainly due to the hybridization of Ni 3*d* with Fe 3*d* orbitals which resolve to remodification of the electronic states around the fermi level. The results confirm that manipulation of the material's composition allows for effective tuning of its magnetic behavior.

Keywords: Heusler alloy, Density Functional Theory, Density of States, Magnetic properties.

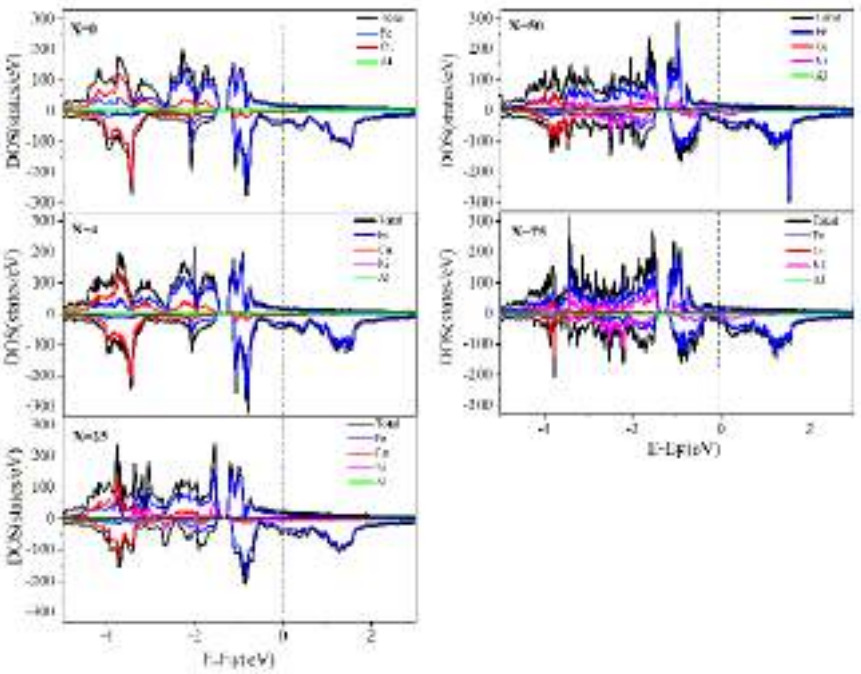


Fig. 1: DOS of $Fe_2Cu_{1-x}AlNi_x$

References:

[1] I. Galanakis; K. Özdoğan; B. Aktaş and E. Şaşıoğlu, Appl. Phys. Lett. 89(4), (2006) 042502

Abstract ID: 167

INSIGHTS INTO DESIGNING FUNCTIONALIZED MOLYBDENUM DISULFIDE-BASED MAGNETIC HETEROSTRUCTURES FOR GAS SENSING DEVICES

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Abstract: Nanomaterials exhibit distinctive physicochemical properties that enable significant advancements in emerging technologies. Among layered two-dimensional (2D) materials, molybdenum disulfide (MoS_2) has garnered considerable attention for environmental remediation applications owing to its tunable band structure, high surface-to-volume ratio, and rich active edge sites [1]. At the same time, the emission of hazardous gases from vehicular and industrial sources remains a major contributor to air pollution, posing serious threats to human health and the environment [2]. The development of sensitive, reliable, and energy-efficient gas sensors capable of detecting low concentrations of harmful pollutants is therefore critical for environmental monitoring and occupational safety [3-5]. In this study, we report the hydrothermal synthesis of functionalized MoS_2 nanostructures integrated with magnetic nanostructured components for room-temperature gas sensing applications. The synthesized hybrid nanostructures demonstrated excellent sensing performance toward volatile organic compounds, specifically n-butanol and toluene, at concentrations as low as 5 ppm at room temperature. These findings highlight the strong potential of MoS_2-based hybrid nanomaterials for the development of efficient, low-power gas sensors capable of operating effectively at room temperature.

Keywords: MoS_2; Gas sensing; Nanocomposite; Toluene; N-butanol, Room-temperature sensing.

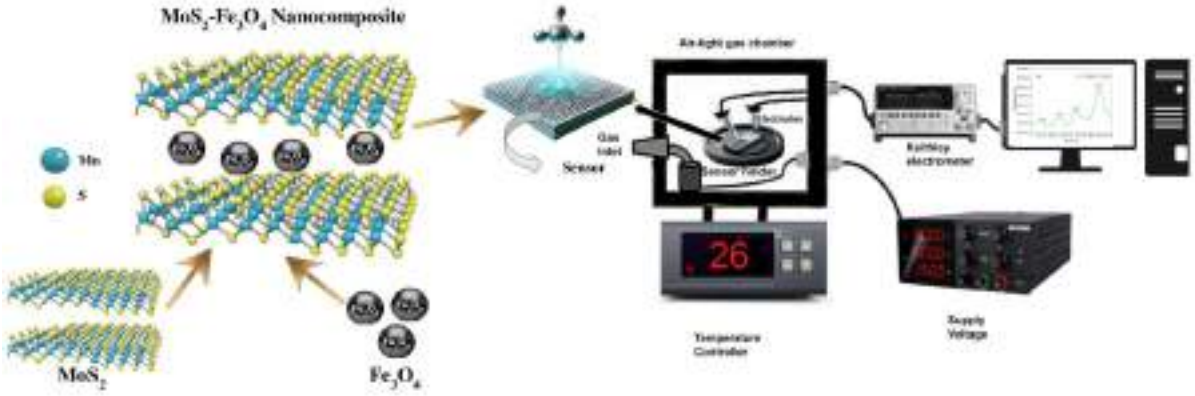


Fig. 1: Schematic of nanocomposite design and experimental setup for gas sensing measurements.

References:

[1] M. I. Rizu, D. Fadil, E. Llobet, npj 2D Mater. Appl. 9 (2025) 28.
[2] R. Thayil, S. R. Parne, Sci. Rep. 14 (2024) 1–10.
[3] R. Thayil, K. G. Krishna, S. Cherukulappurath, V. Kathirvelu, S. Parne, Surf. Interfaces 46 (2024) 104134.
[4] A. Kushwaha, N. Goel, Sens. Actuators B Chem. 393 (2023) 134190.
[5] R. Thayil, S. R. Parne, *Chem. Pap.* (2025).

Abstract ID: 168

MAGNETIC PROPERTIES OF QUASI 1D HEISENBREGE MAGNET: $BaCo_2Si_2O_7$

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Abstract: Quasi-1 dimensional quantum spin systems is intriguing magnetic materials which show novel phenomena such as spin-gap, spin-dimerization, spin-Pierls transition,spin flop transition etc. Silicates such as $BaM_2Si_2O_7$ (M=Co,Mn,Cu) are important materials which exhibit quasi 1D magnetism based on Co^{2+} chain with spin S=3/2 [1]. Here, in this study we focused on magnetic properties of $BaCo_2Si_2O_7$ which is less explored among the series. Pure phase $BaCo_2Si_2O_7$ is obtained by solid state route and its Rietveld refinementof X-ray diffrcation reveals that it crystalize in *C2/c* space groupe and with Monoclinic lattice. Fig.1 inset shows crystal structure of $BaCo_2Si_2O_7$, which confirms presence of chain of Co^{2+} along 'c-axis'. In 'a-c plane' between two Co^{2+} chains are separated by non-magnetic SiO_2 grouping layer giving it a layered structure. Magnetization study reveals antiferromagnetic transition at T_N= 21.5K. and bifurcation in ZFC-FCW curve below T_N. while θ_P= -48.5K , negative θ_P sugget presence of anferromagnetic interaction at high temperature. Which point toward the Ferromagnetic interchain interaction along 'C-chain ' while between chain exist weak antiferromagntic interaction which give rise to long rage order. Effective paramagnetic moment μ_{eff} = 3.37 $\mu_{B/}$ Co atom which is less than thereotical value μ_{theory} = 3.87 $\mu_{B/}$ Co atom. Isotherm at selected tempearture show metamagntic transition at 3.5T and spin flopping at 13.5T for T<10K . Further the magnetization studied through high feild magntization upto 50T. AC magnetic susceptibility , heat capacity and temperature dependent neutron diffrcation to understand complex magnetism which overall suggest complex magnetic structure due to reduced dimensonality.

Keywords: Quasi 1D Magnetism, Heisenberge Chain, exchange interaction. Metamagntic state

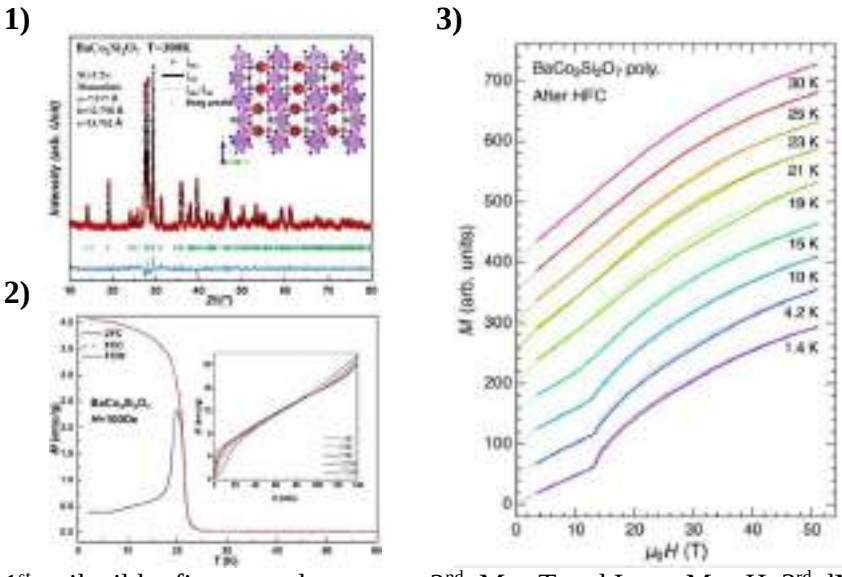


Fig. 1: 1st: reilveild refinenet and structure ,2nd: Mvs T and Inset: M vsH, 3rd:dM/dH vs H.

References:

1. Wang, G. H., Xu, C., J Physical Review, 100(3), (2019).

Abstract ID: 169

CLUSTER-DRIVEN EXCHANGE BIAS IN AN INTERCALATED VAN DER WAALS ANTIFERROMAGNET

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Abstract: Exchange bias (EB) is a fundamental phenomenon in quantum two-dimensional (2D) spintronic architectures, where ferromagnetic moments are pinned through interfacial exchange coupling with an adjacent antiferromagnet [1]. In van der Waals (vdW) materials, EB is particularly attractive because it defines a stable spin-polarization axis, which is essential for realizing non-volatile 2D quantum magnetic devices [2]. However, achieving large EB in a single-phase 2D vdW material remains highly challenging due to the delicate balance of competing magnetic interactions.Here, we demonstrate that partial substitution of Co by Fe in Co⅓NbS₂ provides an effective strategy to tune the competition between antiferromagnetic and ferromagnetic interactions, resulting in a robust EB effect in (Fe_xCo_{1-x})⅓NbS_2 (x = 0.50). Field-cooled magnetic hysteresis measurements reveal a reversible lateral shift of the M–H loop, depending on the sign of the cooling field (H_cool), confirming clear EB behavior. Remarkably, we observe an exceptionally large exchange-bias field (μ₀H_EB) of ~4 T—substantially exceeding previously reported values [3,4]—along with a coercivity greater than 3 T. Complementary experiments and theoretical analysis indicate that mixed Co/Fe valence states promote the formation of ferromagnetic clusters embedded within an antiferromagnetic host. These mixed-valence–mediated cluster interactions provide a powerful route for controlling exchange coupling in intercalated vdW magnets, opening new opportunities for next-generation 2D spintronic devices and high-performance permanent magnets.

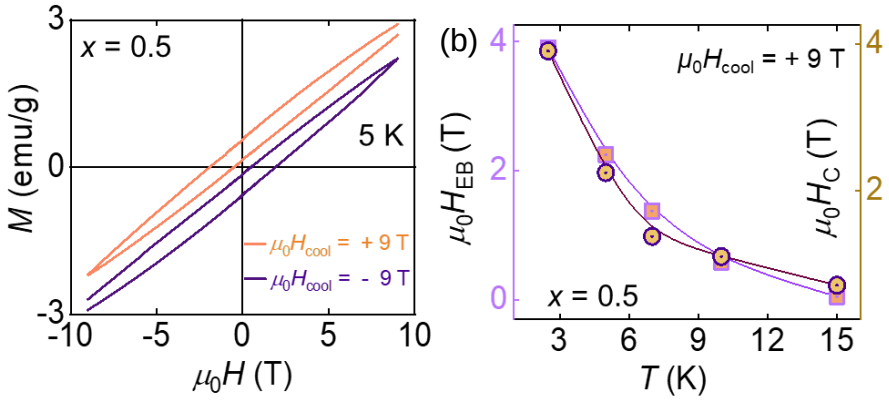


Fig. 1: (a) Magnetization (M) versus applied magnetic field (*H*) hysteresis loops for $(Fe_{0.5}Co_{0.5})_{1/3}NbS_2$ at 5 K after field cooling in ± 9 T (*H* || *c*-axis). (b) Temperature dependence of the exchange-bias field (H_{EB}) (left axis) and corresponding *T* dependence of the coercive field (H_C).

References:

[1] X. Huang *et al.*, Nature Commun. **14**, 2190 (2023).
[2] Z. Jia *et al.*, ACS Nano **19**, 9452 (2025).
[3] A. K. Nayak, *et al.*, Nature Mater. **14**, 679 (2015).
[4] E. Maniv *et al.*, Nature Phys. **17**, 525 (2021).

Abstract ID: 170

CONTROLLED MODULATION OF STRUCTURAL, MAGNETIC AND DIELECTRIC PROPERTIES OF Fe-SITE Al SUBSTITUTED TERBIUM IRON GARNET

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Abstract: This study focuses on exploring the influence of Al^{3+} ions in governing the structural and physical properties of terbium iron garnet, by synthesizing a series of $Tb_3Fe_{3-x}Al_xO_{12}$ (x = 0.00, 0.10, 0.20, 0.30, 0.40, 050) compounds via the conventional solid state reaction method. Room temperature X-ray diffraction patterns, analysed by Rietveld refinement technique confirm the formation of single-phase cubic garnet structure without any impurity phases. A gradual decrease in lattice parameter (a) and unit cell volume (V) is observed, owing to the replacement of Fe^{3+} ions by smaller Al^{3+} ions [1]. Analysis of surface morphology of the samples using scanning electron microscopy indicates a decrease in the average grain size from 1.92 μm to 1.27 μm with increasing Al concentration, which suggests inhibited grain growth. Room temperature magnetic hysteresis measurements show a remarkable reduction in the saturation magnetization (M_S) from 40.99 emu/g to 5.51 emu/g with rise in Al concentration, indicating a dilution of the magnetic Fe^{3+} sublattice and weakened superexchange interactions. Coercivity, on the other hand shows an increasing trend, rising from 104.47 Oe to 337.13 Oe, indicating an enhancement in magnetic hardness of the in the substituted compounds. At room temperature, the real part of impedance spectra (Z') reveals a systematic increase with Al substitution, consistent with the suppression of Fe^{2+}/Fe^{3+} hopping network and reduced charge conduction [2]. The dielectric constant (ε') and dielectric loss (ε'') values decrease systematically with Al replacement, suggesting their potentiality for high frequency applications. The ac conduction behaviour of all compositions follows Jonscher's double power law, with charge transport primarily governed by overlapping large polaron tunnelling and small polaron hopping. These study establishes that Al substitution at Fe sites tailors the magnetic–dielectric behaviour of TbIG, underscoring its relevance for modern technology.

Keywords: Magnetic hardness, Coercivity, Impedance spectroscopy, Dielectric loss

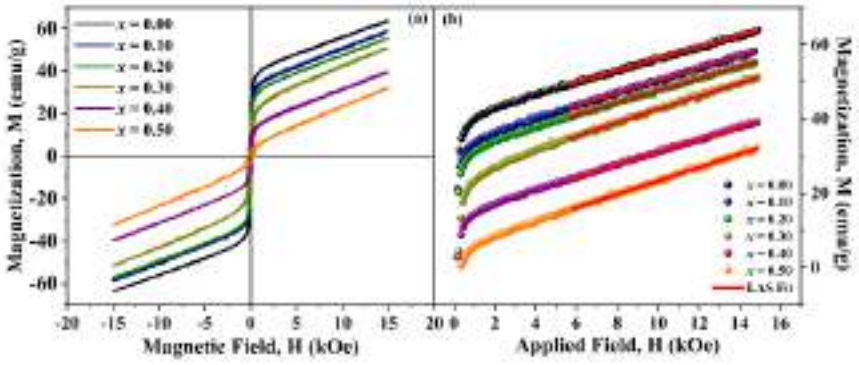


Fig. 1: (a) Magnetic hysteresis loops, **(b)** initial magnetization curves fitted to LAS equation for Al:TbIG (x = 0.00-0.50) samples recorded at room temperature

References:

[1] S. Verma, S, Ravi, Ceram. Int. 50 (2024) 13022-13033.

[2] S. Sarmah, R. Bora, P.K. Maki, S. Ravi, T. Bora, Phys. B Condens. Matter 639 (2022) 414017.

Abstract ID: 171

MAGNETIC AND TRANSPORT PROPERTIES OF THE CANDIDATE TOPOLOGICAL MATERIALS RGaSi (R = Ce, Pr)

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Abstract: We report the growth of high-quality single crystals of CeGaSi and PrGaSi and a comprehensive study of their physical properties. Powder x-ray diffraction confirms that both compounds crystallize in a noncentrosymmetric tetragonal structure with space group $I4_1md$. CeGaSi and PrGaSi orders magnetically around $T_m \sim 11$ K, and ~ 23 K, respectively, as confirmed through the magnetic susceptibility and electrical resistivity data. Further, both compounds exhibit a pronounced λ-type anomaly in their heat-capacity curves at T_m, confirming a bulk magnetic phase transition. In both compounds, magnetic susceptibility and isothermal magnetization indicate pronounced magnetocrystalline anisotropy, but with directionally opposite ease of magnetization: the easy axis is *c* for PrGaSi and lies within the *ab* plane for CeGaSi. Our crystal electric field (CEF) analysis suggests that the Ce^{3+} ($J = 5/2$) multiplet splits into three doublets, while the Pr^{3+} ($J = 4$) multiplet splits into two doublets and five singlets, with the overall CEF energy scale reduced from CeGaSi to PrGaSi. Electrical resistivity data of both compounds confirm metallic behavior. Magnetoresistance data of RGaSi show a competitive interplay between the reduction of spin disorder scattering (negative value) and Lorentz force (positive value). A pronounced anomalous Hall effect is observed in both systems and is primarily governed by skew-scattering mechanisms. In addition, first-principles calculations were performed to examine the electronic and topological properties of CeGaSi. Analysis uncovered nodal line-like features along the *S-G-Z* path lying in the $k_x = 0$ plane, thereby classifying CeGaSi as a nodal-line metal.

Keywords: Single crystal growth, magnetic properties, crystalline electric field, anomalous Hall effect, topological materials.

References:

[1] Rajesh Swami, D. Ram, A. C V, V. Kanchana, and Z. Hossain, "Crystalline electric field and large anomalous Hall effect in the candidate topological material CeGaSi," Phys. Rev. B, 112, 235119 (2025).

[2] Rajesh Swami, D. Ram, and Z. Hossain, "Crystalline electric field and anomalous Hall effect in topological semimetal PrGaSi," Journal of Magnetism and Magnetic Materials, 624, 173022 (2025).

Abstract ID: 172

INTERPLAY OF CORRELATIONS, SPIN-ORBIT COUPLING, AND PRESSURE IN $La_2CoIr_{1-x}Ti_xO_6$

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Abstract: Double perovskites offer a controlled route to tune correlated magnetism under competing electron correlation and spin-orbit coupling (SOC). We study $La_2CoIr_{1-x}Ti_xO_6$ ($0 \leq x \leq 1$), where nonmagnetic Ti^{4+} substitution on the Ir^{4+} site simultaneously dilutes SOC-active 5*d* moments and introduces chemical pressure while retaining the monoclinic $P2_1/n$ structure across the series. Magnetization measurements reveal a continuous evolution from a ferromagnetic-like transition at T_C = 92 K for x = 0 to an antiferromagnetic ground state at T_N = 14.6 K for x = 1, with systematic shrinking of isothermal *M-H* loops as Ti content increases. Hydrostatic pressure provides an additional tuning knob for La_2CoIrO_6, where the ordering temperature increases linearly to ~100 K at 2.22 GPa, and the magnetization grows approximately linearly with pressure, indicating a piezomagnetic response. High-resolution thermal expansion shows a broad anomaly around the magnetic transition, evidencing spin-lattice coupling. An Ehrenfest analysis yields an initial dT_N/dP = 5.9±0.5 K/ GPa consistent with the pressure-dependent magnetization trend. The electronic structure was also investigated using first-principles calculations within GGA+SOC+*U*. The results capture an SOC-driven electronic structure of the insulating state and show a progressive widening of the gap from about 0.28 eV (x = 0) to about 0.44 eV (x = 0.5) and about 1.01 eV (x = 1). This evolution is accompanied by a strong reduction of the Ir moment near x = 0.5, consistent with disrupted Co-O-Ir exchange pathways. Overall, $La_2CoIr_{1-x}Ti_xO_6$ emerges as a controlled materials platform for designing and benchmarking SOC-assisted magnetic and electronic tunability in complex oxides.

Keywords: Double perovskites, Electron correlation, Spin-orbit coupling, Hydrostatic pressure.

References:

[1] S. Nandi, V. Yadav, S. Devi, C. S. Yadav, B. Das, S. Datta, K. Dolui, and R. S. Manna, Tuning the magnetic and electronic properties of the double perovskite $La_2CoIr_{1-x}Ti_xO_6$, Phys. Rev. B **112**, 155144 (2025).

Abstract ID: 173

STRUCTURAL, OPTICAL AND MAGNETIC PROPERTIES OF $MnFe_2O_4$ AND $MnFe_2O_4/WS_2$ NANOCOMPOSITES FOR ENVIRONMENTAL APPLICATIONS

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Abstract: $MnFe_2O_4$ nanoparticles and $MnFe_2O_4/WS_2$ nanocomposites were successfully synthesized by using sol-gel auto-combustion and $MnFe_2O_4/WS_2$ synthesized using the hydrothermal method at 200°C. At first the single phase asprepared $MnFe_2O_4$ nanoparticles was synthesized using $Mn(NO_3)_2{\cdot}4H_2O$, $Fe(NO_3)_3{\cdot}9H_2O$ and $C_6H_8O_7$ at 1:2:3 ratio respectively. The crystalline structure of pure asprepared $MnFe_2O_4$ was confirmed by the XRD and the average crystallite size is found to be 18 nm. The structural, optical and magnetic properties were systematically analysed by SEM, VSM, Raman spectroscopy. As the band gap of $MnFe_2O_4$ lies between ~2.0 eV under visble light region, it is a potential candidate for photocatalytic, HER and OER applications**[1]**. In this study, the reactive oxygen species induced degradation pathways of various organic dyes such as methylene blue, rhodamine B, crystal violet and malachite green will be analysied in detail for $MnFe_2O_4$ and $MnFe_2O_4/WS_2$ nanocomposites. $MnFe_2O_4$ is also a potential candiate for microwave adsorption region X-band (8 to 12 GHz)**[2]**. Hence, The properties of microwave absorption for pure $MnFe_2O_4$ and $MnFe_2O_4/WS_2$ nanocomposites will be studied using vector network analyser.The obtained restults will be analysed based on the annealing temperature, grain growth and composite ratio. These findings provide valuable insights into the suppression of electron-hole recombination and emphasize the role of WS_2 in band gap modulation for improved photocatalytic efficiency. The enhanced microwave absorption performance of the $MnFe_2O_4/WS_2$ nanocomposite is attributed to its broad effective absorption bandwidth and strong reflection loss characteristics will be analysed. The synergistic coupling of $MnFe_2O_4/WS_2$ nanocomposite shows significant potential for multifunctional environmental applications in future.

Keywords: $MnFe_2O_4$, $MnFe_2O_4/WS_2$, Photocatalysis, Sol-gel autocombustion, Microwave absorption.

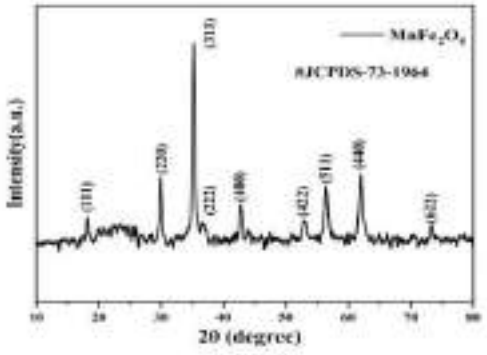


Fig. 1: Shows the XRD pattern of pure asprepared $MnFe_2O_4$ sample.

References:

[1] Wang, Zhixing, et al. *Advanced Powder Technology* 34.7 (2023): 104040.
[2] Zhang, Gengyuan, et al. *Materials Letters* 231 (2018): 209-212.

Abstract ID: 175

EMERGENT INTERPLAY BETWEEN LOCAL MAGNETIC ORDERING AND ELECTRONIC CORRELATION EFFECTS IN HOLE DOPED $EuFe_2As_2$

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Abstract: The discovery of $EuFe_2As_2$ as a prototypical parent compound of the 122-type iron pnictide family provides a robust platform to investigate the influence of elemental doping on intertwined magnetism and electronic correlations [1-2]. In this study, a series of Mn (hole)-doped $Eu(Fe_{1-x}Mn_x)_2As_2$ ($0 \leq x \leq 0.13$) samples were systematically synthesized to explore the evolution of magnetic ordering in both the itinerant Fe and localized Eu^{2+} sublattices. The samples have been characterised in detail using SEM, EDAX and single crystal XRD. Exhaustive analysis of temperature-dependent electrical resistivity and dc magnetization measurements were performed to understand the magnetic phase transitions. From the transport and magnetic measurement data, it is prominently observed that the spin-density-wave (SDW) transition of the Fe sublattice decreases monotonically from ~190 K in the parent compound to ~130 K at $x = 0.13$, indicating a gradual suppression of itinerant magnetism with hole doping. The SDW anomaly remains across the entire doping range, reflecting the robustness of Fe-derived magnetic correlations. To understand these experimental findings detailed density functional theory calculations have been performed which attest the role of Mn in understanding the magnetic ordering and the interplay of the localised Eu in these systems.

Keywords: Fe based superconductors, electronic correlations, A-type antiferromagnetism, spin density wave.

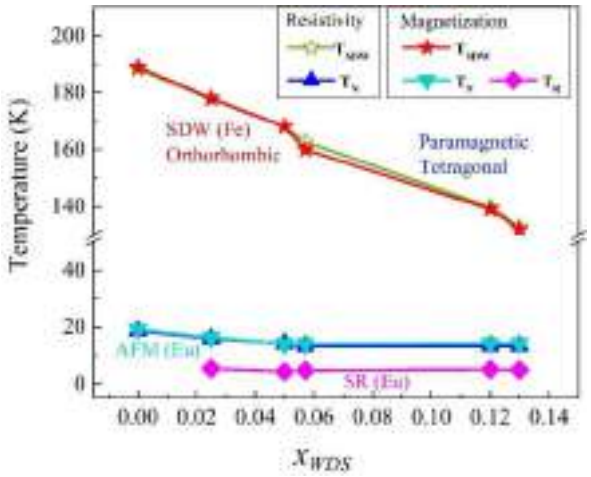


Fig. 1: Doping phase diagram (x_{WDS} vs. T) of $Eu(Fe_{1-x}Mn_x)_2As_2$ for $0 \leq x \leq 0.13$. The data obtained from resistivity and magnetization measurements are summarized in this diagram.

References:

[1] W. T. Jin, Y. Xiao, Z. Bukowski, Y. Su, S. Nandi, A. P. Sazonov, M. Meven, O. Zaharko, S. Demirdis, K. Nemkovski, K. Schmalzl, L. M. Tran, Z. Guguchia, E. Feng, Z. Fu, and T. Br¨uckel, Phys. Rev. B 94, (2016), 184513.

[2] S. Hao, W. Jin, Z. Bukowski, Z. Lin, Y. Xiao, and Y. Su, Phys. Rev. B 107, (2023), 014421.

Abstract ID: 176

EFFECTS OF LIGHT INTERSTITIAL DOPING OF Cu AND Ag ON THE STRUCTURAL, MAGNETIC AND MAGNETO-DYNAMICS PROPERTIES OF $Fe_{85}Ga_{15}$ FILMS

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Abstract: The study examines the effects of lattice modification resulting from the doping of 1.5 (±0.2) at.% of Cu (CFG) and Ag (AFG) on the structural, magnetic, and magneto-dynamic properties of $Fe_{85}Ga_{15}$ (FG) films. In sputter-deposited films, doping was incorporated by placing two 5 mm diameter chips of Cu and Ag on the sputtering target. The structural profiles of the film confirm an A2-type disordered BCC structure with no change in lattice constant, suggesting that the doping mechanism is dominantly interstitial. The magnetization vs magnetic field (MH) curves reveal an enhanced saturation magnetization (M_s) for CFG and AFG systems. A significantly improved squareness ratio of 0.96 is determined through MH studies for AFG, while the same remains nearly the same for CFG. An enhancement of more than 50ºC is observed in the magnetic transition temperature (T_c) in CFG and AFG from the magnetization vs temperature (MT) curve. The increase in M_s and T_c in CFG and AFG is attributed to the induced lattice modifications. Vector Network Analyzer based Ferromagnetic Resonance studies have confirmed a low effective damping parameter for the FG system which increases slightly in CFG and AFG. Additionally, magnetic anisotropy and the inhomogeneous linewidth are found to be substantially reduced in CFG and AFG systems.

Keywords: Galfenol, Magnetron sputtering, Lattice expansion, Ferromagnetic Resonance, Derivative Divide Method

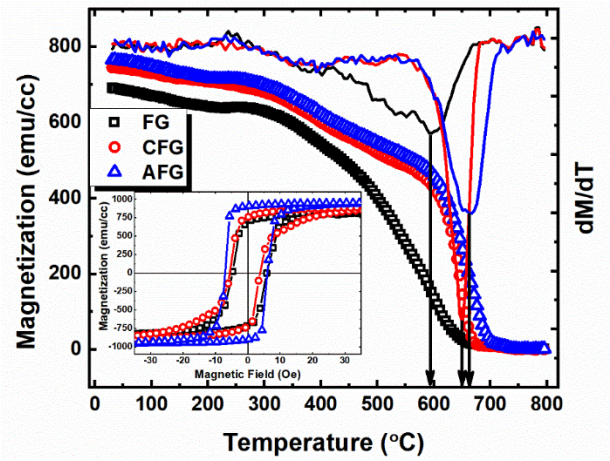


Fig. 1: MH and MT curves of FG, CFG and AFG samples

References:

[1] A. Ahmad, Arun B, P. Rajagiri, K. C. James Raju, J. Magn. Magn. Mat. 634 (2025) 173556.

Abstract ID: 177

MICROMAGNETIC SIMULATION OF SPIN-TRANSFER TORQUE–INDUCED SWITCHING IN MAGNETIC TUNNEL JUNCTIONS FOR LOW-POWER MRAM

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*Corresponding author: physicsw358@gmail.com

Abstract: The basic units of spintronic memory devices such as Magnetic Random Access Memory (MRAM) are Magnetic Tunnel Junctions (MTJs) due to their lack of volatility, high switching rate, scalable properties, and low power usage. This present paper will give a theoretical and micromagnetic simulation study of spin-transfer torque (STT)-controlled magnetization switching in the nanoscale MTJs. The fundamental principles of working of the devices, including the electron spin polarization, tunneling magnetoresistance (TMR), and the STT mechanism, are touched upon briefly in order to constitute the physical background. Micromagnetic simulation is conducted, systematically examining the role of major design variables, i.e., the current density, perpendicular magnetic anisotropy, and also the thickness of the free layer on the switching dynamics and energy dissipation. It has been demonstrated in the results that optimized parameter sets can lead to the elimination of the critical switching current and switching delay and still ensure sufficient thermal stability to ensure reliable data retention. Moreover, the paper explains the trade-off nature inherent with changing speed, power consumption, and stability limitation of nanoscale MTJ-fabricated devices. The results give a better understanding of the magnetization behavior on the nanometer and also give some design principles for how high-density and energy-efficient STT-MRAM architectures can be developed. The piece of work has helped the efforts of further developing next-generation non-volatile memory technology applications in low-power computing.

Keywords: Magnetic Tunnel Junctions (MTJs),Spin-Transfer Torque (STT),Micromagnetic Simulation,STT-MRAM,Tunneling Magnetoresistance (TMR)

References:

[1] T. Moposita, E. Garzón, A. Teman, M. Lanuzza, Nanomaterials 15 (2025) 9.
[2] M. Bendra, et al., Microelectron. Eng. (2025).
[3] P. Sharma, et al., J. Comput. Theor. Nanosci. 19 (2022) 1234–1240.

Abstract ID: 178

DESIGN AND DEVELOPMENT OF MAGNETORHEOLOGICAL (MR) FLUID CLUTCH

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Abstract: Clutches plays a vital role in power transmission in mechanical engineering field. A well known application is in the automotive vehicles where it is used to connect the engine and the gear box. Positive clutches and friction clutches are the basic types utilized in early days. Friction clutches are widely used in all the automobiles. In recent days, lot of development has been done in mechanical power transmission sector. Magnetic clutches, Magnetorheological (MR) fluid clutches, Electro rheological (ER) Fluid clutches are some the innovative clutches developed in recent years Magneto Rheological (MR) fluids and Electro rheological (ER) fluids also comes under smart materials. MR fluid is the suspension of magnetizable soft iron particles in a carrier fluid. Application of magnetic field across the MR fluid gives drastic change in viscosity within few milliseconds. This property of variable viscosity was used to provide collapsible fluid link in MR fluid based clutch under the application of controlled magnetic field. Previous researches gives some basic idea regarding the design, size and capacity of MR fluid based clutches. In present work theoretical calculations have been made and accordingly MR clutch assembly is prepared. Variation of torque transmission capacity is analyzed experimentally and theoretically. It is observed that the design of magnetic source and configuration of MR fluid plays vital role in power transmission by MR Fluid based clutches.

Keywords: MR fluid, Magneto rheological (MR) fluid clutches

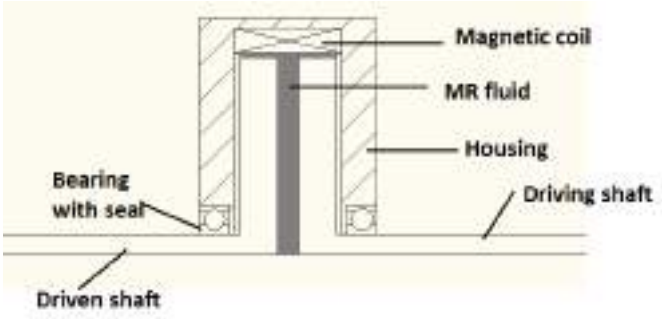


Fig. 1 : MR Clutch

References:

[1] O.I. Abdullah , J. Schlattmann , A.M. Al-Shabibi, "Stresses and Deformations Analysis of Dry Friction Clutch System", Tribology in Industry, Vol. 35, 2013.

[2] Shoaib Iqbal, Thierry Janssens, WimDesmet&Farid Al-Bender, "Transmitted Power And Energy Flow Behavior Of Degrading Wet Friction Clutches",International Journal of Applied Research in Mechanical Engineering (IJARME), Volume.2, 2012.

Abstract ID: 179

THE UNDERSTANDING OF LOW MAGNETIC MOMENT IN QUATERNARY HEUSLER ALLOY NiFeTiGa

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Abstract: The recent advent of zero moment ferromagnets displaying no stray magnetic lines of force have been found to be highly beneficial in the field of spintronics, because of their ultra-fast magnetization reversal, low power switching and reduced cross talks. The recent report of ferromagnetism (T_C ~ 91 K) and low magnetic saturation moment (M_s ~ 0.11 μ_B/f.u.) in a new quaternary Heuslar alloy NiFeTiGa thus demand to test its potential for practical application in this technologically emergent field of research. Heusler alloys form an important class of intermetallic compounds that are known to exhibit a remarkable diversity of magnetic and electronic properties arising from their multi-sublattice crystal structures and compositional flexibility. They are represented as X_2YZ, where X & Y comes from *d*-block, whereas Z usually belongs to *p*-block elements. The quaternary compound, XX'YZ, is a modified form of the standard full Heusler alloys. The compound NiFeTiGa has been reported to crystallize in the cubic ***F-43m*** **(Space Group No.-216)** structure ($a \approx 5.87$ Å) with Ga, Ni, Ti, and Fe occupying the 4a (0,0,0), 4b (0.5,0.5,0.5), 4c (0.25,0.25,0.25) and 4d (0.75,0.75,0.75) sites, respectively. On the basis of absence of (200) Bragg peak in the x-ray diffraction (XRD) data, a proposal of anti-site disorder between Ni and Ti had been proposed which was used to explain the discrepancy between theoretical and experimental M_s values. The XRD data on polycrystalline NiFeTiGa confirm a single-phase cubic Heusler structure (*F-43m*) with lattice parameter 5.867(1) Å. However, we found that the proposed structural disorder between 4*b*-4*c* Wyckoff sites cannot be reliably established solely from the XRD data, due to similar scattering factors of closely spaced *d*-block element Ni and Ti. DC-magnetic measurements at low field reveal an anomaly near 110 K with ZFC–FC bifurcation and non-saturating temperature dependence. Magnetic memory, relaxation, and frequency-dependent ac susceptibility indicate dominant spin-glass behavior with strong ferromagnetic correlations. The low magnetic moment of NiFeTiGa is therefore attributed to a magnetically glassy state rather than true long-range ferromagnetic order.

Keywords: Low-Moment Ferromagnetism, Spin-Glass, Heusler alloys, Intermetallics

(a) **(b)**

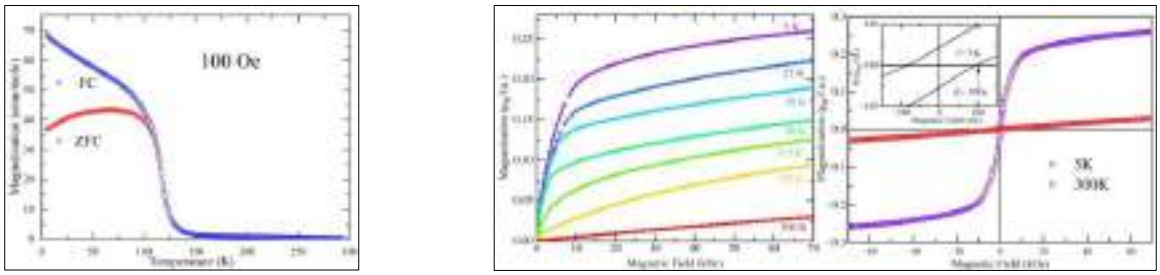


Fig. 1: Magnetization vs. temperature, M(T), under applied field of 0.1 kOe upto 300K, (a) Magnetization vs. Appled Field M(H), in the first quadrant from 5k to 300 K upto 70 kOe. (b) The 5K and 300K 5 quadrant M(H) upto ±70 kOe. Inset The B_c of the compound is shown.

Abstract ID: 180

STRUCTURAL AND MAGNETIC PROPERTIES OF Co_4N THIN FILMS STABILIZED WITH Pd

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Abstract: Antiperovskite Co_4N with a large magnetic moment and high spin-polarization ratio is a promising candidate for spintronic applications [1]. However, its stabilization requires a careful attention due to the high formation enthalpy and N diffusion. Transitioning from binary into ternary or quaternary systems provides an effective route to phase stabilization and defect reduction in transition metal nitrides [2]. In this work, we have incorporated Pd into Co_4N and found that the Pd incorporation stabilizes Co_4N thin films, reduces defects, and enables tuneable magnetization dynamic properties without altering the local structure and saturation magnetization considerably. Ferromagnetic resonance (FMR) studies shows that Pd doping in Co_4N causes a systematic rise in Gilbert damping coefficient (α) accompanied by a reduction in inhomogeneous broadening (ΔH_0). Thermal annealing studies revealed that Pd doping leads to enhanced thermal stability of Co_4N. The reduced disorder in the Co–N bond obtained from extended x-ray absorption fine structure (EXAFS), together with the decreased ΔH_0 extracted from FMR indicates that doping Pd is beneficiary for the stabilization of Co_4N. Further, we achieved epitaxial Pd-doped Co_4N thin films on $LaAlO_3$ (1.4% mismatch) and MgO (11.3% mismatch) at high temperature, where incoherent strain modifies the magnetic anisotropy, resulting in asymmetric hysteresis loops with distinct steps; detailed results will be presented at the conference.

Keywords: Transition metal nitrides, Co_4N, Thin films, EXAFS, FMR

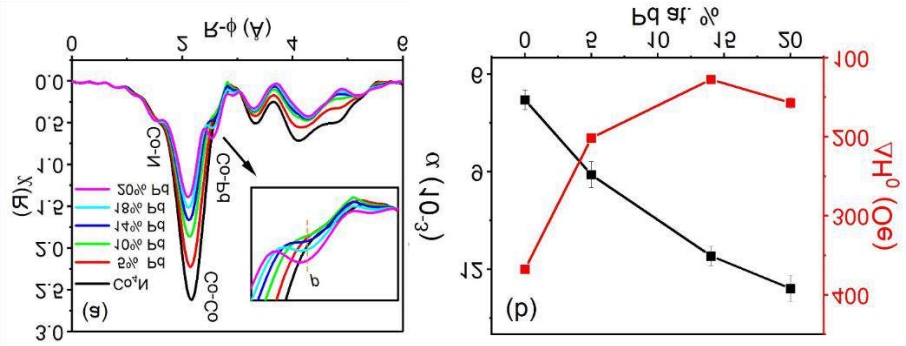


Fig. 1: Fourier transform moduli of Co *K*-edge EXAFS plotted against interatomic distance (a), the inset here shows the enlarged view of Co-Pd feature arising with Pd doping, the feature *p* represents the emerged Co-Pd shell with doping. The variation of Gilbert damping coefficient (α) and inhomogeneous broadening (ΔH_0) with Pd concentration in Co_4N samples obtained from FMR analysis (b).

References:

[1] Imai etal., J. Magn. Magn. Mat. 322, 2665 (2010)
[2] Tayal et al., Phys. Rev. B. **90**, 144412 (2014)

Abstract ID: 181

STRUCTURAL AND MAGNETIC PROPERTIES OF SPIN-5/2 TRIANGULAR LATTICE ANTIFERROMAGNET $RbFe(HPO_3)_2$

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Abstract: We present a comprehensive study of the structural and magnetic properties of a spin-5/2 triangular lattice antiferromagnet $RbFe(HPO_3)_2$ using x-ray diffraction, magnetization, heat capacity, and ^{31}P nuclear magnetic resonance (NMR) experiments on a polycrystalline sample. The crystal structure consists of Fe^{3+} ions forming an equilateral triangular lattice. The thermodynamic measurements reveal the onset of a magnetic long-range order at $T_{N1} \simeq 7.6$ K in zero-field, accompanied by another low temperature field induced ordering at T_{N2} in higher fields. The value of the frustration ratio ($f \simeq 7$) indicates moderate spin frustration in the compound. The NMR spin lattice relaxation measurements further confirm the transition at T_{N1}. The ^{31}P NMR spectra reveal two distinct spectral lines that corresponds to two inequivalent phosphorus sites (P1 and P2), consistent with the crystal structure from which the respective isotropic hyperfine coupling A_{iso}^{hf} are determined to be = 0.55(2) T/μ_B and 0.25(3) T/μ_B. The spectra below T_{N1} evolve into a nearly rectangular powder pattern, indicating a commensurate antiferromagnetic type order. An average exchange coupling of J/k_B = 2.8(2) K is estimated from the magnetic susceptibility and NMR shift data described well assuming a spin-5/2 isotropic triangular lattice antiferromagnetic model. The ^{31}P spin-lattice relaxation rate well below T_{N1} follows a T^3 temperature dependence, implying a two-magnon Raman scattering mechanism in the ordered state. *H-T* phase diagram clearly illustrates the three well defined phase regimes, reflecting a weak magnetic anisotropy in the compound.

Keywords: frustration, triangular lattice, phase transitions, magnetization, specific heat, NMR.

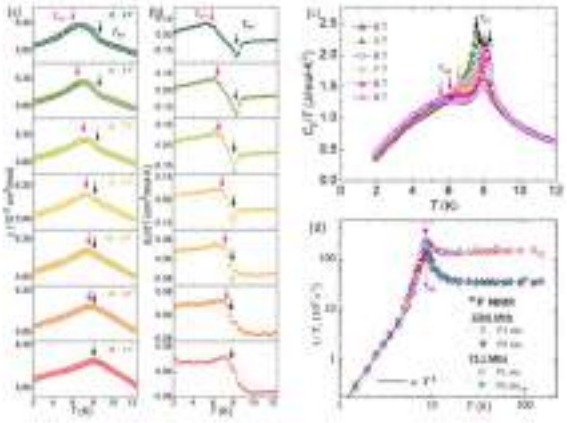


Fig. 1: a) Magnetic susceptibility, and b) temperature derivative at different magnetic fields. c) Specific heat divided by temperature. d) NMR spin relaxation rate versus temperature.

References:

[1] M. F. Collins and O. A. Petrenko, Can. J. Phys. 75, 605 (1997).
[2] P.-E. Melchy and M. E. Zhitomirsky, Phys. Rev. B 80, 064411 (2009).
[3] S. J. Sebastian et. al., Phys. Rev. B 105, 104425 (2022).
[4] R. Ishii et. al., 3, Europhys. Lett. 94, 17001 (2011).

Abstract ID: 182

GEOMETRIC CONTROL OF MODE SWITCHING IN A POLARIZATION-TUNABLE PHOTON–MAGNON HYBRID PLATFORM

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Abstract: We report polarization-controlled mode switching and tunable photon–magnon hybridization in a planar microwave resonator–YIG hybrid platform at room temperature [1]. The system consists of a planar electric LC resonator (ELCR) electromagnetically coupled to a ferrimagnetic YIG film, where axial rotation of the resonator with respect to the incident microwave field enables selective excitation of two orthogonal cavity modes. The radiative coupling strength follows a projection-dependent behavior, allowing continuous control of the magnon–photon interaction by geometric rotation. At 0° and 90°, distinct cavity modes couple individually to the magnon mode, while at intermediate angles both photon modes hybridize simultaneously with the magnon, forming a three-mode coupled system. Experimentally measured transmission spectra ($|S_{21}|$) reveal angle-dependent anticrossing behavior with tunable coupling strength, including transitions between level repulsion and level attraction regimes. The coupling coefficients exhibit a systematic angular dependence consistent with a projection-squared scaling of radiative damping and intermode coupling. To interpret the observed behavior, we develop both an electrical circuit model and a non-Hermitian quantum Hamiltonian framework incorporating dissipative and coheresnt coupling channels. The theoretical eigenvalue analysis reproduces the experimentally observed hybridization, linewidth evolution, and mode switching phenomena. Our results demonstrate a purely geometric route to engineer light–matter interaction strength, non-Hermitian dynamics, and multi-mode magnonic hybridization without altering material parameters or external circuitry. This work establishes polarization-controlled rotation as a versatile mechanism for tunable cavity magnonics and provides a scalable pathway toward reconfigurable hybrid quantum and spintronic devices.

Keywords: Garnet, solid-state reaction, spintronics, electric LC resonator

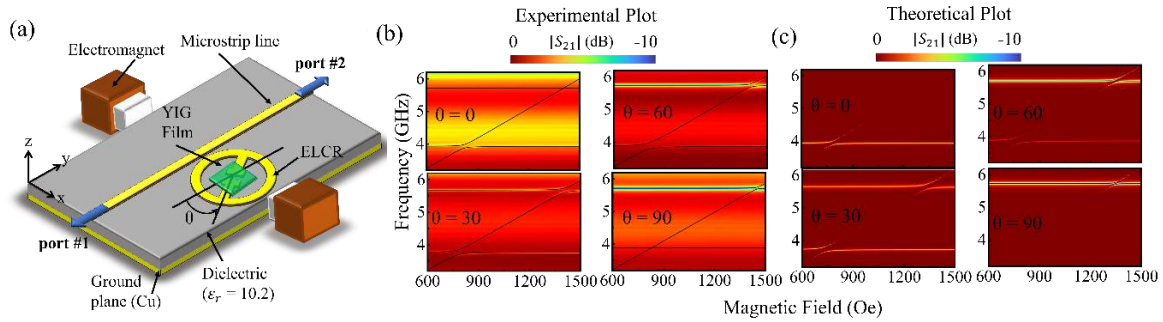


Fig. 1: (a) Schematic of the planar ELCR–YIG hybrid system showing axial rotation angle θ that controls the polarization of the excited cavity modes. (b) Measured $|S_{21}|$ spectra versus frequency and magnetic field for different rotation angles, showing angle-dependent photon–magnon hybridization. (c) Theoretical obtained transmission spectra reproducing the rotation-controlled coupling and mode evolution.

References:

[1] B Bhoi, B Kim, H-C Jeon and S-K Kim 2022, J. Appl. Phys. 132 243901.

Abstract ID: 183

MAGNETIC PROPERTIES OF BULK AND NANO MnP CRYSTALS GROWN BY METALIC FLUX NANONUCLEATION METHOD

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Abstract: Achieving nanoscale and bulk materials of the same composition simultaneously is an important approach for technological applications. MnP is a promising magnetic material for room-temperature applications. While bulk MnP has been extensively explored, nanoscale MnP for magnetic applications remains relatively under investigated. In this work, we develop bulk MnP and MnP nanowires using a metallic flux nanonucleation method[1–3]. A comparative analysis of the magnetic properties and magnetocaloric effect (MCE) at different magnetic fields and temperatures shows that bulk MnP exhibits a higher MCE (3.79 J kg^{-1} K^{-1} at 310 K under 4 T) and better refrigeration capacity than nanoscale MnP (3.7×10^{-2} J kg^{-1} K^{-1} at 310 K under 4 T). The infiltrated nano-MnP displays a weak magnetic moment, resulting in reduced magnetization. The dimensionality effect plays a major role in determining the magnetic properties. Therefore, improving the infiltration rate will be the focus of our future work.

Keywords: MnP, Flux method, Bulk crystals, Nanonucleation method

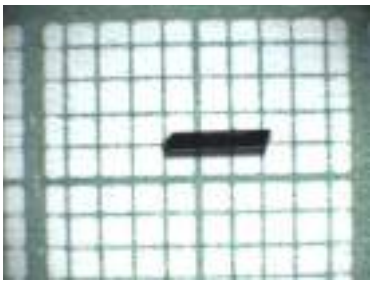


Fig. 1: Dimension of the MnP crystal.

References:

[1] K.R. Pirota, K.O. Moura, A.S.E. da Cruz, R.B. Campanelli, P.J.G. Pagliuso, and F. Béron, in *Magn. Nano- Microwires (Second Ed.*, edited by M. Vázquez, Second Edi (Woodhead Publishing, 2020), pp. 61–84.

[2] E. Navarro, M.U. González, F. Béron, F. Tejo, J. Escrig, and J.M. García-Martín, Nanomaterials **12**, 1186 (2022).

[3] A.A. Mendonça, L. Tomiatti, K.R. Pirota, and F. Béron, Nanoscale Adv. **8**, 123 (2026).

Abstract ID: 184

NEAR ATOMIC SCALE INVESTIGATION OF BULK MAGNETS USING ATOM PROBE TOMOGRAPHY

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Abstract: Understanding magnetism in bulk materials requires insight at the nanometer and even near-atomic scale, where subtle chemical fluctuations and phase separations govern macroscopic performance. While conventional magnetic characterization techniques describe domain structures and hysteresis behavior, they often lack the spatial and chemical resolution needed to directly resolve nanoscale compositional heterogeneities that control coercivity, remanence, and magnetic softness. In this work, we highlight the application of Atom Probe Tomography (APT) as a transformative tool for investigating nanomagnetism in bulk magnets. APT provides three-dimensional chemical mapping with sub-nanometer spatial resolution and near-atomic sensitivity, enabling direct visualization of clustering, spinodal decomposition, elemental segregation, and nanoscale precipitate formation. Through case study on FeCrCo-based permanent–ductile-magnets, we demonstrate how APT uncovers hidden nanoscale architectures, such as FeCo-rich and Cr-rich phase separation pathways, nanoscale chemical partitioning etc., that are otherwise inaccessible using conventional microscopy. By correlating these chemical landscapes with magnetic properties, it is possible to establish clear structure–property relationships rooted in atomic-scale chemistry. This near-atomic perspective provides a powerful framework for rational magnet design, bridging bulk magnetic behavior with nanoscale compositional engineering. The presentation aims to introduce the magnetism community to the capabilities, opportunities, and practical considerations of employing APT for advancing next-generation soft and permanent magnetic materials.

Keywords: Atom Probe Tomography, nanomagnetism, FeCrCo, permanent ductile magnet.

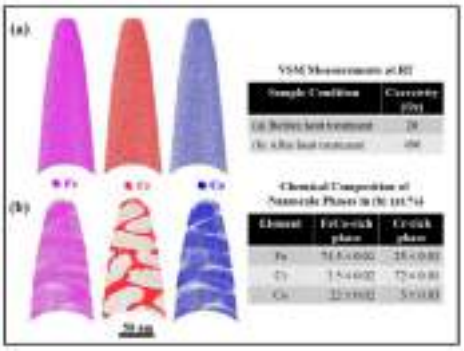


Fig. 1: Atomic distribution of Fe, Cr and Co obtained from atom probe data of Fe-31Cr-15Co (wt. %) alloy before thermal treatment (a) and after thermal treatment (b). Each single, color dot, in these images is a single atom. After thermal treatment, the alloy phase separates into FeCo-rich and Cr-rich nanoscale phases. The chemical composition of these nanoscale phases measured by atom p.

Abstract ID: 185

ROLE OF CHROMIUM IN SPINODAL DECOMPOSITION AND MAGNETIC HARDENING OF IRON–CHROMIUM–COBALT ALLOYS

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Abstract: Development of permanent magnets with reduced Co content has become essential due to the growing uncertainty about availability of Co [1]. Conventional Alnico-5 [2] magnets contain approximately 24–25 wt.% Co, and achieving comparable magnetic hardening at significantly lower Co levels remains an important challenge. In this work, we demonstrate a composition-driven strategy to enhance coercivity in Fe–Cr–Co alloys containing 15 wt.% Co by systematically increasing the Cr content while maintaining identical step-aging treatments within the spinodal regime. Three alloys with 22, 27, and 31 wt.% Cr were investigated using vibrating sample magnetometry and atom probe tomography (APT). Room-temperature hysteresis measurements show an increase in coercivity from ~99 Oe (22 wt.% Cr) to ~200 Oe (27 wt.% Cr) and ~450 Oe (31 wt.% Cr), compared to ~20 Oe in the solutionized condition. However, as expected, the saturation magnetization decreases with increasing Cr content. APT analysis confirms spinodal decomposition into ferromagnetic Fe–Co–rich (α_1) and weakly ferromagnetic Cr-rich (α_2) phases for all the compositions. APT analyses also show that the compositions of α_1 and α_2 phases remain virtually the same for all three alloys. With increasing Cr content, the volume fraction of α_2 phase increases and α_1 regions evolve from a continuous network to isolated regions enveloped by α_2 phase. This leads to a rise in the number of available α_1/α_2 interfaces which enhances the domain wall pinning effect and thus, increases the coercivity. These results establish a clear relationship between the microstructure and magnetic property in Fe–Cr–Co permanent magnets.

Keywords: Spinodal decomposition, Atom probe Tomograpghy, Coercivity

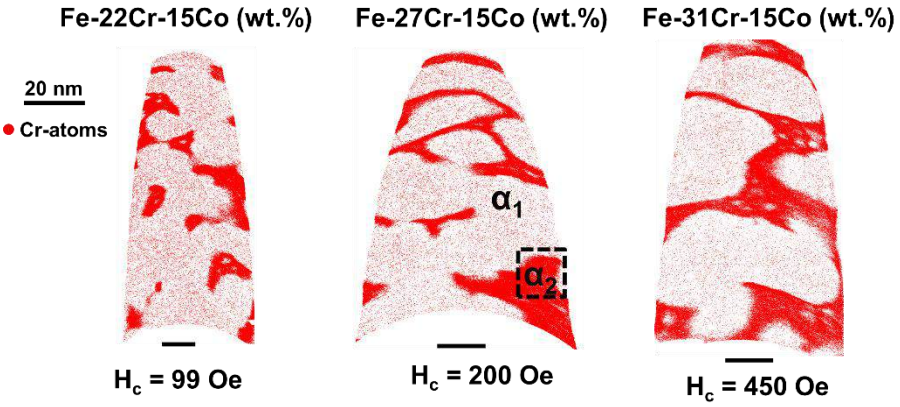


Fig. 1: APT reconstructions of Fe–X Cr–15 Co (wt.%) alloys with X = 22, 27 and 31.

References:

[1] H. Kaneko, M. Homma, K. Nakamura, M. Okada, G. Thomas, Phase diagram of Fe-Cr-Co permanent magnet system, IEEE Transactions on Magnetics 13 (1977) 1325–1327.

[2] Q. Xing, M. K. Miller, L. Zhou, H. M. Dillon, R. W. McCallum, I. E. Anderson, S. Constantinides, M. J. Kramer, Phase and Elemental Distributions in Alnico Magnetic Materials, IEEE Transactions on Magnetics 49 (2013) 3314–3317.

Abstract ID: 186

STRUCTURAL AND MAGNETOELECTRIC COUPLING IN Sc^{3+}, La^{3+} CO-SUBSTITUTED BFO-BTO CERAMICS

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Abstract: Multiferroic materials have become an object of growing interest due to their possibility of displaying both ferroelectric and magnetic characteristics under given conditions in the same phase and a coupling between them over a certain range of temperature termed as magnetoelectric (ME) effect. This property provides opportunities for potential applications in data storage, spin valves, spintronics, quantum electromagnets, microelectronic devices, optoelectronic device. $BiFeO_3$(BFO) is the only material to express coupling between magnetic and ferroelectric orders above room temperature which make it one of the prime candidates for room-temperature ME applications[1]. BFO has a distorted perovskite structure, belonging to R3c space group. $BaTiO_3$ (BTO), is a very well-known perovskite material for its large relative dielectric constant. It is a ferroelectric material with impulsive polarization produced commencing the dislocation of Ti^{4+} ions away from the centro–symmetric position within the TiO_6 octahedra. The enhancement of multiferroic properties in bismuth ferrite-barium titanate (BFO-BTO) ceramics through doping has attracted significant attention due to their potential in multifunctional device applications.

In this report, a solid-state method has been proposed for synthesis of Sc and La modified BFO-BTO ceramics. X-ray diffraction analysis indicated co-doped BFO-BTO ceramics have a pure perovskite structure and Rietveld refinement reveals the crystal structure of BFO-BTO ceramics. Further, the ferroelectric and magnetic studies will be measured for the prepared samples. To explore the crystal structure and magnetoelectric coupling of co-doped BFO-BTO ceramics are investigated and will be presented in the conference.

Keywords: Multiferroics, $BiFeO_3$-$BaTiO_3$, Magnetoelectric coupling, Room temperature, crystal structure.

References:

[1] Muneeswaran, M., Dhanalakshmi, R., & Giridharan, N. v. (2015). Journal of Materials Science: Materials in Electronics, *26*(6), 3827–3839.

[2] Mostari, M. S.; Islam, N.; Matin, M. A. Ceram. Int. 2020, 46, 15840−15850.

Abstract ID: 187

COMPARATIVE STUDY ON THE INFLUENCE OF RARE EARTH ELEMENT ON THE STRUCTURE OF STRONTIUM HEXAFERRITES FOR LEAD ION REMOVAL

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Abstract: Nanotechnology offers promising solutions to water contamination by developing advanced techniques for the efficient removal of hazardous pollutants from water bodies. This study represents a comparative investigation on Strontium Hexaferrites ($SrFe_{12}O_{19}$) and doped Strontium Hexaferrites to remove heavy metals from contaminated water through adsorption mechanism. Understanding the substitute influence of trivalent rare earth elements La^{3+}, Pr^{3+} and Sm^{3+} on the structure, magnetic and removal efficiency of hexagonal ferrites with the chemical formula $SrFe_{12}O_{19}$, $Sr_{0.9}La_{0.1}Fe_{12}O_{19}$, $Sr_{0.9}Pr_{0.1}Fe_{12}O_{19}$, $Sr_{0.9}Sm_{0.1}Fe_{12}O_{19}$ are made via Hydrothermal Method. The XRD examination revealed that the crystallized material formed a M-type hexagonal phase. The characteristics of M-type hexagonal ferrites include absorption bands with low wavenumbers in the FTIR curves between 400 to 1000 cm^{-1}. The goal of the research is to explore the potential of doping magnetic hexaferrites and its influence in wastewater treatment. Various parameters such as pH, contact time, adsorbent dosage influence the adsorption of lead ions from aqueous solutions were also examined. Magnetic separation was carried out by applying an external magnetic field using a permanent magnet.

Keywords: Hexaferrites, Trivalent rare earth elements, Heavy metals, Magnetic separation.

References:

[1] Rania Ramadan, Mai M. El-Masry, Material Science and Engineering:B 310 (2024): 117715
[2] K. Kayalvizhi, L. John Kennedy, Debdatta Ratnal, Ceramics International 50.9 (2024): 16241-16252

Abstract ID: 188

ANOMALOUS HALL AND NERNST EFFECT IN MAGNETIC TOPOLOGICAL SEMIMETAL: Mn_3ZnC

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Abstract: In recent years, antiperovskite materials are recognized for potentially hosting a variety of topological surface states. In carbide Mn-based antiperovskite family Mn_3XC (X = Zn, Sn and Ga), the band structure studies on Mn_3ZnC suggested it to have drum-head surface states with an isolated Weyl nodes in momentum space [1]. Besides, Mn_3ZnC shows paramagnetic (PM) to ferromagnetic (FM) transition at T_c ~ 380 K, followed by a ferrimagnetic (FIM) transition at T_N ~ 233 K [1]. Similarly, Mn_3GaC undergoes from PM to FM transition at T_c ~ 242 K and a antiferromagnetic (AFM) transition at T_N ~ 178 K [2]. Another antiperovskite Mn_3SnC shows paramagnetic (PM) to concurrent AFM/FM transition at T ~ 285 K [3]. In the context of topology and magnetism, these compounds are expected to show transport properties which would be quite useful in understanding the role of magnetic order in topological properties. Here, we present the anomalous Hall effect (AHE) and anomalous Nernst effect (ANE) in Mn_3ZnC. The value of anomalous Hall conductivity is found to be ~ 175 $\Omega^{-1}cm^{-1}$ with intrinsic contribution of ~ 57 $\Omega^{-1}cm^{-1}$. The scaling analysis of the anomalous Hall resistivity suggests that both intrinsic Berry curvature and extrinsic scattering mechanisms contribute to the AHE in the FIM state; and in the FM state, AHE is governed by purely intrinsic Berry curvature mechanism. Further, in the temperature range of T = 2 - 100 K, the electrical and thermal transport properties indicate a significant contribution of electron-magnon scattering. The ANE is also originated due to both intrinsic Berry curvature and extrinsic mechanism and the value of anomalous Nernst conductivity is found to be ~ 0.31 A/mK [4].

References:

[1] S. M. L. Teicher, *et al*. APL Mater. 7, 121104 (20119).
[2] V. N. Gaonka *et al.* Journal of Magnetism and Magnetic Materials 471 215 (2018).
[3] Sunil Gangwar *et al.* J. Phys.: Condens. Matter 36, 375603 (2024).
[4] Sunil Gangwar *et al.* Phys. Rev. B 111, 195106 (2025).

Abstract ID: 189

$Fe_{70}Co_{30}$ NANOPARTICLES: STRUCTURAL EVOLUTION AND MAGNETIC ENHANCEMENT VIA SOLID–SOLID REACTION

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Abstract: FeCo alloy nanoparticles (NPs) are of considerable interest for advanced magnetic applications due to their exceptional magnetic properties, including high saturation magnetization and excellent thermal stability. In this study, $Fe_{70}Co_{30}$ NPs were synthesized via a cost-effective and straightforward room-temperature solid–solid reaction of $FeCl_2 \cdot 4H_2O$, $CoCl_2 \cdot 6H_2O$ and $NaBH_4$ powders. The as-synthesized NPs exhibited an amorphous structure, which transformed into a well-ordered body-centered cubic (bcc) crystalline phase upon annealing in a hydrogen atmosphere. The structural and morphological characteristics of the NPs were thoroughly examined using x-ray diffraction (XRD) and transmission electron microscopy (TEM), while Field emission scanning electron microscopy (FESEM) coupled with energy-dispersive x-ray spectroscopy (EDS) provided insights into the surface morphology and in-situ chemical composition, verifying the uniform distribution of Fe and Co elements within the NPs. Magnetic measurements conducted using a vibrating sample magnetometer (VSM) demonstrated a significant enhancement in magnetic properties with increasing annealing temperatures. Notably, the NPs achieved an impressive saturation magnetization of 225 emu/g at 600 °C, which can be attributed to the improved crystallinity and optimal magnetic ordering in the bcc lattice. The outstanding magnetic performance, with the scalable and economical synthesis approach, positions these $Fe_{70}Co_{30}$ NPs as a promising candidate for next-generation magnetic storage devices, spintronic applications, and other emerging technologies requiring high-performance magnetic materials.

Keywords: FeCo alloy, Magnetic nanoparticle, Magnetization

Abstract ID: 190

FERROMAGNETIC SEMIMETALLIC NATURE IN NiFeMnSn QUATERNARY HEUSLER THIN FILMS

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Abstract: Semimetals occupy an intermediate regime between metals and semiconductors, characterized by a slight overlap between the valence and conduction bands in their electronic band structure, offers promising properties for spintronics applications.[1–3] Thin films of the quaternary Heusler alloy NiFeMnSn were deposited on Si substrates using magnetron sputtering to investigate their structural, magnetic, and transport properties. Room-temperature X-ray diffraction confirms a cubic crystal structure with a polycrystalline nature. Magnetic measurements reveal soft ferromagnetic behavior with a Curie temperature, T_C above 400 K and a saturation magnetization of approximately 130 emu/cc at 5 K, as shown in Fig. 1. The temperature-dependent electrical resistivity exhibits unusual behaviour. The resistivity decreases in the low-temperature region (5–50 K), followed by a nearly plateau-like region with a slight increase between 50 and 200 K, and then decreases again at higher temperatures. This unusual trend suggests a temperature-dependent competition between different charge carriers. Hall resistivity measurements display both ordinary and anomalous Hall contributions. Notably, the Hall coefficient undergoes a sign reversal from negative to positive with increasing temperature, indicating a transition in dominant charge carriers from electrons to holes. Furthermore, the films exhibit negative magnetoresistance at low temperature. The combined magnetic and transport characteristics point toward a magnetic semimetallic nature with possible topological features. The coexistence of soft ferromagnetism, high Curie temperature, relatively low magnetic moment, and semimetallic transport behavior highlights NiFeMnSn thin film as a good candidate to explore future for spintronic applications.

Keywords: Spintronics, Heusler alloys, quateranery heusler alloy thin film, magnetic semimetal.

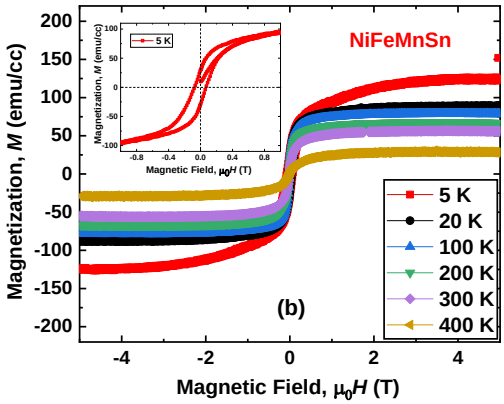


Fig. 1: The field dependence, *H* of In-plane magnetization, *M* as a function of temperature. The inset shows zoomed-in view of *M*-*H* plot at 5 K.

References:

[1] J. Li *et al.*, Chinese Phys. B **28**, 046202 (2019).
[2] R. Kumar, and S. Gupta, ArXiv:2504.17742, (2025).
[3] O. Pavlosiuk, and D. Kaczorowski, Sci. Rep. **8**, 11297 (2018).

Abstract ID: 191

STATIC AND DYNAMIC MAGNETIC PROPERTIES OF FeCo NANORINGS: A MICROMAGNETIC SIMULATION STUDY

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Abstract: Micromagnetic simulations play a crucial role in understanding spin dynamics in nanoscale magnetic structures for magnonic and spintronic applications. In this work, we investigate the static and dynamic magnetic properties of a FeCo-based nanoring using MuMax3 simulations. The nanoring geometry was discretized with SetGridSize(512, 512, 1) and SetCellSize(1 nm × 1 nm × 1 nm), ensuring spatial resolution below the exchange length of FeCo. The material parameters were chosen according to reported experimental values for FeCo alloys: saturation magnetization $M_s = 1.95 \times 10^6$A/m, exchange stiffness $A_{ex} = 32 \times 10^{-12}$J/m, and Gilbert damping constant $\alpha = 0.0014$. The hysteresis behavior was analyzed under an in-plane external magnetic field using quasi-static field sweeping. The coercivity and remanence shift were evaluated as functions of ring width and thickness. The magnetization reversal process was strongly influenced by edge demagnetizing fields and geometric confinement effects. For dynamic characterization, ferromagnetic resonance (FMR) spectra were obtained using a broadband sinc excitation field. The resonance frequencies were extracted from the spatially averaged magnetization dynamics via Fast Fourier Transform (FFT). Spatial mode profiles revealed uniform and edge-localized spin-wave modes. Additionally, the resonance frequency was studied as a function of the applied static magnetic field (field–frequency dispersion). The field-dependent analysis confirms that decreasing the ring width reduces the effective internal field, thereby enhancing demagnetizing effects and shifting the resonance frequency downward. These results demonstrate geometry-dependent tunability of resonance modes in FeCo-nanorings, which is relevant for designing magnonic resonators, tunable microwave filters, and spintronic devices.

Keywords: FeCo nanoring, Micromagnetic simulation, FMR, Spin dynamics, Magnonic devices.

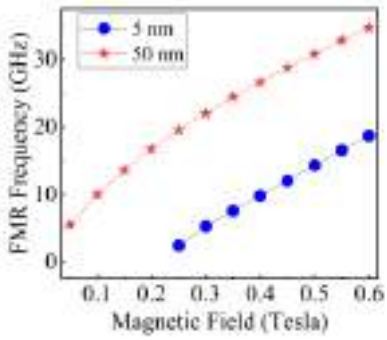


Fig. 1: Ferromagnetic resonance (FMR) frequency as a function of the applied magnetic field for nanorings with widths of 5 nm and 50 nm, illustrating the width-dependent shift in resonance behavior.

References:

[1] F. Q. Zhu, G. W. Chern, O. Tchernyshyov, X. C. Zhu, J. G. Zhu, and C. L. Chien, Phys. Rev. Lett. **96**, 027205 (2006).

Abstract ID: 192

DYNAMIC CONTROL OF MAGNON–MAGNON COUPLING THROUGH PHOTON MEDIATION

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Abstract: Photon–magnon coupling (PMC) is an emerging interdisciplinary research area that bridges microwave photonics, optics, and magnetism, offering a promising platform for hybrid quantum systems [1]. By combining the complementary advantages of these distinct physical systems, PMC enables the exploration of novel phenomena relevant to quantum information processing [2] and coherent signal manipulation. A deep understanding of the coupling mechanism and its controllability is crucial for advancing both fundamental studies and potential applications [3]. In this work, we experimentally demonstrate photon-mediated magnon–magnon coupling in a hybrid system based on a hexagonal ring resonator (HRR) coupled to spatially separated yttrium iron garnet (YIG) films (See Fig. 1(a)). Through both experiments and numerical simulations, we observe the emergence of bright and dark magnon modes arising from the collective interaction between a single photon mode and two magnon modes positioned at different locations along the resonator track. For a single YIG placed at angular positions of 0° and 180°, we observe a consistent coupling strength of approximately 126 MHz. Interestingly, when two YIG samples are simultaneously positioned at 0° and 180°, the coupling strength increases to 166 MHz (as shown in Fig. 1(b)), indicating the presence of photon-mediated magnon–magnon interaction. This enhanced coupling confirms the cooperative nature of the hybrid system. Furthermore, we develop a theoretical model to validate our simulation results and to elucidate the physical origin of the photon-mediated magnon-magnon coupling. Our findings provide valuable insights into controllable multi-magnon interactions mediated by cavity photons and open new avenues for engineering hybrid quantum systems.

Keywords: Hybrid Quantum System, Magnon-Magnon Coupling, Quantum Information Processing.

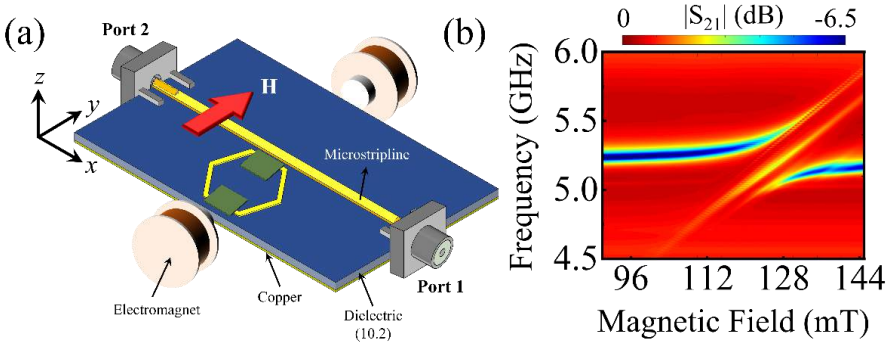


Fig. 1: (a) Schematic of HRR, and YIG hybrid system, (b) $|S_{21}|$ power on the plane of microwave frequency and magnetic field plane (f–H plane) for indirect magnon-magnon coupling.

References:

[1] Y. Tabuchi, et al, Science **349**(6246), 405–408 (2015).
[2] Y. Li et al, J. Appl. Phys. 128 (2020) 130902.
[3] Z.-L. Xiang et al, Rev. Mod. Phys. 85 (2013) 623–653.

Abstract ID: 193

X-RAY SPECTROSCOPIC EVIDENCE OF INTERFACE-MEDIATED MAGNETOELECTRIC COUPLING IN $NiFe_2O_4/BaTiO_3$ HETEROSTRUCTURES

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Abstract: $NiFe_2O_4/BaTiO_3$ (NFO/BTO) multilayer heterostructures grown on (001)-oriented $SrTiO_3$ substrates, comprising alternating ferrimagnetic NFO and ferroelectric BTO layers, exhibit pronounced magnetoelectric (ME) coupling that strengthens with increasing multilayer periodicity and, consequently, a higher density of NFO/BTO interfaces. The local electronic structure and magnetic states of Ni and Fe ions in NFO/BTO multilayers with varying individual layer thicknesses were systematically investigated using x-ray absorption spectroscopy and x-ray magnetic circular dichroism. An increase in the number of bilayers results in a reduction of both Ni and Fe magnetic moments. Furthermore, as the NFO layer thickness decreases, the average magnetic moment of Ni ions is significantly suppressed, whereas that of Fe ions remains largely unchanged, indicating a selective loss of ferromagnetic moments for Ni ions at the NFO/BTO interface. These observations suggest that the enhanced ME coupling originates from interfacial Ni ions, whose ferromagnetic behaviour is weakened due to electronic hybridization with the BTO layers.

Keywords: Magnetoelectric, X-ray absorption, X-ray magnetic circular dichroism, Magnetic materials

Abstract ID: 194

ANTISYMMETRIC MAGNETORESISTANCE IN Fe_3GeTe_2 INHOMOGENEOUS NANOFLAKE

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Abstract: Fe_3GeTe_2 (F3GT) is a van der Waals (vdW) ferromagnet with a relatively high Curie temperature and strong perpendicular magnetic anisotropy, making it a promising candidate for spintronic applications. As a vdW material, F3GT offers the advantage of being easily integrated into heterostructures for device fabrication. Recent studies on current-induced, spin-orbit torque (SOT) driven magnetization switching in F3GT-based heterostructures have highlighted its potential for memory device applications. While most previous studies have focused on homogeneous F3GT-based device architectures, intriguing properties have been reported in heterogeneous films with laterally separated regions of different thicknesses. In this work, we study the antisymmetric magnetoresistance (MR) in a heterogeneous F3GT nanoflake, arising from unsynchronized domain switching across the step edge separating the thin and thick regions. We probe the temperature dependence and field-angle dependence of this antisymmetric MR to characterize its anisotropic nature. Our study opens new possibilities for novel magnetic memory devices that exploit artificial domain fabrication and multi-resistance states.

Keywords: vdW ferromagnet, spintronics, magnetoresistance, magnetic domain, Fe_3GeTe_2

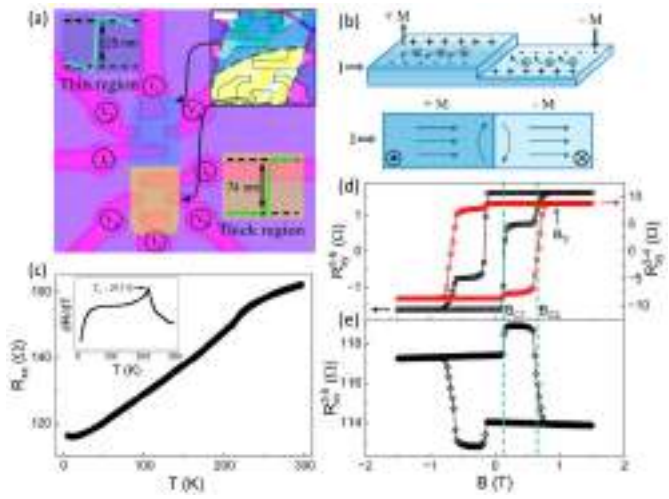


Fig. 1: (a) Optical image of the inhomogeneous F3GT device. (b) Schematics of magneto-trasport. (c) Resistance and (d) Hall and magnetoresistance acquired from the device.

Abstract ID: 195

DOMAIN WALL VELOCITY MEASUREMENTS IN GdCo THIN FILMS WITH DIFFERENT THICKNESS

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Abstract: Rare-earth, transition-metal amorphous alloy thin films such as GdFe(Co) are promising ferrimagnetic materials for spintronics. Due to the antiferromagnetic coupling between RE and TM sublattices, the magnetic properties of these alloy systems can be controlled by changing the intrinsic and extrinsic parameters of the system [1,2,3]. This tunability enables applications and fundamental studies. We examine thickness-dependent magnetic properties and domain dynamics in Ta/Pt/$Gd_{0.30}Co_{0.70}$/Ta/Pt thin films with thickness of GdCo layer as 5, 10, and 20 nm. It is inferred from the MOKE loops (Fig.1) that the magnetic compensation temperature (T_{comp}) is different with thickness and anisotropy changes from out-of-plane to in-plane and the direction as the thickness increases. Further the domain wall velocity measurements were done with MOKE microscope in a quasistatic way with pulse magnetic fields. Fig.1 also shows the domain evolution (near coercive fields) and the domain velocity data, measured with quasistatically and analyzed with MODVORTEx software, for the samples that exhibit out-of-plane magnetization. The data depicts significant changes with thickness of GdCo layer. The observations of the present study i.e., variation in magnetic anisotropy and domain wall velocity dynamics with thickness are explained in terms of the strctural variation with thickness of magnetic layer.

Keywords: MOKE, Domain Wall Velocity, Perpendicular Magnetic Anisotropy (PMA).

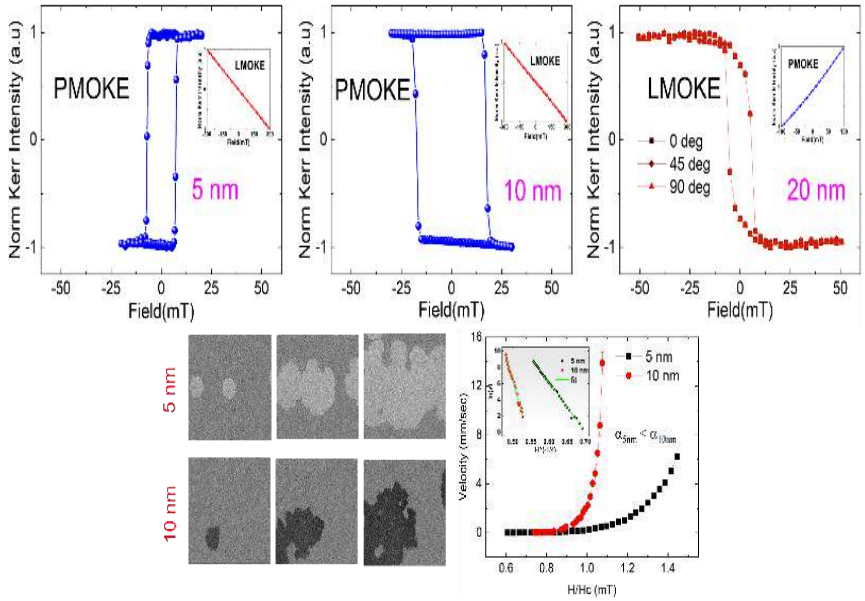


Fig. 1: (Top) MOKE loops of Ta/Pt/$Gd_{0.30}Co_{0.70}$/Ta/Pt with different thickness of $Gd_{30}Co_{70}$ layer (bottom) Domain evolution of for three consecutive magnetic pulses with a pulse duration of 50 msec and the domain velocity data as a function of magnetic field.

References:

[1] Suzuki,et.al.,PRB,107,134430(2023).
[2] Atkinson.,et.al.Appl.Phys.Lett.123-12(2023)
[3] Smritiparna Ghosh,et.al,PHYSICAL REVIEW B 112, 134406 (2025)

Abstract ID: 196

NANOMETER THICK YIG FILM FOR PHOTON-MAGNON COUPLING

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Abstract: Photon–magnon coupling (PMC) enables coherent exchange of information between microwave photons and collective spin excitations, providing a powerful platform for hybrid quantum systems, tunable microwave devices, and coherent signal processing. Strong PMC has traditionally been realized using millimeter-scale yttrium iron garnet (YIG) spheres or micrometer-thick YIG films due to their extremely low magnetic damping and high spin density. However, such bulk or thick-film geometries are not well suited for planar device integration or scalable on-chip architectures.

In this work, we demonstrate that nanometer-thick YIG films can effectively support coherent photon–magnon coupling. We report the growth and detailed characterization of a high-quality 65 nm YIG thin film exhibiting excellent structural uniformity and low magnetic damping. Ferromagnetic resonance measurements reveal a narrow linewidth and a small effective Gilbert damping parameter, indicating minimal extrinsic losses despite the significantly reduced thickness. The ultrathin YIG film is integrated with a planar microwave resonator to realize a cavity magnonic system. Field-dependent microwave transmission measurements show a clear and well-defined anti-crossing between the cavity photon mode and the Kittel magnon mode of the film. The extracted coupling strength exceeds the combined dissipation rates of the photon and magnon subsystems, confirming operation in the strong-coupling regime.

These results establish that a 65 nm YIG film is sufficient to achieve robust strong photon–magnon coupling, eliminating the reliance on bulky spheres or thick magnetic layers. This thin-film approach offers a practical pathway toward fully planar, chip-scale magnon–photon hybrid platforms for integrated quantum and microwave technologies.

Keywords: Photon, Magnon, Magnetic damping, YIG.

Abstract ID: 197

SPECTROSCOPIC SIGNATURES OF NONLINEAR SKYRMION DYNAMICS IN SYNTHETIC ANTIFERROMAGNETS AND THEIR ORIGIN

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Abstract: Skyrmions are topologically protected magnetic textures that are stabilized in the presence of competing magnetic interactions (exchange, Dzyaloshinskii Moriya interaction, anisotropy, etc.), with potential applications in data storage and computing[1]. Synthetic anti-ferromagnetic (SAF) configuration can host skyrmions of opposite chirality with vanishing magnetization and net zero topological charge, which suppresses the skyrmion hall effect, improves thermal stability, reduces stray fields, and enables faster, more controllable skyrmion dynamics at lower current densities. These features address critical limitations of ferromagnetic skyrmions, making SAF skyrmions promising for energy-efficient, high density, and scalable nanoscale devices.

In this work, we employ micromagnetic simulation to study different skyrmion states, realized both in single free-layer (SFL) magnetic tunnel junctions (MTJ) and in SAF free layers with varying strengths of interlayer exchange coupling (IEC). While skyrmion eigen-modes appear as clear resonance peaks in spin-torque ferromagnetic resonance (ST-FMR) simulations of SFL skyrmions, for SAF skyrmions with strong IEC, these eigen-modes are mostly suppressed, and uniform modes dominate. SAF skyrmions stabilized in multilayers with lower IEC shows non-linear skyrmion eigen modes under out-of-plane magnetic fields, accompanied by significant skyrmion radius modulation. ST-FMR results show robust single layer mode detection, whereas SAF modes appear conditionally, emphasizing the interplay between coupling strength, magnetic field tuning, and skyrmion dynamics. These simulation results demonstrate the understanding of SAF skyrmion dynamics and provide valuable insights for their electrical detection and control, thereby advancing the development of next-generation spintronic devices that exploit the unique properties of SAF skyrmions.

Keywords: Skyrmion, Synthetic anti-ferromagnet, Eigen-modes, Inter-layer exchange coupling, Spin-torque ferromagnetic resonance.

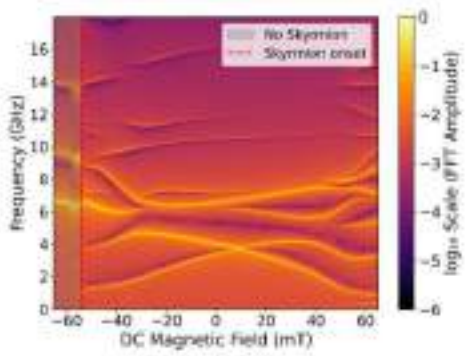


Fig. 1: Frequency eigenmodes in a SAF system hosting a skyrmion excited by perturbing the system with a sinc field pulse.

References:

[1] Fert, A., Reyren, N., Cros, V., Nat. Rev. Mater. **2**, 17031 (2017).

Abstract ID: 198

CHARGE-TO-SPIN CONVERSION AT $SrTiO_3$/NiFe HETERO-INTERFACES

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Abstract: The charge-to-spin interconversion at oxide interfaces has garnered significant attention from researchers due to its potential application in oxide spintronics. We have measured the charge-to-spin conversion at the perovskite STO and Ferromanget NiFe interface. Since STO in bulk is an insulator, we have deposited Oxides such as AlO or AlN, or milled the STO surface to create a conducting 2DEG layer. The charge current flows through the 2DEG layer, and the Rashba Edelstein effect at the STO interface, which locks the spin to momentum, resulting in the spin being polarised in the perpendicular direction of the charge current. We have measured the charge-to-spin conversion at the STO/Oxide/NiFe and STO(Ar+)/NiFe heterostructures. We have also found not only that this charge-to-spin conversion is unconventional [1] but also that it depends on the temperature, unlike the archetypal metallic Pt/NiFe. Our findings may enable applications of complex oxide and ferromagnet interfaces for efficient charge-to-spin conversion, paving the way for low-power oxide-based spintronic devices.

Keywords: Pervoskites, Thin films, Spin torque ferromagnetic resonance, Oxide spintronics

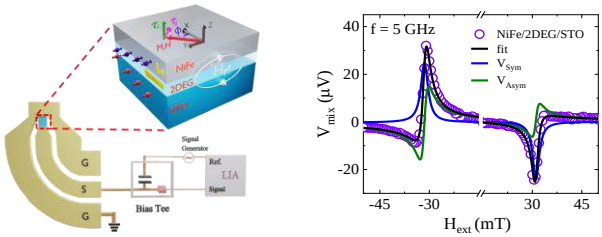


Fig. 1: Schematic of ST-FMR measurement with lock-in setup to measure the Vmix across the device (left panel) and measured Vmix at 5 GHz frequency (right panel)

References:

[1] Amrendra Kumar, Utkarsh Shashank, et al., Appl. Phys. Lett. 126, 032401 (2025).

Abstract ID: 199

COMPETING EXCHANGE INTERACTIONS AND OXYGEN-VACANCY-DRIVEN HOPPING TRANSPORT IN Nd_2FeMnO_6 DOUBLE PEROVSKITE

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Abstract:

The structural, magnetic, and transport properties of Nd_2FeMnO_6 (NFMO) were investigated using a combination of experiments and first-principles density functional theory (DFT) calculations. Rietveld refinement of powder X-ray diffraction confirms a single-phase orthorhombic structure with space group *Pbnm*. X-ray photoelectron spectroscopy reveals mixed-valence states of Mn^{3+}/Mn^{4+} and Fe^{2+}/Fe^{3+}, together with oxygen defect, indicating local charge imbalance in the transition-metal sublattice. DFT calculations identify an antiferromagnetic (AFM) ground state with a semiconducting electronic structure and strong p-d hybridization. Mapping of total energies onto the Heisenberg Hamiltonian reveals strongly anisotropic exchange interactions, where dominant AFM Fe-Fe coupling competes with ferromagnetic (FM) Mn-Mn and anisotropic Mn-Fe interactions. This competition leads to magnetic frustration, which is consistent with experimental observations. Magnetic relaxation and memory experiments further confirm the presence of slow nonequilibrium spin dynamics and a hierarchical energy landscape typical of frustrated magnetic systems [1]. The density of states shows that oxygen vacancies introduce localized in-gap states near the Fermi level, dominated by Mn 3d and O 2p orbitals. These defect states act as carrier-trapping centers, promoting thermally activated hopping transport. Dielectric measurements reveal Maxwell-Wagner type interfacial polarization, while the frequency-dependent conductivity follows Jonscher's power law. The transport mechanism is dominated by Mn^{4+}–Mn^{3+} hopping and is well described by Mott's variable-range hopping model with a high density of localized states near the Fermi level. These results highlight the crucial role of oxygen-vacancy-driven electronic reconstruction and competing exchange interactions in governing magnetic frustration and hopping conduction in NFMO.

Keywords: Double perovskites, Magnetic relaxation, Magnetic memory effect, Bloch's law, Dielectric constant, Arrhenius relation

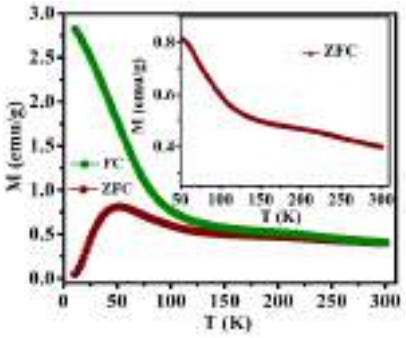


Fig. 1: Temperature-dependant magnetization data recorded under both ZFC and FC modes with inset of ZFC data in expanded scale.

References:

[1] P. Bag, P.R. Baral, R. Nath, Phys. Rev. B. 98 (2018) 144436.

Abstract ID: 200

ADVANCEMENTS AND CHALLENGES IN NEUROMORPHIC HARDWARE DESIGN: THE ROLE OF STT-MTJ BASED LEAKY INTEGRATE-AND-FIRE NEURON EMULATION FOR LOW-POWER AI ACCELERATORS

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Abstract: In the field of neuromorphic computing, there are several indications about the challenges and limitations in hardware design that led to the development of STT-MTJ-based low-power AI accelerators that emulate LIF neurons. Prior to these breakthroughs, the area relied on the fundamental "von Neumann bottleneck," in which processing and memory are disparate components in traditional architectures leading to energy consumption and high latency during data processing, particularly prone for AI workloads[1]. Traditional CMOS technologies are widely used yet suffer from excessive power consumption and demand thousands of transistors for neuron state integration and resetting utilizing advanced [2]. When it comes to scalability and compactness, there were previously large challenges, as existing electronic elements have failed to deliver the requested density nor small footprint for brain scale AI accelerators while preliminary scale up efforts in spintronics showed complicated architectures with poor reset[3]. Moreover, many pre-STT/MTJ approaches lacked intrinsic non-volatility that limited in-memory computing technology and required continuous data reloading, making them energy inefficient. Copying more biologically realistic neuron dynamics above the simple LIF model were not as easily realized, while reset functionality of LIF neurons was routinely important in early spintronic designs yet results fall short. Finally, implementing effective learning mechanisms at the hardware level was in its infancy and demanded devices to be capable of gradual and precise weight modulation, something difficult to achieve with the technologies available at the time. Hence, these cumulative shortcomings emphasized the requirement for new materials and novel device architectures, which created opportunities to seek alternative solutions.

Keywords: Neuromorphic Computing, AI Accelerators, Spin-Transfer Torque (STT), Magnetic Tunnel Junctions (MTJs), Leaky Integrate-and-Fire (LIF) Neuron Model, Von Neumann Bottleneck.

References:

[1] Liu, H., & Ohsawa, T. (2023). A binarized spiking neural network based on auto-reset LIF neurons and large signal synapses using STT-MTJs. Japanese Journal of Applied Physics, 62(4), 044501.

[2] Jooq, M. K. Q., Azghadi, M. R., Behbahani, F., Al-Shidaifat, A., & Song, H. (2023). High-Performance and Energy-Efficient Leaky Integrate-and-Fire Neuron and Spike Timing-Dependent Plasticity Circuits in 7nm FinFET Technology.

[3] Das, D., & Fong, X. (2022). Self-reset schemes for Magnetic domain wall-based neuron (Version 3).

Abstract ID: 201

SKYRMION–ANTISKYRMION LATTICE IN ANISOTROPIC FRUSTRATED CHIRAL MAGNETS

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Abstract: We report the discovery of a thermodynamically stable skyrmion-antiskyrmion lattice (S-AL) in two-dimensional chiral magnets, a paradoxical phenomenon where skyrmions (Q = -1) and antiskyrmions (Q = 1) form a regular long-range ordered lattice despite their inherent propensity for mutual annihilation, akin to particle-antiparticle interactions. This net-zero global topological charge state, resulting from balanced populations of oppositely charged solitons, is demonstrated as a magnetic field-induced topological ground state in frustrated chiral magnets with competing anisotropic interactions—specifically Dzyaloshinskii-Moriya and frustrated exchange interactions, where reduced symmetry (C_{1v}) plays a critical role.

We develop a micromagnetic model that describes the emergence of S-AL as a thermodynamically stable ground state[1]. Using density functional theory and atomistic spin-lattice simulations, we identify three interfacial magnetic films—2Fe/InSb(110), 2Fe/GaAs(110), and 2Fe/CdTe(110)—as ideal candidates[1,2]. In these C_{1v} symmetric heterostructures, exchange frustration and symmetry-enforced anisotropic interactions stabilize the net-zero lattice against annihilation. We reveal a magnetic field-driven ground state phase sequence: cycloidal spin-spiral → S-AL → conical spin-spiral → ferromagnet.

This finding establishes anisotropic frustrated chiral magnets as a material class enabling stable net-zero topological soliton lattices within a single magnetic layer, resolving the paradox of coexisting oppositely charged entities.

Keywords: Topological magnetism, Anisotropic, frustrated chiral magnet, skyrmion-antiskyrmion lattice.

References:

[1] Sayan Banik, Nikolai S. Kiselev, and Ashis K. Nandy; "Paradoxical Topological Soliton Lattice in Anisotropic Frustrated Chiral Magnets.", Advanced Science, (2025) e14568.

[2] Sayan Banik, and Ashis K. Nandy; "Skyrmion-antiskyrmion lattice: A net-zero topological phase in low-symmetry frustrated chiral magnets.", Phys Rev B (Letter) 112 L140404 (2025)

Abstract ID: 202

INTERPLAY OF DISORDER, LOCALIZATION, AND SUPERCONDUCTIVITY IN Cu_xTiSeS

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Abstract: The interplay between competing long range ordered phases e.g. superconductivity and charge density wave (CDW) has always been a central issue in condensed matter physics. The study presents a series of polycrystalline TiSeS samples with varying concentrations of Copper (Cu). The results provide first ever experimental evidence for filamentary superconductivity in polycrystalline TiSeS (without Cu doping), where disorder plays a central role in the emergence of superconductivity. The disorder, originating from sulfur substitution and intercalated Ti local moments, disrupts the charge density wave (CDW) phase, leading to charge localization and the emergence of superconductivity. The second question that is addressed is how metal intercalation modifies these metastable phases. With Cu doping, T_c remained nearly constant but the superconducting volume fraction and metallicity increased, alongside suppression of Ti local moments. Non-Fermi liquid behavior is observed for specific doping levels (x = 0.06 and 0.09). However, recent theoretical models have linked the filamentary metastable phase in TMDs to protected edge states of topological systems. Hence, the potential realization of a non-trivial topological superconducting state in TiSeS can be further investigated through comprehensive future studies.

Keywords: Weak Localization, Disorder, Topological Materials, Superconductivity.

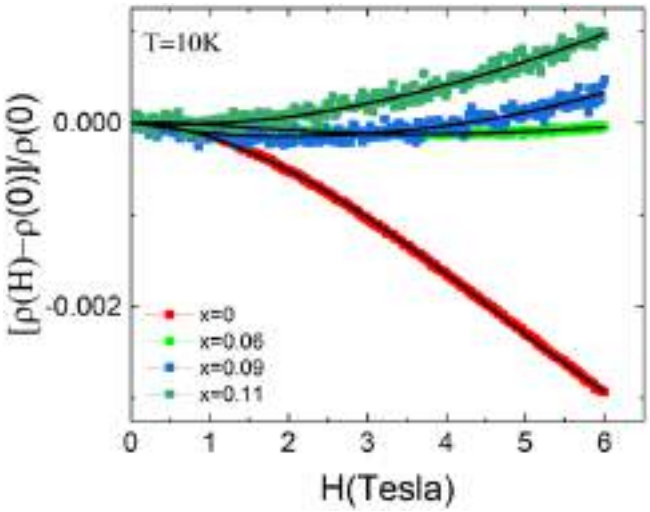


Fig. 1: Shows the MR (Δρ/ρ) data at 10K up to 6 Tesla magnetic field for all four samples (x = 0, 0.06, 0.09, 0.11). The solid black curves are the respective fits.

References:

[1] M. Singh, P. Saha, A. Chahar, H. Singh, B. Birajdar, D.K. Shukla, S. Patnaik. Physical Review Materials 9 (9), 094801 (2025).

Abstract ID: 203

EMERGENCE OF MULTIPLE TOPOLOGICAL FEATURES IN BOTH ELECTRON AND PHONONS IN HALF SEMI-METALLIC Gd_4Bi_3

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Abstract: We present a detailed first-principles study of the structural, electronic, magnetic, dynamical, and topological properties of the half semi-metallic material Gd_4Bi_3. The spin-resolved electronic band structure and density of states reveal symmetry-protected nodal-line and nodal-surface states in specific momentum-space directions, particularly along the N–Γ–P and P–Γ–H high-symmetry paths. In addition, we identify a novel duplet hourglass-like dispersion arising from non-symmorphic symmetry constraints along the N–P–H path. Furthermore, the material hosts intriguing multi-fold fermionic features. The dynamical stability of the system is confirmed by the absence of imaginary phonon modes throughout the Brillouin zone. Analogous to the electronic structure, the phonon dispersion also exhibits nontrivial topological nodal lines and nodal surfaces. These rich topological features in both electronic and phononic spectra suggest that Gd_4Bi_3 is a promising candidate for future topological spintronic applications.

Keywords: Half semi-metallicity, nodal line, nodal surface, duplet hourglass, multi-fold fermions

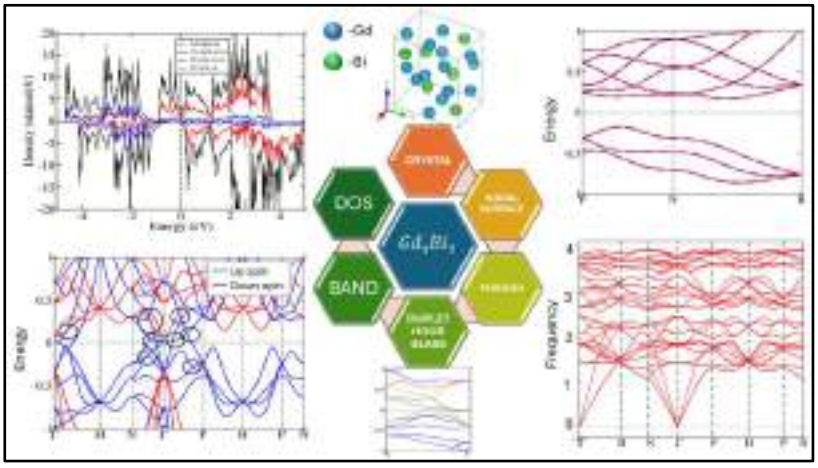


Fig. 1: Graphical abstract.

References:

[1] Liu, X.B. and Altounian, Z., 2009. Exchange Interaction in Gd_4Bi_3 and Gd From First-Principles Calculations. *IEEE Transactions on Magnetics*, *45*(10), pp.3989-3992.

[2] Gambino, R.J., 1967. Rare-earth-Sb and-Bi compounds with the Gd_4Bi_3 (anti-Th_3P_4) structure. *Journal of the Less Common Metals*, *12*(5), pp.344-352.

[3] Methfessel, S. and Kneller, E., 1963. Gd_4Bi_3—A New Ferromagnetic Compound. *Applied Physics Letters*, *2*(6), pp.115-116.

Abstract ID: 204

IMPACT OF THICKNESS ON THE MAGNETIC AND MICROWAVE PROPERTIES OF SPUTTERED YIG THIN FILMS GROWN ON Si SUBSTRATES

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Abstract: We report a comprehensive study of yttrium iron garnet ($Y_3Fe_5O_{12}$, i.e., YIG) thin films deposited on Si (100) substrates via RF sputtering. We have investigated the impact of film thickness on the microwave and magnetic characteristics. The as-deposited amorphous films were transformed into a crystalline phase by post-deposition annealing at 900°C in ambient air, with a heating rate of 3°C/min. Magnetization reversal and dynamic properties were studied using a vibrating sample magnetometer and ferromagnetic resonance techniques, respectively. The saturation magnetization was found to be a maximum of 1847 Gauss for a 267 nm film. The coercive field observed for the 354 nm-thick film was 23 Oe, the smallest among the samples. It is observed that an increase in film thickness promotes grain growth[1], which in turn reduces coercivity and enhances saturation magnetization. We observed a minimum value (~191 Oe) of the ferromagnetic resonance linewidth for the 135-nm-thick film at a frequency of 9 GHz. Our findings suggest that RF sputtering is an effective method for growing high-quality YIG films on Si substrates, offering a scalable and cost-effective approach for integrating microwave and spintronic components into silicon-based electronic platforms.

Keywords: Yttrium iron garnet (YIG); Magnetic thin films; Microwave; Ferromagnetic resonance; RF sputtering

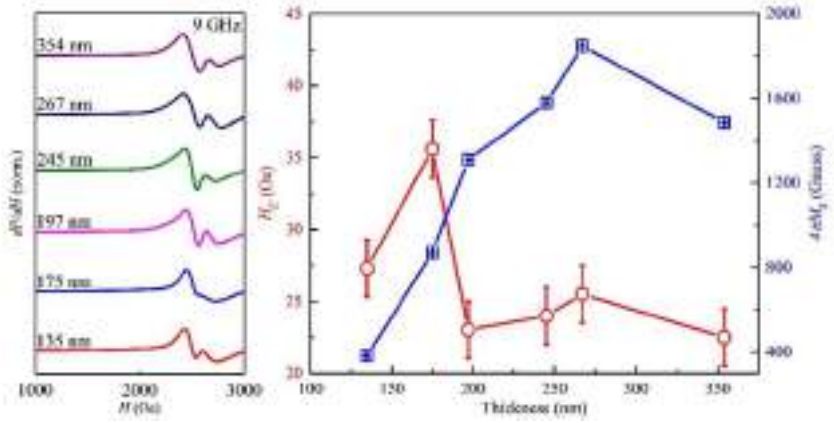


Fig. 1: (a) Derivative FMR signal as a function of YIG thickness for an excitation frequency at 9 GHz. (b) Thickness dependence of H_c and $4\pi M_S$ for all films

References:
[1] G. Herzer, IEEE Trans. Magn. 26 (1990) 1397-1402.

Abstract ID: 205

Fe/Ga B-SITE SUBSTITUTION IN $NdCrO_3$ WITH A FOCUS ON MAGNETIC REVERSAL

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Abstract: In this work, we present a comparative study of the magnetic behaviour of $NdCrO_3$ and its B-site-substituted compositions $NdCr_{0.7}M_{0.3}O_3$ (M = Fe, Ga), with a focus on the magnetic reversal (*MR*). Rietveld refinement of powder XRD confirms that all compositions crystallize in the orthorhombically distorted perovskite structure with the *Pbnm* space group [1]. Both substitution has only a minimal effect on the Cr-sublattice antiferromagnetic ordering temperature. However, the spin-reorientation transition is suppressed in the doped samples relative to the parent compound. For the Fe substitution, the *MR* exhibits with two compensation temperatures, T_{comp1} ~ 140K and T_{comp2} ~ 66K, for applied fields of $\lesssim$ 1000 Oe. The *MR* window narrows as the applied field increases. At higher fields (> 1000 Oe), the *MR* region vanished, and the magnetization remains positive over the entire measured temperature range. Within the *MR* regime (between the two compensation points), the sign of magnetization can be reversibly toggled by tuning the magnetic field at fixed temperature, demonstrating field-controlled bipolar switching. A complementary temperature-controlled switching is also observed, where the magnetization polarity can be reversed by varying the temperature under a fixed field. In addition, all substituted samples exhibit exchange-bias behavior. Overall, the study shows how magnetic and non-magnetic B-site substitution tunes superexchange [Nd^{3+}-O^{2-}-$(Fe/Ga)^{3+}$] interaction, providing a broader picture of magnetization reversal and magnetic anomalies in rare-earth orthochromites.

Keywords: Perovskites, Negative Magnetization, Bipolar Switching, Exchange Bias.

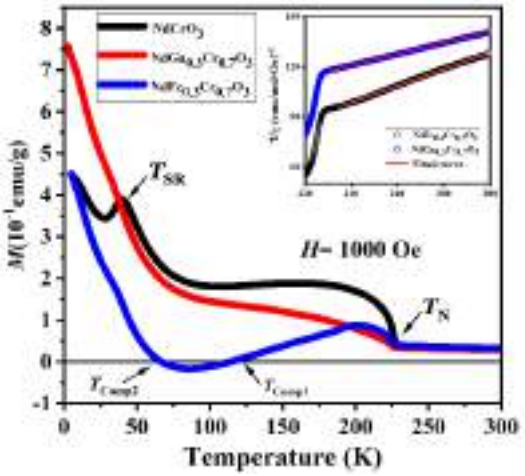


Figure 1: Temperature dependence of magnetization FC curves for $NdCr_{0.7}M_{0.3}O_3$ (M = Fe, Ga), under an applied field of 1000 Oe. Neel temperature (T_N), compensation points (T_{comp}), and spin-reorientation transition (T_{SR}) are marked. The inset shows the inverse susceptibility for the substituted samples, fitted to the Cuire-Wiess law.

References:

[1] Bora T and Ravi S 2014 Bipolar switching of magnetization and tunable exchange bias in $NdCr_{1-x}MnxO_3$ (x = 0.0–0.30) *J. Appl. Phys.* **116**

Abstract ID: 206

INTERFACIAL CONTROL OF REFLECTED SPIN CURRENTS IN SPINTRONIC TERAHERTZ EMITTERS

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Abstract: Ultrafast spin-charge conversion in magnetic heterostructures offers a strong platform for broadband terahertz (THz) generation. In ferromagnet/heavy metal bilayers, femtosecond laser excitation creates a nonequilibrium spin current (I_s) in the ferromagnetic layer (FM). This spin current moves into the nearby non magnetic layer (NM) and converts into a transverse charge current through the inverse spin Hall effect (ISHE), leading to THz emission. The efficiency of this process relies heavily on spin diffusion, interfacial spin transparency, and reflected spin currents from the heavy metal layer. In this work, we investigate how interfacial engineering affects spin transport and THz generation in multilayer spintronic emitters. We introduce an additional metallic layer at the heavy metal interface to control or convert reflected spin currents through interfacial spin charge conversion mechanisms such as inverse Rashba–Edelstein effect (IREE). We use thickness dependent measurements with terahertz emission spectroscopy to analyse how modifications to the interface change spin dynamics and emission efficiency. Our results establish the relationship between spin diffusion, spin memory loss, and interfacial conversion processes. It also seeks to provide guidance for designing improved spintronic THz source.

Keywords: Spin transport, Spin-charge conversion, Spin reflection, Interfacial effects

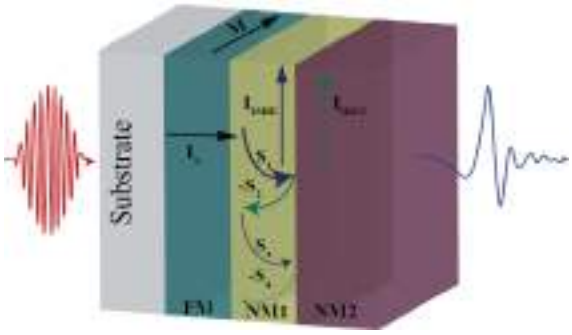


Fig. 1: In this schematic, spin current generated in the ferromagnet undergoes multiple reflections in the non-magnetic layer and converts into charge current via the IREE and ISHE.

References:

[1] Agarwal, P., Yang, Y., Medwal, R., Asada, H., Fukuma, Y., Battiato, M., & Singh, R. (2023 *Advanced Optical Materials*, *11*(23), 2301027.
[2] Seifert, T., Jaiswal, S., Martens, U., Hannegan, J., Braun, L., Maldonado, P., ... & Kampfrath, T. (2016). *Nature photonics*, *10*(7), 483-488.

Abstract ID: 207

PARTICLE SIZE DEPENDENT GRIFFITHS PHASE AND CRITICAL BEHAVIOR IN $La_{0.7}Sr_{0.3}MnO_3$ SYSTEM

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Abstract: $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) manganites in polycrystalline form with particle sizes ranging from 17 to 255 nm were synthesized via a citrate-based sol-gel method by sintering at different temperatures. X-ray diffraction analysis confirms the phase formation of LSMO, having a rhombohedral structure with the $R\bar{3}c$ space group. Magnetisation studies reveal a ferromagnetic (FM) to paramagnetic (PM) phase transition with Curie temperature (T_C) above room temperature (RT). Griffiths phase (GP) is observed in the surroundings of T_C, and is gradually suppressed with increasing particle size and applied magnetic field. This behaviour is attributed to quenched disorder and magnetic phase inhomogeneities [1]. Landau analysis confirms the second-order phase transition for all the LSMO samples. Critical exponent analysis indicates that the mean field model adequately describes the FM regime for samples with particle sizes between 17 to 120 nm, whereas the 3D Heisenberg model provides a better fit for higher particle sizes. The critical behaviour around T_C and the associated universality class are systematically examined using Arrott plots, Kouvel-Fisher analysis, critical isotherms and magnetic entropy scaling [2]. This investigation suggests that the LSMO manganite system can be used as a potential magnetic refrigeration material at RT.

Keywords: $La_{0.7}Sr_{0.3}MnO_3$, Griffiths phase, Critical behaviour, Magnetic phase transition.

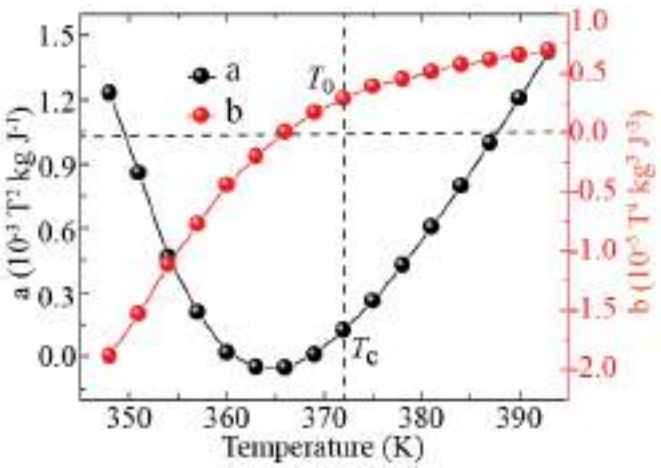


Fig. 1: Temperature-dependent Landau coefficients for LSMO with particle size 255 nm.

References:

[1] A. K. Pramanik, A. Banerjee, Phys. Rev. B 81 (2010) 024431.
[2] A. Gaur, A. Tiwari, G. Singh, R. N. Mahanto, Phys. Rev. B 108 (2023) 024408.

Abstract ID: 208

EFFECT OF LANTHANUM SUBSTITUTION ON THE STRUCTURAL AND MAGNETIC PROPERTIES OF $Y_{3-x}La_xFe_5O_{12}$ ($0 \le x \le 0.5$) FOR ROOM-TEMPERATURE APPLICATIONS

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Abstract: To investigate the influence of lanthanum substitution on the structural, magnetic, and magnetodynamic properties of yttrium iron garnet ($Y_{3-x}La_xFe_5O_{12}$, $0 \le x \le 0.5$, YIG) for room-temperature applications, the samples were synthesized via the sol–gel method. X-ray diffraction confirms the formation of a single-phase garnet structure. A systematic shift of the (420) reflection toward lower diffraction angles indicates lattice expansion due to the substitution of larger La^{3+} ions at the Y^{3+}-site [1]. Rietveld refinement reveals that all compositions crystallize in a cubic garnet structure with space group $Ia\bar{3}d$. Magnetic measurements carried out using a vibrating sample magnetometer show a gradual decrease in saturation magnetization with increasing La concentration. This reduction is attributed to the modification of Fe-O-Fe superexchange interactions and induced spin canting arising from lattice distortion. The coercivity exhibits a non-monotonic trend, correlating with variations in crystallite size, suggesting a domain wall pinning mechanism as the dominant magnetic reversal process [2]. Raman spectroscopy further confirms structural stability through the presence of characteristic E_g, T_{2g}, A_{1g} vibrational modes [3]. Subtle peak shifts with increasing La content indicate local lattice distortion without phase instability. The combined structural, vibrational, and magnetic analyses establish a clear correlation between lattice modification and magnetic response. The results demonstrate that controlled La substitution effectively tunes the magnetic properties of YIG, highlighting its potential for advanced microwave and spintronic applications at room temperature.

Keywords: YIG, Ferrimagnetism, Superexchange, Domain wall pinning.

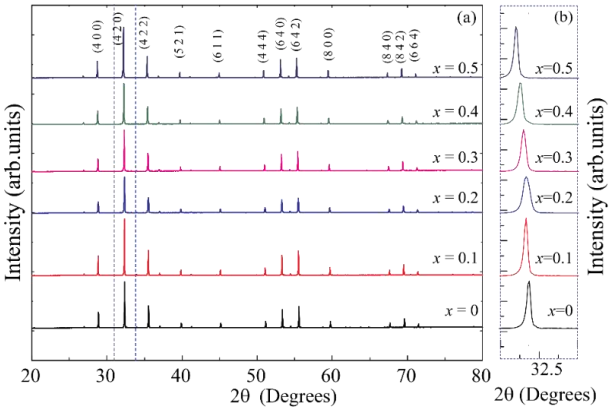


Fig. 1: (a) Room-temperature X-ray diffraction patterns of $Y_{3-x}La_xFe_5O_{12}$ (x = 0-0.5). (b) Enlarged view of the (420) diffraction peak.

References:

[1] H. Wu, F. Huang, T. Xu, R. Ti, X. Lu, et al., J. Appl. Phys. 117 (2015) 144101(1)- 144101(5).

[2] S. H. Dewi, A. Mulyawan, Y. Sarwanto, et al., J. Rare Earths. 41(2023) 578-587.

[3] E. J. J. Mallmann, A.S.B. Sombra, et al., Solid State Phenomena 202 (2013) 65-96.

Abstract ID: 209

CONTROLLING MAGNETIC DISSIPATION AND SPIN-CURRENT GENERATION USING CRYSTAL SYMMETRY

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Abstract: Controlling magnetic dissipation and spin-current generation is essential for realizing robust, low-power magnonic and spintronic devices. Although yttrium iron garnet (YIG) exhibits ultra-low intrinsic damping, extrinsic magnon scattering and nonlinear instabilities often limit device stability and power handling. Here, we demonstrate that crystalline symmetry provides an intrinsic and scalable route to engineer both linear and nonlinear spin dynamics in epitaxial YIG/Pt bilayers. Using in-plane angle-resolved ferromagnetic resonance (FMR) and electrically detected spin pumping via the inverse spin Hall effect (ISHE), we observe a pronounced fourfold anisotropy in resonance field, linewidth, and spin-current amplitude in YIG (001)/Pt, directly reflecting its cubic magnetocrystalline symmetry. In contrast, YIG (111)/Pt exhibits an almost isotropic response due to its higher in-plane rotational symmetry. By separating intrinsic Gilbert damping from extrinsic contributions, we show that the angular linewidth modulation does not originate from anisotropic intrinsic damping or interfacial spin-mixing conductance, but from symmetry-controlled two-magnon scattering. Spin-wave dispersion calculations and micromagnetic simulations reveal that cubic anisotropy reshapes the degenerate magnon phase space, modulating the density of states available for defect-mediated scattering between the uniform mode and finite-wave-vector magnons. This anisotropic redistribution governs both extrinsic relaxation in the linear regime and the onset of nonlinear spin dynamics under strong microwave excitation, leading to orientation-dependent instability thresholds. These results establish crystallographic facet engineering as a symmetry-based strategy to tailor dissipation, spin-current generation, and nonlinear stability in magnetic insulators, providing a unified framework for directionally reconfigurable magnonic and spintronic architectures.

Keywords: Magnon phase space, cubic magneto crystalline anisotropy, two-magnon scattering, nonlinear spin dynamics, spin pumping, YIG thin films

Abstract ID: 210

EFFECT OF EX-SITU ANNEALING ON THE MAGNETIZATION OF Co-Zn FERRITE THIN FILMS

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Abstract: Nanocrystalline spinel ferrites differ significantly from their bulk counterparts due to the change in their cation distribution [1]. Our study investigates the effect of ex-situ annealing (at T_A = 750 °C) on pulsed laser deposited (PLD) $Co_{1-x}Zn_xFe_2O_4$ (Co-Zn ferrite, x = 0.1-0.7). Films were deposited at a base pressure of 5.4×10^{-6} mbar, oxygen pressure of 0.16 mbar and substrate temperature (T_S) of 750°C. *M-H* loops were recorded at 10 and 300 K. Fig. 1(a) shows a gradual increase of $4\pi M_S$ of as-deposited films from 6 to 8.1 kG. Upon ex-situ annealing, enhanced magnetization is noticed, in particular for x = 0.3 (from 6 to 9.2 kG, about 53% enhancement). Similarly, x = 0.5 exhibits a 34% increase, while x = 0.7 shows a slight reduction of about 7%. A similar trend is observed at 300 K. The maximum $4\pi M_S$ of 6.8 kG is obtained for x = 0.3 film after ex-situ annealing at 750 °C, which is higher than that of any known bulk ferrite at room temperature [2]. The increase in $4\pi M_S$ with ex-situ annealing is normally attributed to the increase of grain size [3]. However, a value larger than bulk implies that cation distribution in the films is significantly different from bulk [4]. The full manuscript discusses variation of $4\pi M_S$ values of ex-situ annealed Co-Zn ferrite thin films and the underlying magnetic phenomena.

Keywords: Ferrite, Thin films, PLD, Magnetization, Annealing.

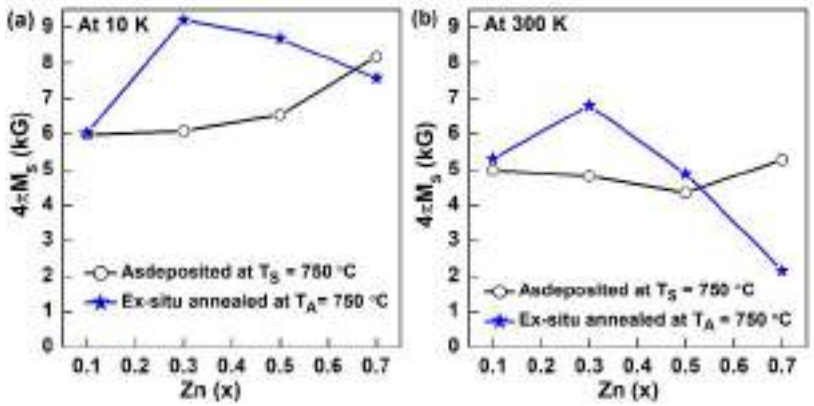


Fig. 1: $4\pi M_S$ values of Co-Zn ferrite at (a) 10 K and (b) 300 K.

References:
[1] Prabhu R. *et. al* IEEE Trans. Magn. 54 (2018) 2002305.
[2] B.D. Cullity, C.D. Graham, Introduction to Magnetic Materials, second ed., Wiley, New Jersey, 2009.
[3] Anumol C. N *et.al* J. Magn. Magn. Mater. 564 (2022) 170100.
[4] Nakashima S *et.al* J. Phys. Condens. Matter. 17 (2005) 137.

Abstract ID: 211

ENHANCEMENT OF CURIE TRANSITION BY SUBSTITUTING SB IN $MnCo_{1-x}Sb_xGe$ (x=0, 0.2, 0.4, 0.6) ALLOYS AND ITS STRUCTURAL, MORPHOGICAL, MAGNETIC, MAGNETOCALRIC INVESTIGATIONS

U. Devarajan[1,3,4*], S. Mohan[2], C. Venkateswaran[1]

[1]*Department of Physics,Indian Institute of Science Education and Research, Pune, India*
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Abstract: We investigate on structure, surface morphology, magnetic and magnetocaloric properties of $MnCo_{1-x}Sb_xGe$ (x=0, 0.2, 0.4, 0.6) alloys. The MnCoGe exhibits doublet-orthorhombic at ambient conditions, after substituting Sb in MnCoGe which are completely crystalized and form mixed structure. The surface morphology of alloys are analyzed by viewing images which exhibits spherical and dumb-bell shape particles. The spherical shaped particles are enhanced with Sb doped samples. The magnetic properties are changed from martensitic-T_M (x=0) to Curie's transformations-T_C (x=0.2, 0.4, 0.6) of alloys. The T_c are enhanced with Sb in the order of 489.6, 519.1, 536.4 K to x=0.2, 0.4, 0.6. The ΔS_M are calculated around T_M from the isothermal [M (H)] curves. However, gradual decreasing trend of MCE are observed in x=0.4, 0.6 alloys. These observations will be highly benefit applications for magneto response materials which is used for magnetic refrigeration technology near room temperature.

Keywords: MnCoGe, Orthorhombic, Magnetic Refrigeration, Curie Transition.

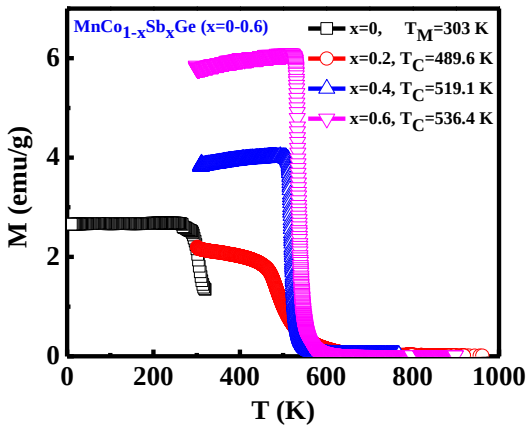


Fig. 1: Temperature dependent magnetization of $MnCo_{1-x}Ni_xGe$ (x=0, 0.2, 0.4, 0.6) alloys at constant field of 0.05 T.

References:

[1] U. Devarajan and Sunil Nair, Mater. Res. Express. 6 (2019) 106117.

Abstract ID: 212

EVOLUTION OF SPONTANEOUS POLARIZATION IN $CoFe_{2-x}Y_xO_4$ VIA STRUCTURAL DISTORTION

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Abstract: $CoFe_2O_4$ is a well-renowned material that exhibits a cubic spinel structure with unique magnetic and electric properties at room temperature. The unique arrangement of metal within the tetrahedral and octahedral cages, surrounded by oxygen ions, is the primary reason for these exceptional magnetic and electrical properties [1,2]. A slight variation in this structure significantly alters the magnetic and electric properties. Numerous studies have investigated $CoFe_2O_4$ to induce spontaneous polarization via structural distortion by foreign-element substitution [2,3]. The present work primarily investigated the magnetic, electric, and magnetoelectric properties of the $CoFe_{2-x}Y_xO_4$ system at room temperature. $CoFe_{2-x}Y_xO_4$ is successfully synthesized using the glycine-assisted sol-gel method. XRD patterns revealed that $CoFe_{2-x}Y_xO_4$ exhibits a mixed cubic spinel structure with an *Fd-3m* space group. An increase in dielectric permittivity with low tangent loss is found at x = 0.02 yttrium-substituted $CoFe_2O_4$, making it a viable candidate for advanced CMOS technologies. Also, a new paradigm, "Modified Havriliak-Negami function associated with space charge contribution," is used to explain the dielectric dispersion curve of $CoFe_{2-x}Y_xO_4$. Ferroelectric studies found non-saturated polarization loops in the $CoFe_{2-x}Y_xO_4$ system, indicating weak ferroelectricity. Also, it is found that the spontaneous polarization increases with yttrium substitution and reaches its maximum at x= 0.04 yttrium content. Magnetic studies confirmed that $CoFe_{2-x}Y_xO_4$ exhibits ferrimagnetic properties at room temperature, and the magnetization decreases with an increase in non-magnetic Y^{3+} content. Magnetoelectric studies also found that x = 0.06 yttrium-substituted $CoFe_2O_4$ exhibits the largest magnetoelectric coupling coefficient, around 52 $mVcm^{-1}Oe^{-1}$. The plausible mechanisms for the dielectric, magnetic, ferroelectric, and magnetoelectric properties of $CoFe_{2-x}Y_xO_4$ will be discussed in detail.

Keywords: Dielectric, Ferrites, Ferroelectricity, Ferrimagnetism

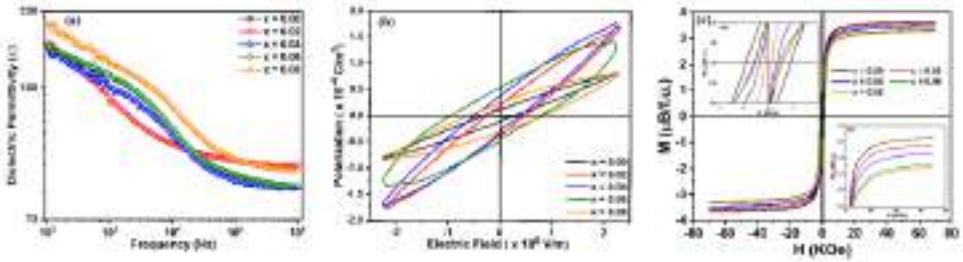


Fig. 1: (a) dielectric, (b) ferroelectric, and (c) magnetic properties of $CoFe_{2-x}Y_xO_4$ (x = 0.00, 0.02, 0.04, 0.06, 0.08) system at room temperature.

References:

[1] S. Hunpratub, S. Phokha, P. Kidkhunthod, N. Chanlek, P. Chindaprasirt, Results in Physics 24 (2021) 104112.

[2] P. Anjana, R.S. Arun Raj, R. Jose, M. Kumari, P.M. Sarun, D. Sajan, Lija K. Joy, Journal of Alloys and Compounds 854 (2021) 155758

[3] R. S. Yadav, J. Havlica, J. Masilko, L. Kalina, J. Wasserbauer, M. Hajdúchová, V. Enev, I. Kuřitka, Z. Kožáková, Journal of Magnetism and Magnetic Materials 399 (2016) 109-117

Abstract ID: 213

INVESTIGATION OF THE DIELECTRIC PROPERTIES OF HYBRID NATURAL FIBER AND CONDUCTIVE FILLER REINFORCED POLYMER COMPOSITES

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Abstract: With the growing need for sustainable and efficient materials in modern electronics, bio-based composites are gaining increasing attention. This study explores the dielectric behaviour of epoxy-based composites reinforced with natural fibres (banana and kenaf) and enhanced with copper powder as a conductive filler. The aim is to understand how fibre length, fibre content, and copper concentration influence the electrical performance of the material. Composites were fabricated using a simple, cost-effective hand lay-up method with fibre lengths of 6 mm, 8 mm, and 12 mm and fibre loadings of 10% and 15%. Copper was added at 2.5% and 5% by weight, along with control samples prepared without copper. Dielectric properties, including dielectric constant, dielectric loss, and dissipation factor, were measured over a range of frequencies using an impedance analyser, in accordance with ASTM standards. The results indicate that both fibre parameters and copper content significantly affect dielectric performance. The addition of copper improved polarisation in the composite, enhancing the dielectric response at specific frequencies. Optimised compositions demonstrated stable dielectric behaviour with manageable energy losses. These findings highlight the potential of hybrid natural fibre composites as sustainable, lightweight, and cost-effective dielectric materials for applications in capacitors, insulation systems, and compact electronic devices.

Keywords: Dielectric property, filler, conductivity, composite, polymer.

Abstract ID: 214

SURFACE-ENHANCED ANOMALOUS HALL CONDUCTIVITY IN FERRIMAGNETIC Mn_2PtSn HEUSLER ALLOY

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Abstract: The transport properties of spintronic materials are strongly influenced by the Hall effect, which originates from spin–orbit coupling and the underlying electronic structure. This effect becomes particularly significant in surface-related studies, as spintronic materials are often employed in thin-film form. Heusler alloys, known for their exceptional magnetic and transport characteristics, are promising candidates for such applications. Despite their potential, no prior reports exist on the Berry curvature-induced Hall effect in the Mn_2PtSn Heusler alloy and its surfaces. In this study, we use a combined approach of density functional theory and maximally localized Wannier functions to investigate the Berry curvature contributions to the Hall effect. Our analysis reveals prominent Berry curvature peaks along high-symmetry k-points, which play a crucial role in determining the anomalous Hall conductivity of this system. The anomalous Hall conductivity is also evaluated as a function of the Fermi level, and the presence of sharp peaks near the Fermi level indicates the potential for further enhancement through Fermi-level tuning. The high value of anomalous Hall conductivity at the surfaces highlights their potential for application in thin-film memory devices, where surface-driven properties are crucial.

Keywords: Anomalous Hall effect, Berry curvature, wannier function, ab-initio calculations, Heusler alloy

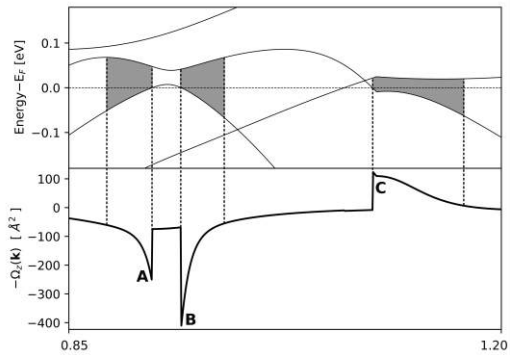


Fig. 1: Electronic band structures within a narrow energy window around the Fermi level (top panels) and the corresponding Berry curvature, Ω_Z (bottom panels).

References:

[1] Kakati, Bhargab, et al. "Berry curvature induced anomalous Hall effect in Pt2MnGa." Journal of Applied Physics 136.8 (2024).

[2] Alom, Sadikul, et al. "Exploring the stability and relaxation effects of (001) terminating surfaces in Mn2PtSn." Vacuum 233 (2025): 113998.

Abstract ID: 215

EMERGENCE OF MULTIFERROIC PROPERTIES IN A STUFFED TRIDYMITE FRAMEWORK

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Abstract: Multiferroics are the materials that coexist with multiple ferroic orders, such as ferromagnetism, ferroelectricity, ferroelasticity, and ferrotoroidicity [1,2]. The discovery of multiferroic materials has enabled the development of next-generation logic and memory devices [3]. To attain this goal, a suitable multiferroic material is needed that exhibits strong magnetic and electric ordering at room temperature and large magnetoelectric coupling. Combining these conditions into a single-phase material is quite difficult; most candidates have a transition temperature below room temperature or a lower coupling efficiency. $BaFe_2O_4$ is an interesting material that exhibits antiferromagnetism (T_N = 890 K) and ferroelectricity (T_{FE} > 1038 K) at room temperature, mainly due to its unique non-centrosymmetric stuffed tridymite structure [3]. The present work primarily focused on the magnetic and ferroelectric properties of $BaFe_2O_4$ with Gd substitution in Fe sites. $BaFe_{2-x}Gd_xO_4$ are successfully synthesized by an ethylene glycol-assisted sol-gel method. XRD patterns reveal that $BaFe_{2-x}Gd_xO_4$ exhibits an orthorhombic structure with the non-centrosymmetric *Bb2₁m* space group, and the substitution of larger ions induces structural distortion in the tetrahedral sites. MH and PE measurements reveal that $BaFe_{2-x}Gd_xO_4$ exhibits antiferromagnetic behavior with G-type magnetic ordering of Fe ions and weak improper ferroelectricity, respectively. It is found that the spontaneous polarization increases with Gd substitution without sacrificing magnetization. The coexistence of G-type antiferromagnetism and ferroelectricity at room temperature suggests that $BaFe_2O_4$ is a promising candidate for multiferroic applications, and Gd substitution is a viable approach to enhance the multiferroic properties. The plausible mechanisms underlying the magnetic and ferroelectric properties of $BaFe_2O_4$, and the effect of Gd substitution on these properties, will be discussed in detail.

Keywords: Multiferroics, Ferrites, Ferroelectricity, $BaFe_2O_4$.

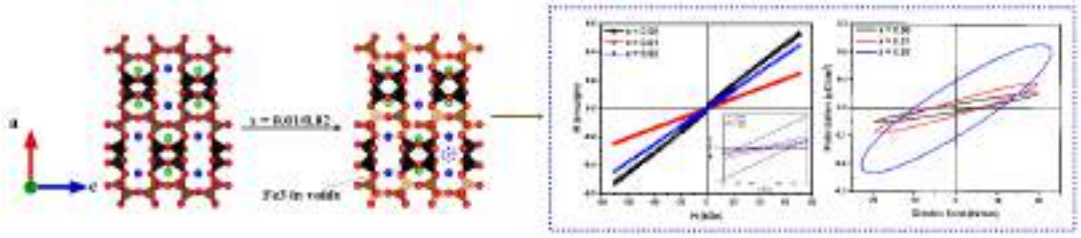


Fig. 1: Structural, magnetic, and ferroelectric properties of the $BaFe_{2-x}Gd_xO_4$ system at room temperature.

References:

[1] W. Eerenstein, N. D. Mathur, J. F. Scott, Nature 442 (2006) 759-765.
[2] M. Fiebig, T. Lottermoser, D. Meier, M. Trassin, Nature Review Materials 1 (2016) 16046.
[3] F. Orlandi, et.al. Nature Communications 13 (2022) 7968.

Abstract ID: 216

OPTICAL AND STRUCTUAL PROPERTIES OF MoS_2/Fe_3O_4 NANOCOMPOSITE

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Abstract: Transition metal dichalcogenides (TMDCs) are important two-dimensional materials due to their layered structure and remarkable electronic and optical properties [1]. Among them, MoS_2 has attracted significant attention because of its high stability, suitable band gap, and strong light matter interaction [2]. In this study, MoS_2/Fe_3O_4 nanocomposites were synthesized using a simple hydrothermal method to combine the semiconducting properties of MoS_2 with the magnetic characteristics of Fe_3O_4 nanoparticles.The structural properties of the synthesized samples were investigated using X-ray diffraction (XRD) to analyze phase formation and crystallinity. Surface morphology and microstructural features were examined by scanning electron microscopy (SEM) and transmission electron microscopy (TEM) to evaluate the distribution of Fe_3O_4 nanoparticles on MoS_2 nanosheets [3]. Raman spectroscopy was employed to investigate the vibrational and structural characteristics of the prepared nanocomposites. The characteristic vibrational peaks of MoS_2 were clearly identified, and the influence of Fe_3O_4 incorporation on these features was systematically examined [4]. After the addition of Fe_3O_4, slight peak shifts along with noticeable broadening were observed, indicating interfacial interaction and strain effects within the nanocomposites structure. Furthermore, the presence of distinct Raman-active peaks corresponding to Fe_3O_4 provides strong evidence for its successful formation and effective incorporation into the MoS_2/Fe_3O_4 nanocomposites system [5].

The excellent structural stability and modified optical response indicate enhanced functional performance. These findings suggest that the prepared MoS_2/Fe_3O_4 nanocomposites are promising materials for applications in photocatalysis, sensing, and energy-related device

Keywords: TMDCs, Nanocomposites, Raman spectroscopy, Structural properties, Magnetic Nanoparticles.

References:

[1] M. Zakotnik, A.J. Williams, G. Martinek, I.R. Harris, J. Alloys Compd. 450 (2008) 23-30.
[2] X. Wang, Y. Li, Z. Wang, H. Zhang, J. Phys. Chem. C 114 (2010) 6140–6144.
[3] Sun, H. Zeng, D.B. Robinson, S. Raoux, P.M. Rice, et al., J. Am. Chem. Soc. 126 (2004) 273–279.
[4] K.F. Mak, C. Lee, J. Hone, J. Shan, T.F. Heinz, Phys. Rev. Lett. 105 (2010) 136805.
[5] D. Voiry, M. Salehi, R. Silva, T. Fujita, M. Chen, T. Asefa, et al., Nano Lett. 13 (2013) 6222–6227.
[6] Y. Yu, C. Li, Y. Liu, L. Su, Y. Zhang, L. Cao, Sci. Rep. 3 (2013) 1866.
[7] J. Liu, Z. Zhang, T. Wang, Z. Liu, G. Wang, J. Alloys Compd. 509 (2011) 2033–2037.

Abstract ID: 217

HARNESSING ORBITAL ANGULAR MOMENTUM OF ELECTRONS FOR SPINTRONIC DEVICES

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Abstract: As conventional electronics approaches the limits described by Moore's law, new strategies are required. Spintronics, which uses electron's spin rather than its charge, it has been viewed as a possible substitute due to its low-power consumption and non-volatile operation. However, generating and manipulating spin currents typically relies on strong spin–orbit coupling (SOC), which is large in heavy elements. The concept of orbitronics has recently been introduced. Orbitronics uses the orbital angular momentum (OAM) of the electron to transport information rather than spin. Because orbital currents can be produced without the need of heavy metals, lighter and more plentiful materials can be used. In this work, we use first-principles density functional theory (DFT) as implemented in the Vienna ab initio simulation package (VASP) to investigate the electronic properties of transition-metal dichalcogenides TiX2 (X = S, Se, Te). We evaluate the transport properties of the materials such as orbital Hall conductivity (OHC) and spin Hall conductivity (SHC) using Kubo formula, with the tight-binding Hamiltonian constructed using maximally localized Wannier functions. The orbital Berry curvature (OBC) and spin Berry curvature (SBC) is also calculated. Our calculations reveal that OHC exceeds the SHC by a significant margin, which shows that the material has a moderate spin Hall effect and a substantial orbital Hall conductivity and strong orbital Berry curvature. These results imply that substantial Hall effects in light-element materials can be achieved without the use of heavy elements. This demonstrates orbitronics' promise as a substitute strategy for upcoming spintronics applications.

Keywords: Orbitronics, Orbital Hall Conductivity, Spintronics, Density Functional Theory.

References:

[1] Dae Geun Jo, Dongwook Go, Gyung-Min Choi, and Hyun-Woo Lee, npj Spintronics 2024, 2, 19.
[2] Armando Pezo, Diego García Ovalle, and Aurélien Manchon, Physical Review B 2023, 108, 075427.

Abstract ID: 218

KINETIC AND MECHANISTIC INSIGHTS INTO DOXORUBICIN LOADING ON HYPERTHERMIA-ACTIVE PEG–$CoFe_2O_4$ MAGNETIC NANOPLATFORMS

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Abstract: Polyethylene glycol **(**PEG)-functionalized cobalt ferrite ($CoFe_2O_4$) magnetic nanoparticles (size ~13 nm) were synthesized using microwave-assisted protocol as dual-functional platforms for combining chemotherapy and magnetic fluid hyperthermia-based cancer therapy. The nanoparticles exhibited a saturation magnetization of ~66 emu/g (Fig.1a) and a high specific absorption rate (SAR) of ~326 W/g at 1 wt.% concentration (Fig.1b) confirming their suitability for efficient heat generation under alternating magnetic fields. Doxorubicin hydrochloride (DOX·HCl) loading was performed at a physiological pH of ~ 7.4 and room temperature using an initial drug concentration of ~0.3 mg/mL. Time-resolved loading studies (0 to 60 h) revealed a progressive adsorption process, reaching a maximum loading efficiency of ~71% at 60 h. The loading kinetics exhibited a biphasic behavior with an initial rapid adsorption phase followed by a slower approach to equilibrium (Fig.1c). Kinetic analysis revealed that the intraparticle diffusion model exhibited the highest correlation (R^2 ~ 0.95), indicating that diffusion within the PEG-coated interfacial layer predominantly governed the doxorubicin loading process. The pseudo-second-order model also showed good agreement (R^2 ~ 0.91), suggesting that surface interactions contributed significantly to the adsorption behavior. In contrast, the poor fit to the pseudo-first-order model confirmed that simple concentration-dependent physisorption is not likely the primary mechanism. Overall, the loading process appeared to be controlled by diffusion-assisted adsorption, where electrostatic interactions and hydrogen bonding within the PEG-modified environment facilitated doxorubicin binding. Combined high DOX loading efficiency (~71%) and strong magnetic field-induced heating performance demonstrated the significant potential of these magnetic nanoaprticles (MNPs) for magnetically triggered combined chemotherapeutic-hyperthermia applications, thereby facilitating multi-modal therapy.

Keywords: PEG-coated $CoFe_2O_4$ nanoparticles, drug loading, doxorubicin, hyperthermia

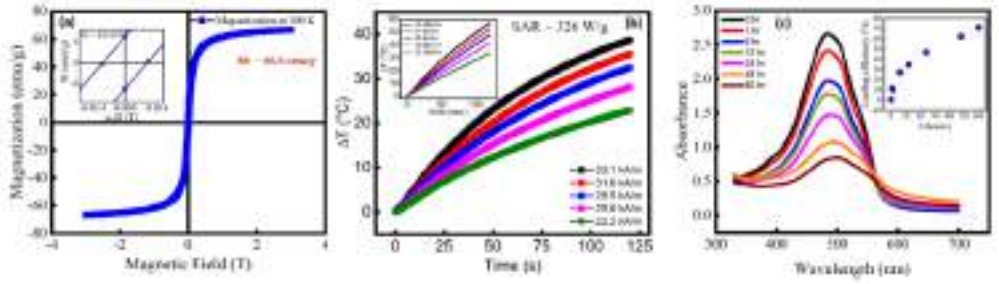


Fig. 1: (a) M-H curve (at 300 K) for PEG-coated $CoFe_2O_4$ nanoparticles. (Inset) magnified view of low-field region (b) Time-temperature curves for 1 wt.% of PEG-coated $CoFe_2O_4$ at varied field amplitudes. (c) Absorbance as a function of wavelength for DOX-loaded PEG-coated MNPs. (Inset) DOX loading efficiency as a function of time.

References:

[1] Altalhi, T.A., Ibrahim, M.M., Mersal, G.A., et al., 2022. *J. Mol. Struct.1263*, 133160.

Abstract ID: 219

EFFECT OF SINTERING TEMPERATURE ON STRUCTURAL MICROSTRUCTURAL AND MAGNETIC PROPERTIES OF $La_{0.8}Sr_{0.2}MnO_3$: EVOLUTION OF FACETING AND TERRACE-LIKE MORPHOLOGY

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Abstract: Polycrystalline $La_{0.8}Sr_{0.2}MnO_3$ (LSMO) manganites with particle sizes ranging from ~110 to ~700 nm were synthesized via a citrate-based sol-gel method, followed by sintering at different temperatures. X-ray diffraction confirms that all samples crystallize in a rhombohedral structure with the $R\bar{3}c$ space group. FESEM reveals pronounced grain growth from ~97 nm to ~4.2 µm with terrace-like features, indicating step-flow growth with enhanced crystallinity. Magnetization studies along with Landau analysis reveal a ferromagnetic (FM) to paramagnetic (PM) phase transition with second order, and Curie temperature (T_C) is found to be well above room temperature. A pronounced Griffiths phase (GP) is observed in the vicinity of T_C which is progressively suppressed with increasing particle size and applied magnetic field. This behavior is attributed to quenched disorder and magnetic phase inhomogeneities in these materials [1]. Critical exponent analysis indicates that the mean-field model adequately describes the FM regime for samples with particle sizes between 110 nm and 340 nm, whereas the 3D Heisenberg model provides a better fit for larger particle sizes. The critical behavior around T_C and the associated universality class are systematically examined using Arrott plots, Kouvel-Fisher analysis, magnetic entropy scaling, and critical isotherms [2]. The coexistence of short-range FM interactions in the PM regime and mean-field-type interactions in the FM state is expected to play a crucial role in the stabilization of skyrmionic bubble phases in centrosymmetric LSMO manganite systems.

Keywords: Terrace-like grain, Griffiths phase, Manganite, Landau analysis

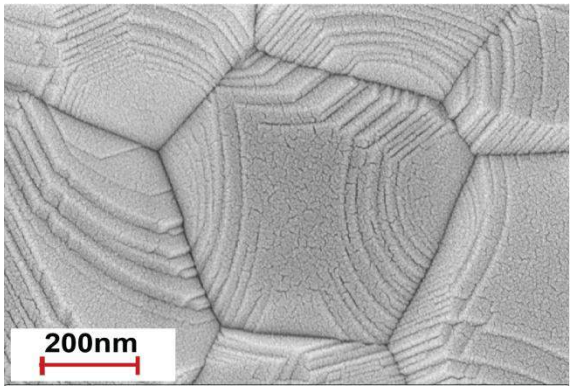


Fig. 1: Terrace-like grain in $La_{0.8}Sr_{0.2}MnO_3$ sample sintered at 1350 °C.

References:

[1] S. Saha, A. Dutta S. Gupta, S. Bandyopadhyay, I. Das Phys. Rev. B 105 (2022) 214407(1) - 214407(16).
[2] A. Gaur, A. Tiwari, G. Singh, R. N. Mahato, Phys. Rev. B 108 (2023) 024408(1) - 024408(14).

Abstract ID: 220

CORRELATION BETWEEN MAGNETIC ORDERING AND CRITICAL BEHAVIOR IN $Nd_{1-x}Sr_xMnO_3$ (x = 0.3 and 0.5) MANGANITE SYSTEM

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Abstract: $Nd_{1-x}Sr_xMnO_3$ (NSMO) manganites exhibit rich magnetic and electrical properties, where x = 0.3 represents optimally doped ferromagnetic metallic behavior and x = 0.5 corresponds to the half-doped antiferromagnetic insulating state with charge ordering. To comprehensively compare the correlation between magnetic ordering and the associated universality class of magnetic behavior near the phase transition temperature, NSMO samples with x = 0.3 (NSMO30) and x = 0.5 (NSMO50) were synthesized using sol-gel technique and sintered at 1300 °C. X-ray diffraction (XRD) analysis confirms the formation of single-phase compounds, with NSMO30 and NSMO50 crystallizing in the *Pnma* and *Imma* space groups respectively. Microstructure and morphological characterizations were carried out. Temperature-dependent magnetization (*M-T*) measurements reveal a ferromagnetic to paramagnetic (FM–PM) transition at T_C = 232 K for NSMO30. In contrast, NSMO50 exhibits multiple magnetic transitions, namely an antiferromagnetic to ferromagnetic transition (T_N = 229 K), an FM–PM transition (T_C = 274 K), and a charge-ordering transition (T_{CO} = 155 K). Landau free-energy analysis of the magnetization (*M-H*) isotherms confirms a first-order phase transition (FOPT) for NSMO30, whereas NSMO50 undergoes a second-order phase transition (SOPT). Both samples display the presence of a Griffiths phase, which is progressively suppressed with increasing applied magnetic field. Critical behavior analysis was carried out to determine the microscopic mechanisms, governing magnetic nature. Overall, the present study highlights that Sr doping plays a crucial role in tuning the magnetic interactions, enabling the system to explore diverse magnetic phenomena and their underlying origins.

Keywords: Magnetic order, Landau analysis, Phase transitions.

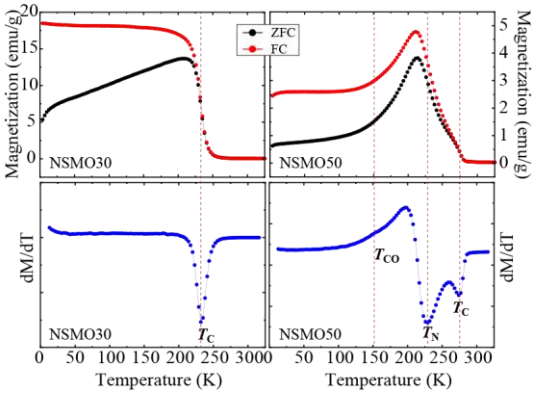


Fig. 1: Temperature-dependent magnetization (M-T) and corresponding dM/dT versus temperature plots of NSMO30 and NSMO50 samples.

References:

[1] H. Wang, F. Dong, H. Wang, B. Zhao, Y. Wang, W. Tan J. Appl. Phys. 136 (2024) 093902-093916.

Abstract ID: 221

SPIN-BASED QUANTUM COMPUTING FOR CANCER MOLECULAR ANALYSIS AND MEDICAL IMAGING

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Abstract: The electron spin system is denoted by ± ½ as the spin quantum number, with the inherent magnetic moment providing a means for precise control over quantum-state manipulation with external magnetic fields. This spin system provides an intrinsic two-level physical realization of the qubit and provides the basis for implementing qubits in the form of superpositions and entanglements to advance quantum computing. Spin-based quantum computing presents a way to accurately analyze the complex molecular Hamiltonians associated with abnormal tissue growth or cancer cells for use in the context of medical applications.

In particular, the spin-based qubit architecture proposed here applied to variational quantum algorithms such as the Variational Quantum Eigensolver allows for estimating the ground state energy of biologically relevant cancer-related molecules beyond very simple systems. The proposed approach will model the electronic structure of a molecular system onto a corresponding set of spin operators represented by Pauli matrices to provide an efficient means of approximating the energy landscapes that govern tumor growth and biochemistry of biological interactions. Furthermore, integration of the principles of spin-based magnetic sensing with Magnetic Resonance Imaging will lead to improved image quality for early detection of malignancies in tissues. The integration of these fields - spin physics, quantum Hamiltonian modeling and diagnostics - creates a pathway using scalable quantum computing technologies to develop precision-based oncology.

Keywords: Spin Qubits, Quantum Oncology, Variational Quantum Algorithms,Quantum Magnetic Sensing, Precision Medicine, Quantum Diagnostics.

References:

[1] J. Li, L. Li, N. Liu *et al.*, "Quantum Oncology: The Applications of Quantum Computing in Cancer Research," *J Med Syst.*, 49(1):99, 2025.

[2] S. Ramesh, T. Tomesh, S. J. Riesenfeld *et al.*, "Quantum Computing for Oncology," *Nat. Cancer*, 5, 811–816, 2024.

Abstract ID: 222

INERTIAL MAGNONS INDUCED TOPOLOGICAL EDGESTATES IN 2D HONEYCOMB FERROMAGNET

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Abstract: Ferromagnetic honeycomb lattices with out-of-plane magnetization are known to host topological magnonic phases, where interactions such as pseudodipolar coupling and Dzyaloshinskii–Moriya interaction (DMI) gap out the conventional precessional magnon spectrum and generate robust, unidirectional edge states [1,2]. Beyond these familiar precessional modes, ferromagnets also support high frequency nutational excitations originating from spin inertia [3]. In this work, we demonstrate that the hybridization between precessional and nutational magnons gives rise to an additional magnonic gap whose topology can become nontrivial even without DMI. We show that in a honeycomb ferromagnet the nearest-neighbor pseudodipolar interaction not only gaps the precessional Dirac cones, but also drives anti-crossings between precessional and inertial branches. As the inertial relaxation time increases, this gap closes and reopens, signaling a topological phase transition.

By computing Berry curvatures and Chern numbers across the full magnon spectrum, we reveal that the nutational–precessional gap hosts chiral, topologically protected edge states analogous to those in conventional magnonic Chern insulators. We further show that these states are coherent, unidirectional, and exhibit negligible dissipation, making them suitable for information transport. Our results identify spin inertia—without the need for Dzyaloshinskii–Moriya interaction—as a powerful mechanism for realizing topological magnonic phases, and they open a path toward nanoscale, THz-frequency magnonic devices exploiting chiral inertial edge modes.

Keywords: Inertial magnons, Topological magnons, Ultrafast terahertz magnonics, Edge mods.

References:

[1] A. Mook et al., Phys. Rev. B 90, 024412 (2014).
[2] X. S. Wang et al., Phys. Rev. Appl. 9, 024029 (2018).
[3] R. Mondal et al., Phys. Rev. B 106, 134422 (2022).

Abstract ID: 223

$CaFe_2O(PO_4)_2$: A COMPOUND WITH S = 5/2 CORNER SHARING TRIANGULAR SAWTOOTH CHAINS

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Abstract: Combining geometrical frustration and one-dimensional magnetism boosts quantum fluctuations and leads to unusual states of quantum matter [1-2]. We report the magnetic behavior of a well-separated S = 5/2 saw-tooth spin chain compound $CaFe_2O(PO_4)_2$ (CFPO). Magnetic susceptibility, heat ca-pacity, and ^{31}P nuclear magnetic resonance (NMR) measurements show evidence of strong magnetic frustration in the compound. Despite a relatively large antiferromagnetic Curie-Weiss temperature of about -1073 K, the compound exhibits multiple magnetic transitions at low temperatures at 15.5 K, 10.4 K, and 7.8 K, respectively, with a frustration parameter ($f \approx |\theta_{CW}|/T_N$) about 70. The Knight shift shows a broad maximum around 70 K for P1 and P2 sites. The spin-lattice relax-ation rate $1/T_1$ follows temperature-independent behavior well above the long-range order (LRO). First-principles calculations capture the strong antiferromagnetic interactions in this quasi-1D saw-tooth lattice, providing a microscopic explanation for the experimentally observed frustration, low-dimensionality, and the onset of LRO at low temperatures. Our results indicate that CFPO exhibits the presence of short-range correlations and persistent spin dynamics characteristics above the LRO,which probably stem from the S = 5/2 sawtooth spin chain model [3].

Keywords: Geometrical Frustration, Quantum Matter, Nuclear Magnetic Resonance

References:

[1] L. Savary, L. Balents, Phys. Rev. B 80 (2016) 016502.
[2] A. Vasiliev, O. Volkova, E. Zvereva, M. Markina, npj Quantum Mater. 3 (2018) 18.
[3] R. C. Moharana, Sk. Soyeb Ali, V. K. Sahu, J. Link, etal., Phys. Rev. B (2026), accepted. https://doi.org/10.1103/1gmv-zkvj

Abstract ID: 224

EVIDENCE OF INERTIAL EFFECTS IN RELAXATION DYNAMICS OF SKYRMION-HOSTING $Co_8Zn_7Mn_5$

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Abstract: Magnetization relaxation dynamics serve as a powerful tool for understanding the intrinsic mechanisms governing the energy dissipation and magnetic response in complex systems. In this work, we investigate the relaxation dynamics for β-Mn-type $Co_8Zn_7Mn_5$ through AC susceptibility across a frequency range of 1 kHz to 10 kHz, spanning different magnetic phases. While the dynamics of most magnetic systems are captured by the Debye-like relaxation with non-zero distribution or the Cole-Cole formalism, our analysis reveal that these conventional models fail to describe frequency dependence of ac susceptibility across different magnetic phases in $Co_8Zn_7Mn_5$. Instead, an inertial component is required to successfully explain the dynamics, suggesting the presence of unconventional relaxation behaviour. The inertial term has been previously invoked to describe the dynamics in spin ice systems due to the propagation of magnetic monopoles. However, it's necessity in our system, points to a wider significance in magnetization dynamics that goes beyond the conventional spin ices and domain walls. By systematically ruling out well-known mechanisms like monopoles, domain walls and skyrmions, we demonstrate that the inertial effect is an intrinsic property of β-Mn-type Co-Zn-Mn compounds that is independent of any particular phase transition. This finding reveals a broader significance of inertial effects in chiral magnets and open new avenues for understanding unconventional relaxation processes in complex magnetic systems.

Keywords: Magnetic Relaxation, AC susceptibility, Skyrmions, Inertial effects

References:

[1] P. Saha, M. Singh, P. D. Babu, and S. Patnaik, Unconventional relaxation dynamics in the chiral magnet $Co_8Zn_7Mn_5$: Evidence of inertial effects, Phys. Rev. B (2026), https://doi.org/10.1103/x2jv-dqhb

Abstract ID: 225

UNVEILING THE ANNEALING INDUCED ENHANCED MAGNETIZATION OF CoFeNiCuTi HIGH ENTROPY ALLOY THROUGH SYNCHROTRON BASED PHOTO-EMISSION SPECTROSCOPY AND X-RAY MAGNETIC CIRCULAR DICHROISM

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Abstract: In the present investigation, we have synthesized CoFeNiCuTi high entropy alloy (HEA) through mechanical alloying technique. The as-synthesized HEA consists of fcc phase along with a slight amount of R-phase. The thermal stability of the as-synthesized HEA was investigated through vacuum annealing the sample at 700°C for 20 hr. We found that the evolved phase remained stable after annealing. On magnetic measurements, the value of Ms was found to be 85 emu/g. After annealing the sample at 700°C for 20 hr, the value of Ms increased to 122 emu/g. It is interesting to find that the value of Ms changed significantly by about 45% on increasing the annealing temperature. The increase in the crystallinity and decrease in the lattice parameter cannot be solely responsible for the 45% increase in the value of Ms. On detailed structural analysis, interestingly, we also observed that the fcc phase found after annealing was different from the fcc phase evolved in the as-synthesized state (confirmed through the ratio of two most intense peaks of the fcc phase (I_{111}/I_{002})). Therefore, in order to understand the underlying physics for the enhanced magnetization, we have investigated the as-synthesized and annealed samples through valence band spectra analysis. The element specific magnetic moment was also evaluated for each alloying element through XMCD technique and correlated with the magnetization of the samples. The increase in the value of Ms after annealing may attribute to the change in the electronic structure. The enhancement in the magnetization after annealing is mainly due to the increased DOS corresponding to Co near the fermi level and increase in the magnetic moment of Co after annealing. The detailed insight of the investigations and results will be discussed during the presentation session.

Keywords: Mechanical Alloying, Annealing, Magnetization, Valence band Spectra.

Abstract ID: 226

IMPACT OF EFFECTIVE STRAIN TRANSFER ON MAGNETIC ANISOTROPY OF $CoFe_2O_4$-$Ba_{0.85}Ca_{0.15}Zr_{0.1}Ti_{0.9}O_3$ MAGNETOELECTRIC NANOCOMPOSITE

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Abstract: Magnetoelectric (ME) nanocomposites were fabricated with alternating layers of $CoFe_2O_4$ (CFO), a ferrimagnetic layer and $Ba_{0.85}Ca_{0.15}Zr_{0.1}Ti_{0.9}O_3$ (BCZT), a soft ferroelectric layer with 2-2 connectivity of different periodicity using pulsed laser deposition. CFO having lattice parameter (8.38Å) twice the lattice parameter of BCZT (~3.99Å) facilitated epitaxy-like columnar grain-to-grain growth aiding in effective strain transfer between the layers of 2-2 nanocomposites. In addition to morphology, the effective strain transfer layer confined to the interface of BCZT and CFO has influence on the magnetic anisotropy with respect to periodicity of the nanocomposites with same volume fraction of CFO. Further, the magnetization versus temperature confirms the spin glass like transition is affect by the effective strain transfer between the layers in ME nanocomposite. Raman and x-ray diffraction pattern confirms the structural phase transition associated to BCZT at morphotropic phase boundary under magnetostriction assisted by epitaxial strain via phonon-phonon coupling.

Keywords: Magnetoelectric, Magnetic anisotropy, Magnetostriction, Phonon coupling

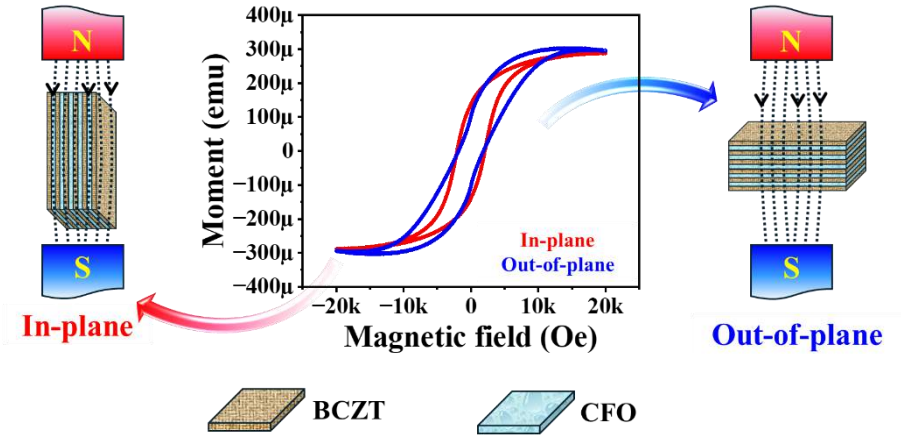


Fig. 1: Schematic illustration of magnetic anisotropy in multilayers of CFO and BCZT under in-plane and out-of-plane magnetic field.

References:

[1] Bhat, A.P., Joshi, M.C., M, H., Ummethala, G., P, S., Kibkalo, L., Tavabi, A.H., Malladi, S.R.K., Dunin-Borkowski, R.E., Manivannan, A. and Ramadurai, R., ACS Applied Nano Materials, 5(12) (2022), pp.17652-17663M. Zakotnik, A.J. Williams, G. Martinek, I.R. Harris, J. Alloys Compd. 450 (2008) 23-30.

Abstract ID: 227

MAGNETIC AND MAGNETO-TRANSPORT PROPERTIES OF AN OFF STOICHIOMETRIC LAYERED $NbNi_{1.08}Te_{2.48}$ SINGLE CRYSTALS

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Abstract: Emergent magnetism in two-dimensional Van der Waals materials have garnered significant attention due to their potential applications in next-generation spintronic devices and quantum computation. Herein, we report the synthesis and characterization of high-quality single crystals of layered $NbNi_{1.08}Te_{2.48}$ grown using the chemical vapor transport. We have investigated the magnetic and electronic properties using the dc-susceptibility and magneto-transport measurements. The magnetic measurements indicate antiferromagnetic behavior around 6 K with weak ferromagnetic component, which gets strengthened with increasing field above 1 T. Temperature dependent electrical resistivity data reveals metal-to-insulator transition at lower temperatures below 120 K along with an anomaly at higher temperature around 275 K. Further, magneto-transport data for both longitudinal and transverse magnetoresistance shows asymmetric butterfly-shaped feature with negative magnetoresistance. Moreover, we observed a hysteresis in magnetoresistance, which is consistent with magnetization measurements. Hall resistivity data indicates that both type of charge carriers participate in transport. Our findings highlight that the extra or intercalated Ni or Te in the pristine $NbNiTe_2$ layered system serves as a feasible approach to manipulate their magnetic and transport properties.

Keywords: Van der Waals, magnetoresistance, magnetic properties, magnetotransport.

Abstract ID: 228

INTERFACE ENGINEERING OF TOPOLOGICAL BiSb/CoFeB HETEROSTRUCTURES FOR EFFICIENT SPIN-CHARGE CONVERSION

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Abstract: Topological insulators (TIs) like BiSb show high spin-charge conversion efficiency due to their topological surface states, positioning them as promising for energy-efficient spin-orbital-torque (SOT) devices and alternatives to heavy metals in spintronics. However, challenges such as producing high-quality TI thin films and managing interfacial effects with ferromagnetic layers can degrade these properties. Developing an effective interlayer (IL) at the BiSb/ferromagnet interface is essential to prevent intermixing and enhance spin-charge conversion efficiency in TI-based heterostructures. In this work, we employed various IL materials, ranging from pure elemental materials to metal-semiconductor compounds, within the BiSb/CoFeB system. We observed a significant improvement in spin transport properties when the appropriate ILs were used. To efficiently measure the SOT efficiency, we patterned the deposited films into a bar structure integrated with a coplanar waveguide using UV lithography and performed spin-torque ferromagnetic resonance (ST-FMR) measurements. Figure 1 shows a representative ST-FMR spectrum for the sample of BiSb/IL/CoFeB, measured at in-plane magnetic field angle $\varphi = 45°$ with a frequency of $f = 12$ GHz and a power of 15 dBm. After quantitatively estimating the torque efficiencies in all samples, we observed a remarkable improvement in SOT efficiency, from BiSb/CFB to BiSb/IL/CFB systems. This improvement in SOT efficiency may be attributed to the ILs preserving the topological surface states of BiSb and suppressing elemental diffusion in the heterostructures. Interface engineering in TI/FM systems is crucial for the practical applications of TI-based spintronic devices.

Keywords: Topological Insulators, Spin-torque efficiency, Interlayers, STFMR.

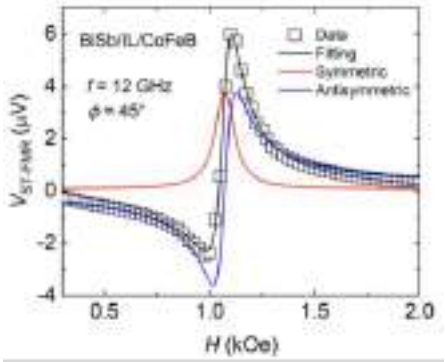


Fig. 1: The ST-FMR signal generated from the BiSb/IL/CoFeB multi-layered stack was decomposed into its symmetric and anti-symmetric components.

References:

[1] H. Y. Poh et al., Phys. Rev. Applied 19, 034012 (2023).
[2] N. H. D. Khang et al., Nat. Mater. 17, 808 (2018).

Abstract ID: 229

MÖSSBAUER INVESTIGATION OF PROCESSING INDUCED MAGNETIC DISORDER IN Fe–Ga ALLOYS

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Abstract: Fe–Ga alloys are well-known magnetostrictive materials that exhibit strong coupling between magnetic and mechanical properties, making them a promising candidate for sensor and actuator applications. Mössbauer spectroscopy was employed to investigate the influence of processing conditions on the local magnetic environment of Fe–Ga alloys subjected to annealing and cold working. Room-temperature Mössbauer spectra of both samples were successfully fitted using two magnetic sextets, indicating the presence of two distinct ferromagnetic iron environments. The extracted hyperfine magnetic field values (~30.6–30.7 T) confirm the retention of ferromagnetic ordering in both processing states. Comparable relative spectral areas suggest similar population of Fe sites in the annealed and cold-worked alloys. However, the cold-worked sample exhibits increased linewidths and larger uncertainties in hyperfine parameters, reflecting enhanced magnetic disorder and lattice distortion introduced by mechanical deformation. These findings highlight the impact of processing on altering the local magnetic and structural properties of Fe-Ga alloys while preserving their ferromagnetic characteristics.

Keywords: Mössbauer spectroscopy, Fe–Ga (Galfenol) alloys, Hyperfine interactions, Magnetic properties.

References:

[1] V. Milyutin, I. Gervasyeva, A. Kalonov, D. Shishkin, D. Davydov, et al., Condens. Matter 10 (2025) 8.
[2] D.G. Grey, M.B. Miglierini, J. Radioanal. Nucl. Chem. 334 (2025) 4189-4197.

Abstract ID: 230

DEVELOPMENT OF $(Mn,Fe)_2(P,Si)$/Al MAGNETOCALORIC COMPOSITE WITH EXCELLENT THERMAL CONDUCTIVITY AND MECHANICAL PROPERTIES

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Abstract: Magnetic refrigeration based on the magnetocaloric effect is an environmentally benign and theoretically energy-efficient technology with the potential to replace conventional vapor-compression refrigeration systems [1,2]. Nevertheless, the technological deployment of magnetic refrigeration remains challenging due to the stringent material requirements, namely the simultaneous achievement of a giant and reversible magnetocaloric effect, high thermal conductivity, and excellent mechanical strength. Here, we report development of fully dense bulk $(Fe,Mn)_2(P,Si)$/Al composite material that simultaneously demonstrates high magnetocaloric performance (ΔS_T), enhanced thermal conductivity (λ), and improved mechanical strength. The $(Fe,Mn)_2(P,Si)$ powders were prepared by strip cast process with optimized parameters. The composite material was prepared by hot press. The developed composite exhibits an isothermal entropy change of $\Delta S_{iso} \approx 18$ J kg^{-1} K^{-1} at 2 T and at the transition temperature of 298 K, a thermal conductivity of $\lambda \approx 54$ W m^{-1} K^{-1}, and a bending strength of $\sigma \approx 80$ MPa. These values represent one of the best combinations of comprehensive properties reported so far for the near-room-temperature magnetocaloric composite systems [3], as shown in **Fig. 1a**. Based on detailed microstructural characterization (**Fig. 1b**), we discuss how a three-dimensional interconnected Al-rich intergranular phase surrounding the $(Fe,Mn)_2(P,Si)$ grains with negligible interdiffusion of Al intergranular phase and mainphase, with an optimized volume fraction, enables successful multi-objective optimization of the material's physical properties, paving the way toward the practical implementation of magnetocaloric refrigeration devices.

Keywords: Magnetoclaoric, thermal conductivity, bending strength, Fe_2P type alloy, solid state refrigeraiton, entropy change.

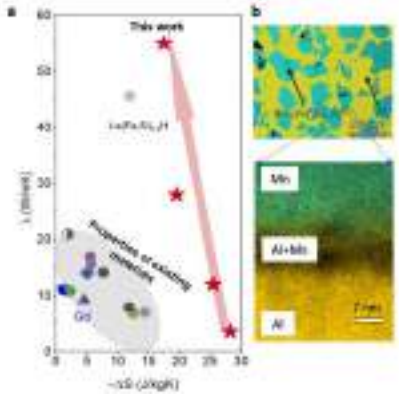


Fig. 2: (a) Thermal conductivity (λ) vs entropy change (ΔS_{iso}) for the existing mateirals and $(Fe,Mn)_2(P,Si)$/Al composite, (b) EDS mapping of the composite at various length scales.

References:

[1] Kitanovski, A. *Advanced Energy Materials*, 10 (2020) 201903741 (2020).
[2] Franco, V., Blázquez, J. S., Ipus, J. J., et al., *Progress in Materials Science*, *93* (2018) 112-232.
[3] Zhang, M., Yanyan S., Chunhui Li, et al., *Journal of Alloys and Compounds* 962 (2023): 171123.

Abstract ID: 231

TAILORING TOPOLOGICAL DEFLECTION, MOBILITY AND GUIDED MOTION OF SKYRMIONS IN SYNTHETIC FERRIMAGNETS

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Abstract: Magnetic skyrmions are topologically protected spin textures that are promising nanoscale information carriers for next-generation memory and logic devices. Recent studies have demonstrated linear skyrmion motion in the domain-wall(DW) flow regime for compact skyrmions in synthetic ferrimagnetic and antiferromagnetic multilayers[1, 2]. Here, we investigate spin–orbit torque(SOT)-driven skyrmion dynamics in Pt|Co|Tb|Al synthetic ferrimagnetic multilayers, where the Tb layer thickness(t_{Tb}) is varied between 0 to 1 nm. Experimental observations and micromagnetic simulations which demonstrate that at low current densities(J), skyrmions are deflected toward the nanotrack edge but propagate parallel to it without annihilation due to edge repulsion. Above a threshold current density(J_{th}), the total driving force(F_{SOT}) overcomes the edge repulsive force(F_{Rep}) leading to edge annihilation. We performed theoretical calculations based on the Thiele formalism parametrized with experimental values [3] for each sample (±10% uncertainty). The model employs: $\theta_{SkHA}(R) = tan^{-1}\left[\frac{1}{\alpha}\frac{n}{D(R)}\right]$ and $\mu(R) = \frac{\alpha D(R)}{G^2+(\alpha D(R))^2}\frac{h}{e}\theta_{SH}$ where, $D(R) \approx |n| \exp\left(-\frac{2\pi R}{|n|\Delta}\right) + \frac{2\pi R}{\Delta}$ and $n = 4\pi$. The dotted lines and half-filled symbols in Fig. 1(a), (b) represent these theoretical results, which map closely to experimental (solid symbols) and micromagnetic simulation (open symbols) data. The shaded region between 80–110 nm defines the critical skyrmion radius where minimal size and maximal velocity coexist, defining an optimal regime of high mobility and reduced skyrmion Hall angle. We further quantify the forces as functions of the skyrmion radius as shown in Fig. 1(c). Systematic trends in Hall angle, mobility, dissipation, and effective mass confirm that lower damping and higher spin Hall efficiency (θ_{SH}) enhance mobility, demonstrating excellent agreement across theory, experiment, and simulation.

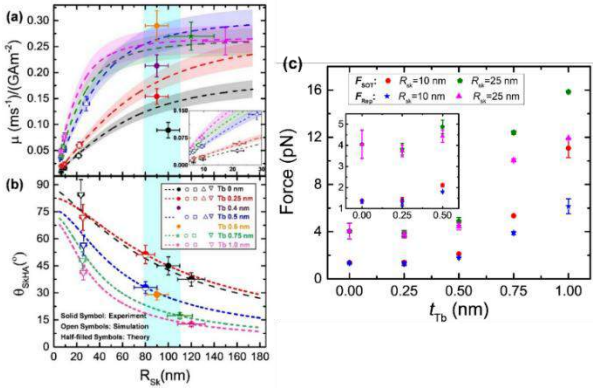


Fig. 1: (a),(b) Skyrmion Hall angle(θ_{SkHA}) and Mobility(μ) as a function of the skyrmion radius(R_{sk}). (c) Total driving force(F_{SOT}) & edge repulsive force(F_{Rep}) vs Tb thickness(t_{Tb}).

References:

1. S. Mallick *et al, Nature Communications* **15**, 8472 (2024)
2. V. T. Pham *et al, Science* **384**, 6693 (2024)
3. S. Mallick *et al, Physical Review B* **112**, 014437 (2025)

Abstract ID: 232

COUPLED STRUCTURAL, MAGNETIC, AND ELECTRONIC EVOLUTION IN OXYGEN-DEFICIENT $BaFeO_{3-\delta}$ THIN FILMS

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Abstract: Iron-based perovskites featuring iron in the unusually high Fe^{4+} valence state ($AFeO_3$; *A*=Ca, Sr, Ba) have attracted significant attention for their versatile magnetic textures and potential in next-generation spintronic and magneto-optical devices [1]. Among them, $BaFeO_3$ serves as a model system for studying coupling among structural, magnetic, and electronic properties and high-valence iron chemistry and their sensitivity to oxygen content. Here we report structural, magnetic, and electronic properties of $BaFeO_{3-\delta}$ epitaxial thin film grown over STO(001) via pulsed laser deposition technique. We also prepared a film with similar condition followed by in-situ post annealing of the film in ambient oxygen pressure of 1 atm for 1.5 hours to stabilize the metastable cubic perovskite phase. Figure1 (a) shows the XRD patterns of as grown film and post annealed film with oxygen. The XRD reveals hexagonal phase of the as-grown film with c axis lattice of 24.99 Å, while the oxygen annealed films adopts the cubic phase with c axis lattice parameter of 3.99Å. Figure 1 b) shows temperature-dependent magnetization of the film carried out at 0.1T field cooled (FC) protocol via 7 T SQUID-VSM for both the films. The as-grown film does not show any magnetic phase transition down to 5K, whereas the one with post annealing in the presence of oxygen shows ferromagnetic transition below 150K. Photoelectron spectroscopy reveals the presence of oxygen vacancy even in the oxygen annealed film. It is observed that the strain-induced lattice distortions is resposible for magnetic ordering.

Keywords: Oxygen Vacancies; Epitaxial Perovskite Oxides; Electronic Structure; Magneticroperties; Synchrotron Photoemission

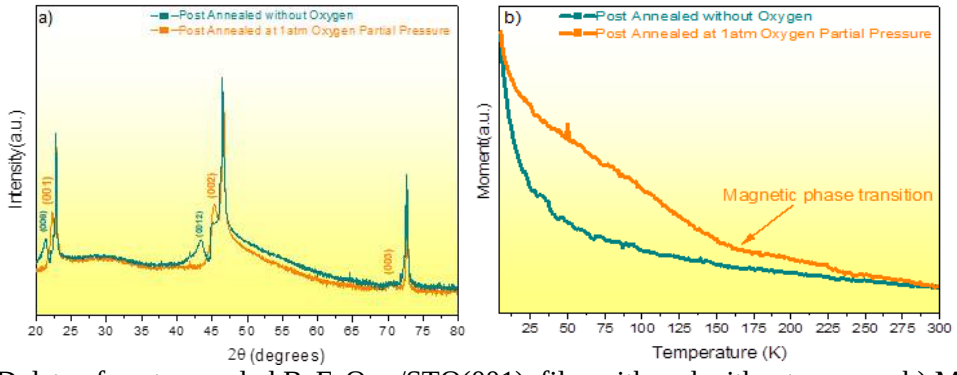


Fig. 1: a) XRD data of post-annealed $BaFeO_{3-\delta}$ /STO(001) film with and without oxygen. b) M-T data of post annealed $BaFeO_{3-\delta}$ /STO(001) film with and without oxygen.

References:

[1] Chakraverty, S., Matsuda, T., Ogawa, N., Wadati, H., Ikenaga, E., Kawasaki, M., Tokura, Y., Hwang, H. Y. (2013). *Applied Physics Letters*, *103*(14), 142416. https://doi.org/10.1063/1.4824210

Abstract ID: 233

EPITAXIAL GROWTH OF CR-PT LAYERS FOR SPIN ORBIT TORQUE SWITCHING IN MAGNETIC TUNNEL JUNCTIONS

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Abstract: Here, we report some of the main challenges in the growth of 2D multilayers, exploring the concept of spin-orbit torque (SOT) for novel Spintronic devices. Generally, materials compatible with such devices are chosen from the 4*d* and 5*d* heavy metallic elements of the periodic table, which act as reservoirs of charge currents and are commonly used in magnetization switching devices [1]. These materials exhibit strong spin-orbit coupling, enabling the generation of large spin currents through the spin-Hall effect [1,2]. Focusing on these aspects first, we fabricated a $Cr_{60}Pt_{40}$ (10 nm) SOT thin layer using the sputtering technique involving $Co_{20}Fe_{60}B_{20}$ (1.1 nm) as the free layer, MgO (1.8 nm) as the insulating barrier, and Ta (1 nm) as the capping layer (fig. 1(a)). These layers were deposited at 500°C under an Ar pressure of ~ 0.65 Pa. The surface morphology of these thin-film multilayers is being studied using atomic force microscopy (AFM), which revealed an average roughness (*Ra*) of ~9.145×10^{-2} nm and a peak-to-valley (PV) value of ~1.97 nm. The out-of-plane *X*-ray diffraction (XRD) patterns confirmed the formation of a face-centered tetragonal (fct) crystalline structure, with an estimated crystalline-order-parameter of ~43% (fig. 1(b)). The perpendicular magnetic anisotropy (PMA) probed by the Magneto-optical Kerr effect (MOKE) measurements indicates that the thin-films of $Cr_{60}Pt_{40}$ (10 nm) subjected to the vacuum annealing at 300°C significantly improve the PMA bheaviour resulting in the coercivity H_C ~500 Oe (fig. 1(c)). For SOT characterization, we further fabricated the device with the following architecture: MgO (001) substrate//$Cr_{60}Pt_{40}$ (10 nm)/$Co_{20}Fe_{60}B_{20}$ (1.1 nm)/MgO (1.8 nm)/Ta (1 nm) (fig. 1(a)). Finally, the Anomalous Hall effect (AHE) measurements on the patterned devices exhibit a longitudinal resistance of about 2 Ω, which could be further explored for the SOT switching.

Keywords: Spintronics, Perpendicular Magnetic Anisotropy, Anomalous Hall effect, Spin-orbit torque.

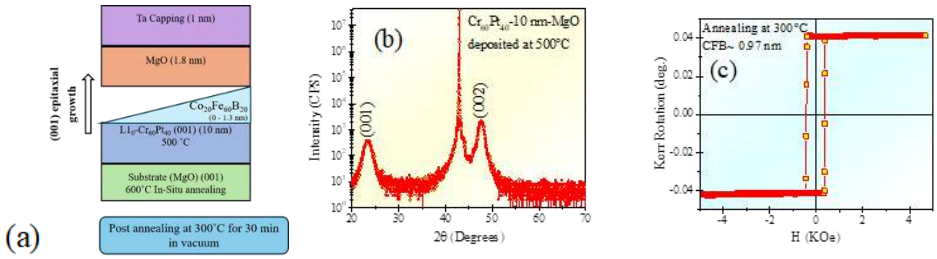


Figure 1: (a) Best structure describing PMA bottom electrode for MTJs using Cr-Pt SOT-layers. (b) Out-of-plane XRD patterns of 10nm thick $Cr_{60}Pt_{40}$ films deposited at 500˚C on MgO (001) substrate. (c) Successfully achieved PMA bottom electrode for MTJs after post annealing at 300˚C with the coercivity of ~500 Oe.

References:

[1] S. Mangin et al., *Nature Mater*. 5, 210-215 (2006).
[2] D. Bergman et al., *Nature Physics*, 3, 487, (2007).

Abstract ID: 234

EMERGENT MAGNETIC RELAXATION AND CRYSTAL FIELD PHONON STUDY IN Mn-SUBSTITUTED $Dy_2Ti_2O_7$

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Abstract: $Dy_2Ti_2O_7$ belongs to a spin disordered system, the structure follows the prototype of a pyrochlore lattice (space group $Fd\bar{3}m$) which falls in the class of magnetically frustrated system. We report a systematic investigation of spin dynamics and crystal field–phonon coupling in Mn-doped spin-ice pyrochlore $Dy_2Ti_{2-x}Mn_xO_7$ (x = 0, 0.10, 0.20). The parent compound $Dy_2Ti_2O_7$ is a canonical dipolar spin ice, where strong crystal electric field (CEF)-induced ⟨111⟩ Ising anisotropy stabilizes the "two-in two-out" ground state. Substitution of Mn at the non-magnetic Ti site introduces chemical pressure and magnetic disorder, significantly modifying the magnetic relaxation behaviour [1].

AC susceptibility measurements reveal the emergence of an additional relaxation peak (T*) around ~5 K for x = 0.10 and 0.20, even in zero dc bias field, indicating the presence of a short-range magnetically ordered state in the paramagnetic region. This peak is absent in the pristine compound and becomes more pronounced with increasing Mn concentration. Griffith-like state is inferred from magnetic frustration with Mn inclusion at the Ti site [2]. With increasing dc bias field, the multiple relaxation features broaden and merge into a single hump-like structure.

Temperature-dependent synchrotron X-ray diffraction confirms retention of the cubic $Fd\bar{3}m$ structure with systematic lattice contraction upon Mn substitution down to15K. Debye–Grüneisen analysis of lattice volume reveals enhanced crystal field–phonon coupling and a shift of its onset to higher temperature in the Mn-doped samples. Such a small perturbation in the composition leads to magnetic ordering above the transition temperature [3].

Keywords: chemical-pressure, magnetically frustrated systems, pyrochlores, spin-ice

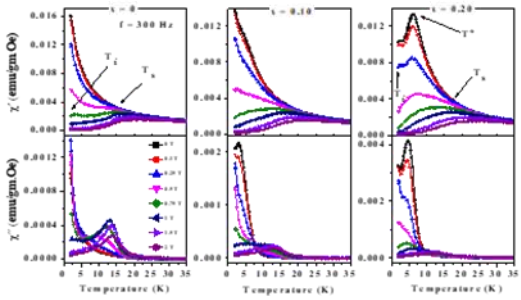


Fig. 1: (i) The real (upper panel) and imaginary part (lower panel) of ac susceptibility at different applied dc magnetic fields at frequency of 300 Hz for $Dy_2Ti_{2-x}Mn_xO_7$ (x = 0, 0.10, 0.20).

References:

[1] 1 J.S. Gardner, M.J.P. Gingras, J.E. Greedan, Magnetic pyrochlore oxides, Rev. Mod. Phys. 82, 53–107, (2010).
[2] H.S. Nair et al., J. Appl. Phys. 110, 1–6, (2011)
[3] Rajnikant Upadhyay et al. J. Magn. Magn. Mater. 566, 170308, (2023).

Abstract ID: 235

FINITE ELEMENT BASED VIBRATION ANALYSIS OF MAGNETIC BEARING SUPPORTED ROTOR SYSTEM

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Abstract: Magnetic bearings are being used more frequently in high-speed rotating machinery because they operate without friction, experience less wear, and offer better performance than traditional bearings. However, the lack of mechanical contact makes the rotor system very sensitive to vibration and stability problems. This study looks at the vibration analysis of an active magnetic bearing system using finite element-based multiphysics simulation. A three-dimensional rotor-bearing model is created, incorporating equivalent magnetic stiffness and damping to show the magnetic levitation effect. Modal and harmonic analyses are conducted with finite element analysis (FEA) to find the natural frequencies, mode shapes, and vibration response under dynamic loading conditions. The results highlight critical frequencies and their corresponding deformation patterns, which are vital for preventing resonance and ensuring stable operation. The analysis also examines how rotor mass and magnetic stiffness affect vibration characteristics. The findings show that carefully designing magnetic bearing parameters significantly reduces vibration amplitude and improves system stability. This study offers valuable insights for designing and optimizing magnetic bearing-supported rotating systems in applications like turbines, compressors, and aerospace machinery.

Keywords: Magnetic Bearing; Vibration Analysis; Rotor Dynamics; Modal Analysis; Natural Frequency; Finite Element Method.

Abstract ID: 236

THERMAL STRUCTURAL PERFORMANCE ANALYSIS FINITE ELEMENT MODELING OF A LINEAR ELECTROMAGNETIC ACTUATOR

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Abstract: Linear electromagnetic actuators are highly prolific in the manufacturing assembly lines since they are small, react quickly, and hold the things straight. The disadvantage however is that the coil will be hot even when it is on and this may cause the magnetic core and the housing to come out and hook one another. Such effects caused by heat may disorganize the functioning of the actuator, its duration and the extent to which the actuator is actually confident.

In this project, we constructed a linear electromagnetic actuator model to test the heat and stress of the actuator under constant electrical conduct with the help of a finite-element model under a finite-element program. Firstly, to determine the dissemination of the magnetic flux and the forces it generates, we did a magnetostatic simulation. After which we calculated the radiated heat of the coil, and used that as a thermal load, and carried out a steady-state thermal analysis. The temperature map obtained was passed into a structural analysis to determine the thermal stresses and deformations within the parts.It provides the results that present a better understanding of the extent of temperature increase, the locations where the worst stress occurred, and the safety of the structure when functioning like usual. The reason is emphasized why it is essential to do a thermalstructural check at an early step in order to make the device more stable and to avoid premature breakdown. Our finite-element methodology may be a methodical explanation of assessing and enhance electromagnetic actuators in actual industrial gears.

Keywords: Linear Electromagnetic Actuator, Finite Element Analysis, Thermal–Structural Coupling, Magnetostatic Analysis, Soft Magnetic Materials, Actuator Reliability.

Abstract ID: 237

FINITE ELEMENT MODELING AND SIMULATION OF MAGNETO-MECHANICAL BEHAVIOR IN Fe_3O_4 REINFORCED MAGNESIUM NANOCOMPOSITES FOR MULTIFUNCTIONAL APPLICATIONS

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Abstract: Magnesium-based composites are common in the field of lightweight structural engineering, but the combination of magnetic capabilities with structural engineering materials creates new prospects of multifunctional engineering systems. To examine the magneto-mechanical behavior of Fe_3O_4 nanoparticle-reinforced magnesium nanocomposites, a finite element-based multiphysics model has been developed in the present study. A representative volume element (RVE) model with randomly dispersed magnetic nanoparticles is created to represent the coupled response of mechanical stress and magnetic field. The composite behavior is studied at different reinforcement weight fractions (1–5 wt%) and external magnetic field levels. The effective stress distribution and effective elastic properties under mechanical loading conditions are assessed and the magnetic flux density and field interactions within the composite are simulated to evaluate magnetic responsiveness. The findings demonstrate that the presence of magnetic nanoparticles can greatly impact the local stress concentration and the distribution of magnetic flux in the magnesium framework. The work also determines the interrelationship among particle volume fractions, dispersion attributes, and magneto-mechanical coupling efficiency. The developed model provides a predictive framework for the design of lightweight multifunctional magnetic composites that can be used in electromagnetic shielding, smart sensors and aerospace structural applications. This modeling method provides an inexpensive approach for optimizing material behavior before experimental validation, and thus contributes to the advancement of interdisciplinary magnetic materials research.

Keywords: Magnesium Matrix Composites, Fe_3O_4 Nanoparticles, Magneto-Mechanical Coupling, Finite Element Modeling, Multiphysics Simulation, Magnetic Flux Distribution, Lightweight Multifunctional Materials.

References:

[1] M. Wang and Z. Zhang, *RSC Adv.* 14 (2024) 7891–7902
[2] J. Guo, H. Li, X. Chen, *Compos. Sci. Technol.* 258 (2024) 110917
[3] A. Singh, S. Patel, R. Kumar, *Mater. Des.* 241 (2024) 112367
[4] Y. Zhao, L. He, J. Huang, *J. Magn. Magn. Mater.* 613 (2023) 169754

Abstract ID: 238

LOW MAGNETIC MOMENT CoVGe FOR SPINTRONIC APPLICATIONS

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Abstract: In this present work, we experimentally realize CoVGe for the first time and investigate its structural, magnetic, and transport properties, supported by theoretical calculations. The material crystallizes in a cubic structure (space group no. 216, $F\bar{4}3m$) and from magnetization measurements, shows a very low magnetic moment of 0.13 μ_B per formula unit at 5 K. The temperature dependence of electrical resistivity, deviating from quadratic (T^2) temperature dependence as observed in conventional ferromagnets, suggests half-metallic behaviour [1-2]. Magnetoresistance shows a positive, non-saturating linear field dependence at low temperature which gradually weakens with increasing temperature. The combination of low magnetic moment and unusual magnetotransport behaviour positions CoVGe as a promising platform for exploring spin-dependent transport in Heusler-based materials.

Keywords: CoVGe, half metallic, half Heusler alloy, spintronics, low magnetic moment

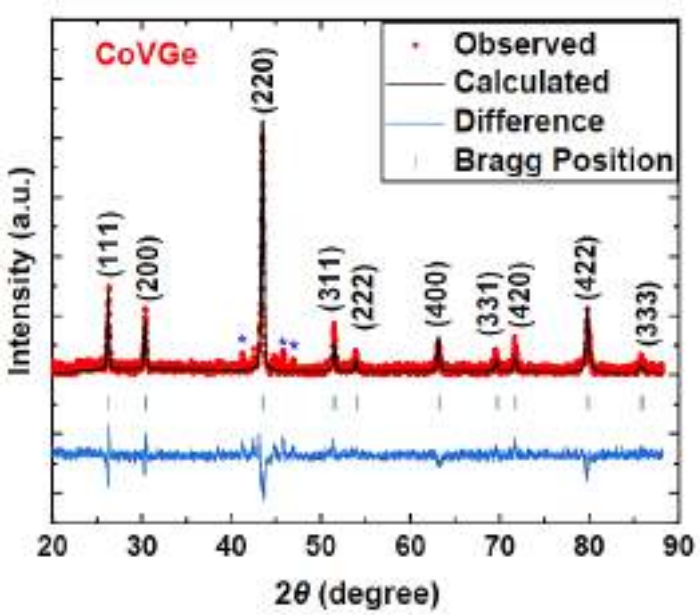


Fig. 1: Room temperature powder X-ray diffraction pattern of CoVGe along with the Rietveld refinement.

References:
[1] D.A. Goodings, Phys. Rev. **132**, 542 (1963).
[2] R. Kumar, and S. Gupta, Appl. Phys. Lett. **124**, 022402 (2024).

Abstract ID: 239

ROLE OF CoFeB/Pt STACKING ORDER ON INTERFACIAL DZYALOSHINSKII MORIYA INTERACTION DRIVEN SPIN WAVE ASYMMETRY

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Abstract: Chiral magnetic structures such as skyrmions are being actively investigated as potential building blocks for next-generation data storage and processing technologies[1]. The interfacial Dzyaloshinskii-Moriya interaction (iDMI) plays a vital role in stabilizing skyrmions and enabling nonreciprocal spin-wave propagation, both of which are essential for the development of next-generation spintronic devices[2]. Controlling iDMI through material design and interface engineering is therefore important for achieving more energy-efficient information technologies. CoFeB/Pt heterostructures are particularly versatile due to their adjustable magnetic and spin-orbit properties. In this study, we examine how stacking sequence, interface quality, and magnetic moment density influence iDMI in CoFeB/Pt thin films using magnetometry and Brillouin light scattering spectroscopy. We find that changing the layer order, creating symmetric stacks, or inserting spacer layers significantly alters spin-wave nonreciprocity. Notably, the frequency shift when CoFeB is deposited on top of Pt is more than twice and iDMI constant is almost four times higher than that when Pt is on top of CoFeB, and the effects related to ferromagnet thickness and moment density confirm that the iDMI origin is at the interface. These findings offer practical insights into interface engineering for tunable chiral spin dynamics in ultrathin magnetic films.

Keywords: Skyrmions, Dzyaloshinskii-Moriya interaction, Brillouin light scattering (BLS), chiral spintronics, non-reciprocal spin wave.

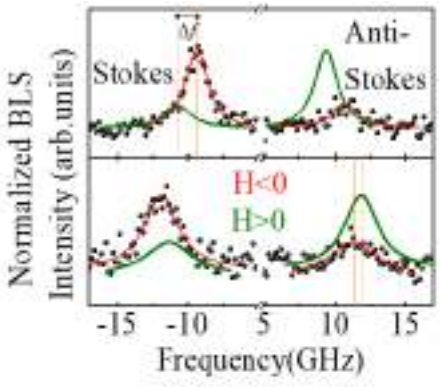


Fig. 1: Comparison of BLS spectra for SiO_2/Ru/Pt(3nm)/CoFeB(1nm) (top) and SiO_2/Ru/CoFeB(1nm)/Pt(3nm) (bottom) measured at a wave vector of $k_x = 9.97 rad/\mu m$.

References:

[1] A. Fert, V. Cros, and J. Sampaio, "Skyrmions on the track," Nat. Nanotechnol. 8(3), 152–156 (2013).
[2] C. Deranlot, P. Warnicke, P. Wohlhüter, A. Fert, "Additive interfacial chiral interaction in multilayers for stabilization of small individual skyrmions at room temperature," Nat. Nanotechnol. 11(5), 444–448 (2016).

Abstract ID: 240

BULK TO THIN FILM TRANSLATIONAL INSIGHTS ON STRUCTURAL AND MAGNETIC CHARACTERISTICS OF Sr_2CoMoO_6

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Abstract: Transitioning from bulk ceramics state to two-dimensional thin film states has profound effects on the physical properties of cobaltates due to factors like substrate-induced strain, interfacial effects etc. In this work, we studied the structural and magnetic characteristics of double perovskite Sr_2CoMoO_6 (DP-SCMO) in bulk and thin-film forms to probe the dimensional effects. Bulk DP-SCMO was synthesized via solid-state reaction, [1] while thin films were deposited on (100) oriented single-crystal $LaAlO_3$ (LAO), $SrTiO_3$ (STO), and MgO substrates using pulsed laser deposition. X-ray diffraction data of bulk system confirms phase-pure tetragonal DP-SCMO and thin films reveal substrate-dependent epitaxial growth with preferential (001) orientation. A peak shifts in films, relative to bulk indicate the impact of lattice-induced strain, arising from lattice mismatch between substrate-film interface. We also have observed that the strain varies with deposition conditions and film thickness, showing dimensional confinement effects. M-T measurements reveal an antiferromagnetic transition in bulk SCMO at ~37 K with typical ZFC–FC behavior as well as a linear Magnetization versus magnetic field (M-H)response [2]. In contrast, the LAO-grown thin film shows a broadened magnetic anomaly near ~75 K with clear ZFC–FC bifurcation and modified field-dependent behavior, indicating strain-induced modification and/or dimensional impact. These effects are attributed to strain-induced modification of Co–O–Mo bond angles, bandwidth tuning, and possible antisite disorder under reduced dimensionality. Our results divulge a direct correlation between substrate-induced strain, reduced dimensionality, and magnetic properties in DP-SCMO.

Keywords: Dimensionality, Strain, Magnetization, Antiferromagnetic, Substrate-film interface.

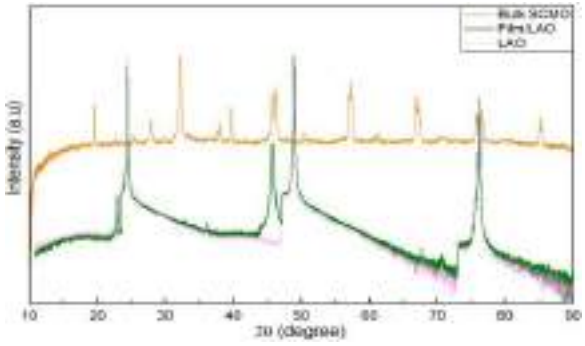


Fig. 1: XRD of Bulk DP-SCMO and 60 minute DP-SCMO deposition on LAO substrate.

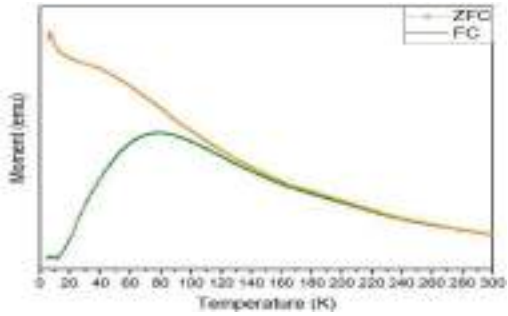


Fig. 2: M Vs. T of 60 minute deposition on LAO substrate.

References:

[1] Azizi, A. Kahoul, G. Schmerber, et al., International Journal of Modern Physics B, 22, 21 (2008).
[2] Y.H. Huang, G. Liang, M. Croft, M. Lehtimaki, et al., Chem. Mater. 2009, 21, 11, 2319–2326.

Abstract ID: 241

TUNING THE STRUCTURAL, OPTICAL AND MAGNETIC PROPERTIES OF TRANSITION METAL DOPED ZINC OXIDE NANOPARTICLES

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Abstract: Transition metal Ni^{2+} doped ZnO nanoparticles were prepared by co-precipitation route with the general formula $Zn_{1-x}Ni_xO$ (x = 0.00, 0.04, 0.08, and 0.12). The influence of transition metal doping on the structural, optical, and magnetic characteristics of ZnO nanoparticles has been explored employing a variety of characterization techniques, such as XRD, HRTEM, UV and PL. HRTEM was used to study the size distribution and morphology of the particles. The optical energy bandgap was initially found to blue shift from 3.27 to 3.36 when Ni dopant level increased from 0 to 8%, and further red shifted from 3.36 to 3.29 when the Ni dopant level increased from 8% to 12%. The PL study shows a broad violet emission band at 425 nm, indicating the presence of zinc interstitials and oxygen interstitial defects in the ZnO lattice. Room temperature magnetization (M-H) loops suggested that the diamagnetic behaviour of ZnO changes to weak ferromagnetism when doped with Ni.

Keywords: ZnO, Bandgap, Spintronics, Ferromagnetism.

References:

[1] N. Aggarwal, K. Kaur, A. Vasishth, N. K. Verma, J. Mater. Sci.: Mater. Electron. 27, 13006 (2016).
[2] M. Mazhdl, M. J. Tafreshl , Appl. Phys. A 126, 272 (2020).

Abstract ID: 242

UNCONVENTIONAL MAGNETIC GROUND STATE DRIVEN BY ELECTRONIC INSTABILITIES IN QUASI-1D ZIG-ZAG FRUSTRATED SPIN CHAINS

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Abstract: Geometric frustration in low-dimensional systems paves the way for quantum fluctuations to dictate the magnetic ground state [1,2]. Here, we study the magnetic ground state of the quasi 1D Kondo lattice, Ce_3ZrBi_5 forming in hexagonal crystal structure [3]. Besides the exotic magnetism, this class of materials also show potential for topological electronic structure [4]. for Experimental results show characteristic heavy-fermion and Kondo behavior with signature of suppression of Ce 4f moment. Magnetization data exhibit two distinct antiferromagnetic transitions at 4.8 K and 4.1 K. In-plane magnetization data at low field aligns well with the antiferromagnetic behavior while a tendency of saturation is observed at high field. The easy-axis moment quenches significantly and drops below the hard-axis value showing an interesting deviation from observed magneto-crystalline anisotropy. Density functional theory calculations project an increase in the electronic density of states along the Bi linear chains as a result of strong spin-orbit coupling. The 1D nature of the electron density ensures higher screening of Ce moments along the easy axis. The Kondo screening of electrons directly affects the magnetic ground state. Interestingly, the out-of-plane magnetization reveals signature of fractional magnetization plateaus evidencing frustration leading to a quantum-mechanical fluctuation induced exotic magnetic phase [5]. These results provide an unique example of selective fractionalization arising from geometric frustration and topological electronic structure mediated magnetic ground state in a correlated system.

Keywords: Frustration; Kondo effect; Electronic Structure; Magnetism; Topology

References:

[1] Z. Xu, Y. Wang, C. Zhang, H. Liu, X. Han, L. Wu, X. Zhang, Q. Wu, and Y. Shi, Phys. Rev. B 110 (2024) 165106.
[2] D Vojtasová, D Staško, F Hájek, R H Colman, and M Klicpera, J. Phys.: Condens. Matter 36 (2024) 325805.
[3] G. Motoyama, M. Shinozaki, M. Tsubouchi, M. Kuninaka, S. Nishigori, K. Miyoshi, K. Fujiwara, J. Gouchi,
and Y. Uwatoko, JPS Conf. Proc. 30 (2020) 011180.
[4] J. F. Khoury, B. Han, M. Jovanovic, R. Singha, X. Song, R. Queiroz, N.-P. Ong, and L. M. Schoop, J. Am. Chem. Soc. 144 (2022) 9785.
[5] R. Singha, T. H. Salters, S. M. Teicher, S. Lei, J. F.Khoury, N. P. Ong, and L. M. Schoop, Adv. Mater. 33 (2021) 2103476.

Abstract ID: 243

ROOM-TEMPERATURE STABILISATION AND THERMAL EVOLUTION OF SKYRMIONS IN Co/Pt MULTILAYER STACKS

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Abstract: Magnetic skyrmions are particle like whirling topological spin textures stabilised in systems that lack inversion symmetry, where the resulting Dzyaloshinskii-Moriya interaction (DMI) promotes chiral spin textures[1]. The formation of skyrmions results from the competition among DMI, symmetric exchange, and other magnetic interactions. The engineering of magnetic stack to realize magnetic skyrmions at room temperature is a challenging task. Further, understanding the effect of temperature on density and size of the skyrmions is essential for employing them in device applications.

In this work, Co/Pt multilayer stacks (Ta(4)/Pt(4)/[Co(0.5)/Pt(0.75)]3/Co(0.5)/Pt(3) thickness in nm) were deposited on Si wafers using DC magnetron sputtering. Magneto-Optical Kerr effect (MOKE) studies confirmed the presence of perpendicular magnetic anisotropy (PMA) in the system. The magnetization reversal shows the hysteresis loops near the switching field to be canted opening the possibility of switching via nucleation of skyrmions. Kerr microscopy studies confirmed the presence of skyrmions of size ~ 1.1 microns at 250 Oe at room temperature. Temperature-dependent MOKE imaging revealed shrinking in skyrmion size at lower temperatures (90 K) compared to room temperature. Further, Hall cross structures were patterned for electrical measurements to confirm the skyrmion signature. Dynamics of skyrmions under the application of current will be studied to observe the Skyrmion Hall Effect, which will confirm the chiral nature of the texture. Anomalous Hall measurements exhibited consistent magnetic switching behaviour. These highlight the potential of Co/Pt multilayers for realising tunable, thermally stable skyrmion states for energy-efficient, high-density spintronic memory and logic devices.

Keywords: Magnetic Skyrmions, Temperature-dependent MOKE, AHE

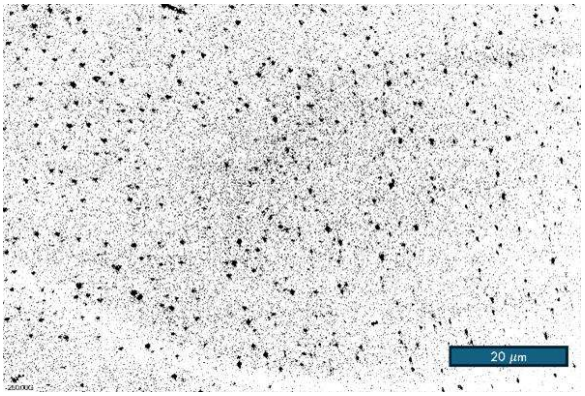


Fig. 1: Skyrmions observed at room temperature in Co/Pt multilayers via MOKE Microscopy imaging.

References:

[1] Fert A, Reyren N and Cros V, Nat. Rev. Mater. **2** 17031 (2017).

Abstract ID: 244

STRUCTURAL AND MAGNETIC PROPERTIES OF Ga_2MnNi REVERSE HEUSLER ALLOY

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Abstract: Magnetism in cubic reverse-Heusler system Ga_2MnNi has been found interesting, as the system shows thermo-magnetic hysteresis which is not related to temperature dependent first order transition in structure or magnetism [1]. As reported, the annealing protocol can affect the structure of polycrystalline Ga_2MnNi, such that, annealing at high temperature keep the structure cubic while temper annealing creates tetragonal distortion resulting in monoclinic structure [2]. The plausible structural metastability, which has been masked in the reported structural studies with X-ray and neutron diffraction [1], we investigate here through detailed magnetic characterisation. The field dependent magnetization of Ga_2MnNi given in figure shows the variation in magnetization at 2 K and 50 K. The field induced magnetic metastability is investigated with magneto-transport and thermal cycling magnetization studies. Our results provide better understanding of Heusler alloys in Z_2XY type reverse composition, whose local structure and ground state magnetic properties suffer deviation from the expected regular-Heusler framework [3].

Keywords: Heusler alloys, Reverse-Heuslers, Magneto-transport, Metastability.

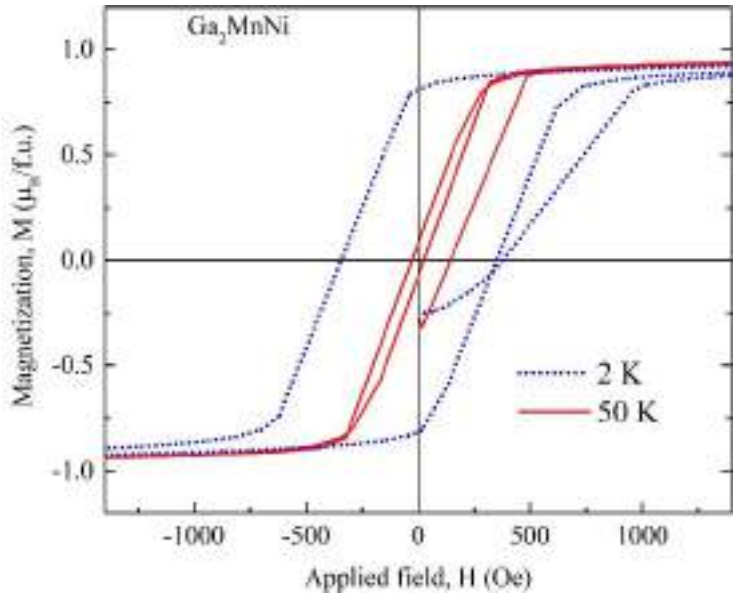


Fig. 1: Field dependent magnetization of Ga_2MnNi at 2 K and 50 K.

References:

[1] J. L. Wang, L. Ma, M. Hofmann, J. Appl. Phys., 115, 17A904 (2014).

[2] S. R. Barman, Aparna Chakrabarti, Sanjay Singh, Phys. Rev. B, 78, 134406 (2008).

[3] T. Samanta et.al., J. Phys. Chem. C ,126, 17670−17679 (2022)

Abstract ID: 245

DATA-DRIVEN MODELING OF MAGNETIC ORDERING AND SPIN INTERACTIONS IN ADVANCED MAGNETIC MATERIALS

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Abstract: Magnetic ordering and spin interactions play a fundamental role in determining the performance of advanced magnetic materials used in spintronic devices, memory technologies, and energy systems. Conventional methods such as density functional theory, micromagnetic modeling, and exchange interaction analysis provide detailed understanding of magnetic behavior but are computationally intensive and difficult to scale across diverse material systems. Recent data-driven approaches have largely focused on predicting bulk properties such as Curie temperature, magnetization, and anisotropy, while limited emphasis has been placed on modeling the interaction mechanisms that govern spin alignment and ordering transitions. In this work, a data-driven modeling framework is developed to examine how structural parameters and magnetic descriptors influence spin exchange interactions and phase stability. Spin coupling is represented using the Heisenberg exchange formulation $H = -\sum_{ij} SiSj$, magnetization response is analyzed using $M = \chi H$, and temperature-dependent ordering behavior is studied through $M(T) \propto (1 - \frac{T}{Tc})\hat{}\beta$. The model evaluates relationships between exchange interaction strength, spin configuration stability, and ordering transitions across different magnetic material systems. Results indicate that capturing non-linear dependencies between structural characteristics and interaction energy improves the representation of magnetic phase evolution and stability. The proposed approach enables computationally efficient analysis of spin-driven magnetic behavior and provides a scalable framework for understanding and optimizing advanced magnetic materials for next-generation spin-based and memory device applications.

Keywords: Magnetic ordering, Spin interactions, Exchange coupling, Phase transitions, Magnetic materials.

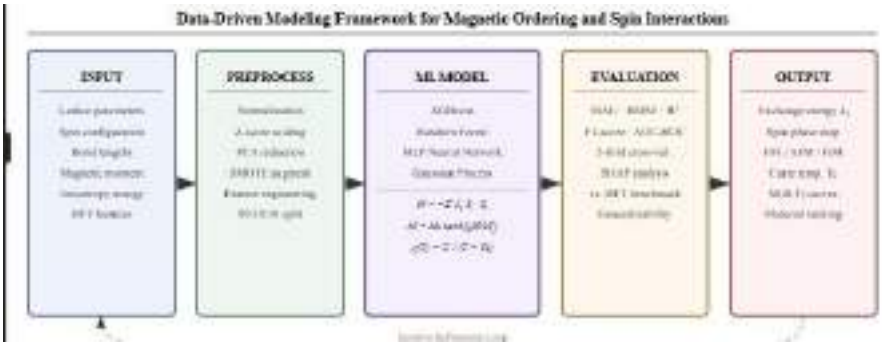


Fig. 1: Proposed data-driven framework for modeling magnetic ordering and spin interactions in advanced magnetic materials.

References:

[1] C. Mera Acosta, E. Ogoshi, J.A. Souza, G.M. Dalpian, *ACS Appl. Mater. Interfaces* 14 (2022) 9855–9866.
[2] P. Singh, T. Del Rose, A. Palasyuk, Y. Mudryk, *Chem. Mater.* 35 (2023) 6304–6312

Abstract ID: 246

ALTERMAGNETISM IN TRANSITION METAL DICHALCOGENIDES

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Abstract: Altermagnetism is a recently proposed magnetic phase characterized by zero net magnetization but momentum-dependent spin splitting arising from crystal symmetry [1]. This distinguishes it from conventional antiferromagnets and makes it promising for spintronic applications. Transition metal dichalcogenides (TMDs), owing to their layered structure and tunable electronic properties, provide a suitable platform for exploring such unconventional magnetic states. In this work, high-quality single crystals of selected magnetic TMD compounds were successfully grown using the chemical vapor transport (CVT) technique. The crystal structure and phase purity were confirmed by powder and single-crystal X-ray diffraction (XRD), which showed excellent agreement with the expected structure. Elemental composition and stoichiometry were verified using energy-dispersive X-ray spectroscopy (EDX), confirming uniform elemental distribution. To determine the magnetic ordering, neutron diffraction measurements were performed, revealing a compensated collinear magnetic structure consistent with symmetry conditions required for altermagnetism [1,2]. These experimental results provide strong evidence for the realization of altermagnetic behavior in TMD systems.

Keywords: Altermagnetism, Transition Metal Dichalcogenides, Single Crystal Growth, Neutron Diffraction, Spintronics.

References:

[1] L. Šmejkal et al., Nature 618, 481–487 (2023).
[2] I. I. Mazin et al., Phys. Rev. X 12, 031042 (2022).

Abstract ID: 247

INVESTIGATION OF MAGNETIC AND MAGNETO-TRANSPORT PROPERTIES OF FeMn FILMS THROUGH THICKNESS MODULATION

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Abstract: Thin-film of transition metal alloys have garnered substantial interest owing to their pivotal role in the advancement of spintronic devices, attributed to their distinctive magnetic and electronic functionalities. A series of FeMn films has been deposited on the (001) oriented Si, using RF magnetron sputtering under meticulously optimized deposition parameters. Structural elucidation through X-ray diffraction (XRD) analysis confirmed the oriented growth of the films, the absence of secondary phases, and characterized by well-defined diffraction peaks corresponding to the FCC phase of FeMn, signifying high crystallographic order. Atomic force microscopy (AFM) studies further corroborated the structural quality by revealing rough but smoother film surfaces, with roughness values quantified at the nanometer scale. Scanning electron microscopy (SEM) analysis confirmed the uniformity and continuity of the surface, highlighting the homogeneous film growth across the substrate. Collectively, the results from XRD, AFM, and SEM analyses underscore the high structural integrity, phase purity, and superior surface characteristics of the FeMn films, laying a robust foundation for subsequent device fabrication and exploration of their functional properties. Magnetotransport measurements were carried out using a Physical Property Measurement System (PPMS), while magnetic characterization was performed using a SQUID magnetometer. The films exhibit pronounced anisotropic magnetoresistance, with resistance strongly dependent on the orientation of the applied magnetic field relative to the film plane and spin configuration. SQUID-based M–H measurements reveal very low coercivity, confirming soft magnetic behaviour, and M–T data show an antiferromagnetic magnetic transition around 325 K near room temperature. The coexistence of tunable anisotropic transport and soft magnetic characteristics highlights the potential of FeMn thin films for spintronic applications.

Keywords: RF Sputtering, Thin Films, Magnetoresistance, Magnetic Ordering, Binary Transition Metal Alloy.

Abstract ID: 248

SYNTHESIS AND MAGNETIC PROPERTIES OF $Gd_2Ni_{0.90}Ge_{2.90}$

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Abstract: A new ternary intermetallic compound $Gd_2Ni_{0.90}Ge_{2.90}$ was synthesized using the arc melting method. Powder X-ray diffraction (XRD) analysis revealed that the compound crystallizes in the hexagonal AlB_2-type structure with space group *P6/mmm* (No. 191) having lattice parameters $a = b = 4.0889(1)$ Å and $c = 4.0815(2)$ Å [1]. During the synthesis, multiple phases were detected in the fully stoichiometric compound Gd_2NiGe_3, prepared by the arc melting process. A single-phase material was obtained only when vacancies were introduced at both the Ni and Ge sites, leading to the defect composition $Gd_2Ni_{0.90}Ge_{2.90}$. DC magnetization measurements of $Gd_2Ni_{0.90}Ge_{2.90}$, performed under zero-field-cooled (ZFC) and field-cooled (FC) protocols at an applied magnetic field of 0.5 kOe, revealed that the system undergoes a paramagnetic to antiferromagnetic transition below the Néel temperature T_N = 8.9K [2]. The estimated Curie–Weiss temperature θ_{CW} = –13 K, indicates the presence of dominant antiferromagnetic interaction in this compound and the compound is moderately frustrated with frustration parameter $f \approx 1.5$.The temperature dependence of DC magnetization under the FC protocol at various applied magnetic fields shows that no field-induced effects are observed up to 2 kOe, while such effects appear at higher fields for H ≥20 kOe. The effective paramagnetic moment, calculated using the Curie–Weiss law from the inverse magnetic susceptibility, is 7.94(1) μ_B per Gd ion, which is in close agreement with the theoretical free-ion value ($\mu_{theo} = g_J\sqrt{J(J+1)} = 7.94\ \mu_B$), confirming that the localized 4*f* electrons ($S = 7/2$) are primarily contributing to the magnetic behavior. A λ-type peak is also observed at T_N in the zero-field heat capacity behavior, confirming the long-range nature of the magnetic ordering [3].

Keywords: Intermetallic Compound, arc melting process, zero-field-cooled, field-cooled, magnetic ordering, localized 4*f* electrons.

References:

[1] Pakhira, Santanu, et al. Physical Review B 94.10 (2016): 104414.
[2] Chen, J. W., et al. Journal of Physics: Conference Series. Vol. 266. No. 1. IOP Publishing, (2011).
[3] Litzbarski, L. S., et al. Physical Review B 105.5 (2022): 054427.

Abstract ID: 249

STUDY OF NOISE PERFORMANCE AND MAGNETIC FIELD RESOLUTION LIMITS IN xMR SENSORS

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Abstract: Magnetoresistive (MR) sensors, such as multilayer giant magnetoresistance (ML-GMR), Spin-valve giant magnetoresistance (SV-GMR) and tunnel magnetoresistance (TMR) sensors are used for wide range of magnetic field-sensing applications. Most of these applications demand the suppression of low-frequency sensor noise, largely governed by electrial and magnetic 1/*f* noise. Also, other noises like thermal noise, shot noise, random telegraph noise (RTN) contributes significantly and limits sensor's performances.

In this work, noise characteristic of ML-GMR, SV-GMR and TMR sensor having linear and bipolar magnetic sensing mechanism were studied. Also, these sensors were configured in Wheatstone bridge (WSB) formation to have differential voltage output [1]. Typical sensitivity of ML-GMR, SV-GMR and TMR sensors are 0.2, 0.7 and 103 mV/V/Oe respectively [1,2]. Noise spectra of ML-GMR, SV-GMR and TMR sensors were measured using a spectrum analyzer, with the Low Noise Preamplifier (LNPA) gain set to 60dB and a bias voltage of 1.2V. It was observed that ML-GMR and SV-GMR sensors exhibited the lowest noise density, 24nV/√Hz and 26nV/√Hz respectively at 10Hz. In contrast, the TMR sensor showed noise level ~370nV/√Hz at 10Hz. The effective 1/f noise due to various phenomena, including charge trapping in the barrier layer, spin-dependent scattering, random magnetization switching, domain wall motion, the tunnelling effect in TMR, and other electric and magnetic effects may be responsible for such high noise in case of TMR. Considering high senitivity of TMR sensor, it showed lowest detectivity 0.63nT/√Hz at 1Hz as compared to GMR sensors (24nT/√Hz for the ML-GMR and 5.5nT/√Hz SV-GMR at 1Hz).

Keywords: Tunnelling Magneto-resistance (TMR), Giant Magneto-resistance (GMR), Multilayer (ML-GMR), Spin Valve (SV-GMR), Noise density, Detectivity.

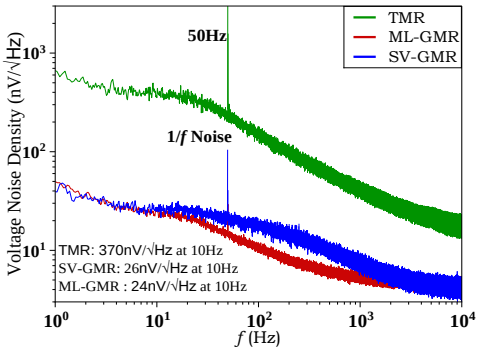


Fig. 1: Noise spectra of TMR and GMR sensors.

References:

[1] A. Kaul, Gopika C T, B. Behera, J. Khan, P. Chowdhury. Physica Scripta, 100(9) (2025) 095960.
[2] T. C. Gawade, U. P. Borole, B. Behera, J. Khan, H.C. Barshilia, P. Chowdhury. Journal of Magnetism and Magnetic Materials, 587 (2023) 171234.

Abstract ID: 250

PLANAR HALL EFFECT IN EPITAXIAL Sb_2Te_3 THIN FILMS FOR MAGNETIC FIELD SENSING

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Abstract: Anisotropic magnetoresistance (AMR) and the planar Hall effect (PHE) are widely used for magnetic-field sensing, typically relying on ferromagnetic materials that introduce hysteresis, stray fields, and thermal instability. Here we demonstrate a robust and tunable PHE response in nonmagnetic epitaxial Sb_2Te_3 thin films, enabled by strong spin-orbit coupling and anisotropic charge transport. High-quality epitaxial films grown on c-plane sapphire exhibit growth-temperature-dependent transport ranging from metallic behavior to variable-range hopping, allowing systematic control of carrier concentration and disorder. Under in-plane magnetic fields up to 9 T, the films display pronounced AMR and a clear sinusoidal PHE with quadratic field dependence [1]. The PHE magnitude reaches ~–73 nΩ·m at 9 T for the optimally grown film, exceeding by more than an order of magnitude the values reported for related tetradymite compounds such as Bi_2Te_3[2-3]. Hall measurements yield a mobility of ~10^2 cm² V^{-1} s^{-1} with a carrier density of ~10^{19} cm^{-3}, indicative of high electronic quality. The absence of ferromagnetism, together with a sizable room-temperature PHE response, establishes epitaxial Sb_2Te_3 as a promising platform for low-noise planar Hall magnetic-field sensors.

Keywords: Planar Hall effect, anisotropic magnetoresistance, Sb_2Te_3 thin films, thermoelectric chalcogenides, magnetic field sensing

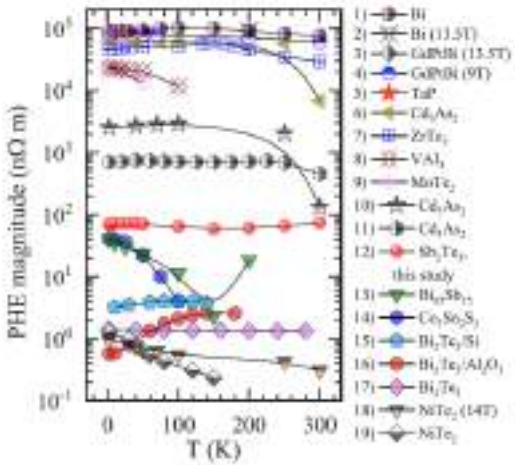


Fig. 1: Temperature-dependent planar Hall effect (PHE) magnitude $|\rho_{xy}|$ comparison of various materials from the literature.

References:

[1] R. Kumar, P. Bajracharya, P.H. Ashtiani, R. Paxson, R. Kolagani, R.C. Budhani, Phys. Rev. B **109** (2024) 075421.
[2] R. Nepal, V. Sharma, L. Pogue, N. Drichko, R.C. Budhani, Thin Solid Films **761** (2022) 139520.
[3] A. Bhardwaj, S. Prasad P., K.V. Raman, D. Suri, Appl. Phys. Lett. **118** (2021) 241901.

Abstract ID: 251

PSP LINKAGES AND MATERIAL INFORMATICS FOR MAGNETS

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Abstract: The transition toward sustainable energy technologies needs advanced hard and soft magnetic materials, yet balancing their complex Composition-Process-Structure-Property relationships and electromechanical properties remains a challenge [1,2]. For hard magnets (REE-NdFeB systems), reducing heavy rare-earth elements (HREEs) through LREE substitution and eutectic grain-boundary engineering is important for supply-chain stability and high coercivity. Additionally, soft magnetic materials: specifically electrical steels and nanocrystalline alloys, require the simultaneous optimization of: high yield strength, ductility, electrical resistivity, and high saturation magnetization. To accelerate discovery across these diverse alloy systems, we use a thermodynamic computation combined machine learning (ML) framework. High-throughput CALPHAD [3] computations are deployed to map thermodynamic phase equilibria, solid-solution limits and other parameters. To overcome the sparsity of experimental data, a transfer learning is performed on CALPHAD datasets and fine-tuned using experimental databases. Inverse PSP relationships are also developed, which given a specific target property, give the input parameters. This engineering magnet material development approach helps to develop Composition-Process-Structure-Property optimization.

Keywords: ML, CALPHAD, magnetic materials, REE.

References:

[1] Rajesh Jha, Nirupam Chakraborti, David R. Diercks, Aaron P. Stebner, Cristian V. Ciobanu, Computational Materials Science, Volume 150, 2018, Pages 202-211, ISSN 0927-0256.

[2] Abe T, Morishita M, Chen Y, Saengdeejing A, Hashimoto K, Kobayashi Y, Ohnuma I, Koyama T, Hirosawa S. Sci Technol Adv Mater. 2021 Jun 4;22(1):557-570. doi: 10.1080/14686996.2021.1936627

[3] Chen Shen, Computational Materials Science, Volume 258, 2025, 113970, ISSN 0927-0256.

Abstract ID: 252

NONRECIPROCITY IN PHOTON–MAGNON COUPLED SYSTEM

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Abstract: Cavity magnonics provides a versatile hybrid framework that bridges photonics and spintronics for manipulating light–matter interactions in the microwave regime. However, integrating strong photon–magnon coupling with nonreciprocal signal transmission remains a fundamental challenge due to the requirements of symmetry breaking. In this our work, we demonstrated nonreciprocal photon–magnon coupling using a planar split-ring resonator (SRR) coupled to a yttrium iron garnet (YIG) film. This hybrid system is systematically investigated through full-wave electromagnetic simulations performed using CST Studio Suite and experimentally validated by microwave transmission measurements using a vector network analyzer (VNA) under an externally applied magnetic field [1]. Magnetically induced time-reversal symmetry breaking gives rise to direction-dependent microwave transmission, manifested as asymmetric coupling strengths and unequal mode hybridization for opposite propagation directions[2]. Distinct anticrossing features observed in the transmission spectra confirm the realization of strong and nonreciprocal coupling. Furthermore, we provide a non-Hermitian quantum theoretical framework to explain the observed anticrossing phenomenon due to photon-magnon interaction, which shows strong agreement with the simulation. The demonstrated approach establishes a robust and tunable cavity-magnonic platform for engineering nonreciprocal light–matter interactions. Our results pave the way toward scalable quantum transducers, reconfigurable microwave components, and compact on-chip nonreciprocal devices, highlighting the potential of cavity magnonics for next-generation microwave and quantum information technologies.

Keywords: SRR, Non-reciprocal, Hybrid device.

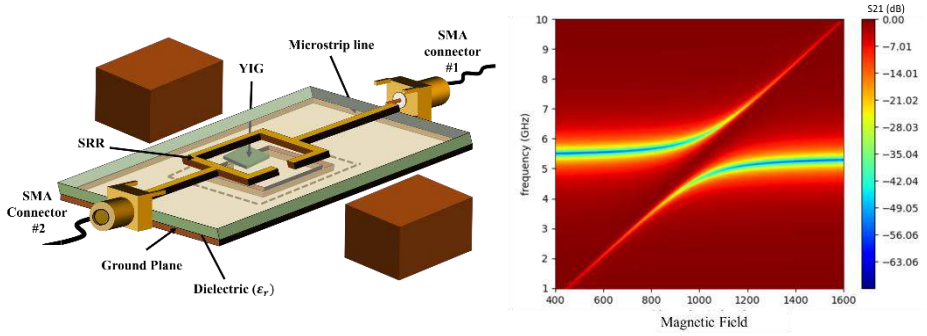


Fig. 1: Schematic of the SRR–YIG hybrid system and corresponding microwave transmission spectra, showing anticrossing behavior for nonreciprocal photon–magnon coupling.

References:

[1] B. Bhoi, B. Kim, S.-H. Jang, J. Kim, J. Yang, Y.-J. Cho, S.-K. Kim, Abnormal anticrossing effect in photon-magnon coupling, Phys. Rev. B 99 (2019) 134426, https://doi.org/10.1103/PhysRevB.99.134426

[2] Kim, J., Kim, B., Kim, B., Jeon, H. & Kim, S.-K. Magnetic-field controlled on-off switchable non-reciprocal negative refractive index in non-hermitian photon-magnon hybrid systems. Nat. Commun. 15,9014 (2024).

Abstract ID: 253

EFFECT OF EU-DOPING ON PHYSICAL PROPERTIES OF NANOCRYSTALLINE $La_{0.9}Ba_{0.1}MnO_3$

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Abstract: We examined the structural, morphological, and magnetic characteristics of the Sol-gel-synthesised $La_{0.85}Eu_{0.05}Ba_{0.1}MnO_3$ nanocrystalline compound in this work. The orthorhombic crystal structure with space group Pnma was confirmed by Rietveld refinement of X-ray diffraction data using FullProf software. The average crystallite size was determined to be approximately ~15 nm using the Scherrer method. Transmission electron microscopy (TEM) images show that the particles are spherical in shape and the average particle size is ~ 40 nm. The high-resolution TEM provides fringe width corresponding to planes, and the chosen area electron diffraction pattern validates the crystallinity. Under an external magnetic field of 0.05T, temperature-dependent magnetic measurements were performed in the temperature range of 2 to 300 K. The results showed that at about ~182 K, there was a ferromagnetic to paramagnetic phase shift. The paramagnetic Curie temperature (θp), which is around ~214 K, was calculated using the Curie-Weiss law. The magnetic moment's theoretical value was found to be around 4.81 μ_B/f.u., while the experimental value was approximately 7.89 μ_B/f.u. The M-H hysteresis loops exhibit paramagnetic behaviour at normal temperature and ferromagnetic behaviour at low temperatures at 300 K and 2 K. The M-H loop was also used to derive the coercivity and retentivity values, which are 0.0244 T and 19.59 emu/g, respectively, Fig.1(b). Implies the possibility of the sample functioning as a magnetic refrigerant.

Keywords: Perovskite oxides, Magnetic phase transition, X-ray diffraction, Crystal structure, etc

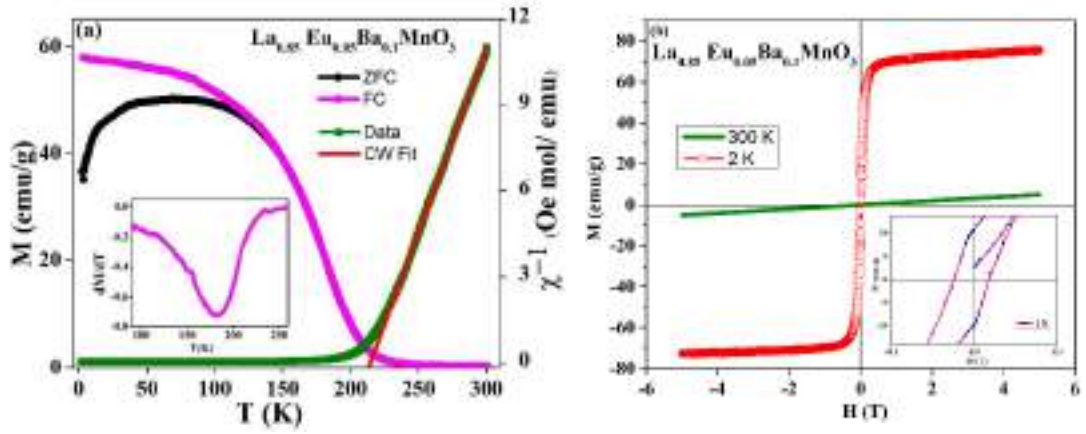


Fig. 1: (a) Magnetization vs temperature plots and Curie-Weiss fitting for $La_{0.85}Eu_{0.05}Ba_{0.1}MnO_3$ at 0.05T applied magnetic field. Inset shows the plots for derivatives (dM/dT vs. T). (b) M-H hysteresis loop at 2 K and 300 K. Inset shows zoomed 2 K Hysteresis loop.

Abstract ID: 254

REVIEW ON MAGNETIC PROPERTIES OF MnBi AND MnAl THIN FILMS

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Abstract: Permanent magnets are widely used in different industries, including electrical machinery, consumer electronics, computers, power production, wind energy, electric vehicles, and medical equipment. NdFeB and SmCo magnets are currently leading the market due to their remarkable qualities. But because of their heavy reliance on rare earth elements (REEs), these magnets are vulnerable to price swings and supply chain interruptions. Rare-earth-free (REF) magnets have attracted a lot of attention from academics and business experts as an alternative to permanent magnets based on REEs. Manganese-based compounds, notably Mn-Al and Mn-Bi, are among the REF magnets that have attracted attention owing to the economical availability of Mn and Al elements and their relatively strong magnetic characteristics. Mn-based magnets have been studied in various forms over the last few decades, including bulk magnets, thin films, and nanoparticles. MnAl alloys exhibit strong ferromagnetism and anisotropy, indicating a high potential for magnetic applications. MnBi alloys have sparked ongoing theoretical and practical study because of their high coercivity (Hc), unusual positive temperature coefficient of coercivity, and significant potential as REF magnets. However, there are difficulties with mass production because the magnetic τ-MnAl phase can only form in a very limited composition range of MnAl alloys. High-quality MnBi magnets are not readily produced commercially because of problems with their complicated microstructure and impurity phases, which result in subpar magnetic performance. This study explores the latest developments in permanent magnets based on non-rare-earth elements, MnBi and MnAl, and provides a thorough examination of their magnetic characteristics and uses.

Keywords: MnBi Alloy, MnAl Alloy, Ferromagnetism

References:

[1] D. Rajbanshi, N. Deka, S.C. Sarkar, S.K. Srivastava, Journal of Alloys and Compounds, 1037 (2025) 182388.
[2] B. Mallik, S.K. Srivastava, Next Materials, 10 (2026) 101501.
[3] P.Z. Si, Y. Yang, L.L. Yao, H.D. Qian, H.L. Ge, J. Park, K.C. Chung, C.J. Choi, Journal of Magnetism and Magnetic Materials, 476 (2019) 243.
[4] Shaochang Song, Youliang He, Journal of Magnetism and Magnetic Materials, 628 (2025) 17318.

Abstract ID: 255

MAGNETIC DROPLET STABILITY IN CONSTRICTION-BASED SPIN HALL NANO-OSCILLATOR

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Abstract: Magnetic droplet solitons are nonlinear, topologically trivial, and spatially localized dynamical excitations that can be nucleated in nanoscale magnetic devices possessing large perpendicular magnetic anisotropy (PMA) [1]. While their properties are well established in spin-torque oscillators, only a limited number of studies have investigated their dynamical behavior in spin Hall nano-oscillators (SHNOs) [2]. SHNOs are particularly attractive due to their high energy efficiency and scalability to large oscillator networks, making them promising candidates for neuromorphic computing applications. In this study, we investigate the magnetic droplet nucleation and dynamics in constriction-based W(5 nm)/CoFeB(1.4 nm)/MgO(2 nm) SHNOs (see Fig. 1(a)) using micromagnetic simulations. The material parameters employed are [3]: Saturation magnetization (M_s) = 0.93 T, Gilbert damping (α) = 0.023, exchange stiffness (A_{ex}) = 19 pJ/m, PMA field ($\mu_0 H_k^{\perp}$) = 1 T. Fig.1(b) shows the frequency and FFT amplitude distributions as a function of applied current for an applied field of 0.45 T at an angle of 80°; the orange dashed line marks the ferromagnetic resonance (FMR) frequency. The spectrum shows that the frequencies lie well below the FMR, emphasizing the localized nature of the excitation. For current values exceeding 1.65 mA, sidebands appear, which are associated with droplet drift and deformation. A magnetization snapshot at I_{dc} = 1.5 mA and magnetization z-component line profile along the x = 0 line, shown in Fig. 1(c) and (d), reveals total magnetization reversal, further confirming the formation of a magnetic droplet. We further investigate droplet stability and distinct dynamical modes, including unstable, propagating, and perimeter modes, as functions of the applied field, its angle, and PMA. We observe that, for a given PMA, droplets exhibit instability at lower fields and higher angles, whereas higher fields and lower angles promote stable droplets. Further tilt in the field towards in-plane leads to propagating droplet formation.

Keywords: magnetic droplet soliton, spin Hall nano-oscillator, pure spin current, side bands.

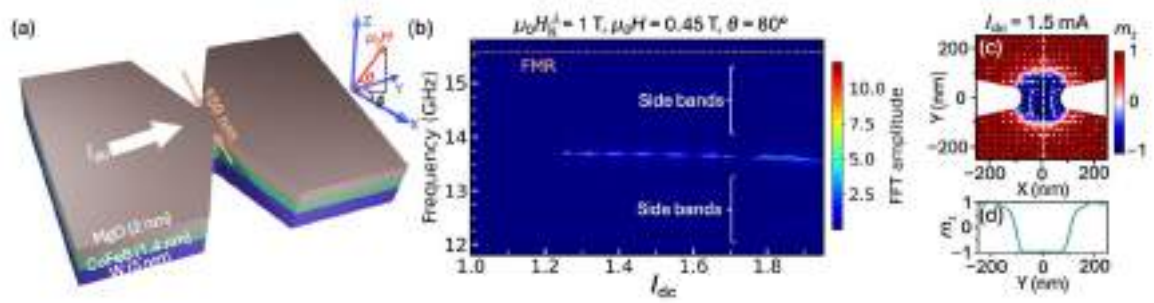


Fig. 1: (a) Schematic of trilayer SHNO device. (b) Frequency distribution as a function of applied current, the orange line shows ferromagnetic resonance (FMR) frequency. Magnetization snapshot and line profile for I_{dc} = 1.5 mA are shown in (c) and (d), respectively.

References:

[1] M. A. Hoefer *et al.* (2010) Phys. Rev. B **82**, 054432.
[2] B. Divinskiy *et al.* (2017) Phys. Rev. B **96**, 224419.
[3] H. Fulara *et al.* (2019) Sci. Adv. **5**,eaax8467.

Abstract ID: 256

TUNING STRUCTURAL, MORPHOLOGICAL AND MAGNETIC PROPERTIES VIA Mn DOPING IN $Na_2Co_{2-x}Mn_xTeO_6$

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Abstract: Honeycomb lattice oxides have significant attention due to their unique two-dimensional hexagonal crystal structure, inherent magnetic frustration leading to provide diverse magnetic properties. Mn-doped $Na_2Co_{2-x}Mn_xTeO_6$ (x = 0.0, 0.2, 0.4) compounds were synthesized via the conventional solid-state reaction route. The effect of Mn^{2+} (S = 5/2) substitution on the structural, morphological, and magnetic properties was systematically investigated using X-ray diffraction (XRD), FESEM–EDX, X-ray photoelectron spectroscopy (XPS), and through magnetic measurements. Rietveld refinement of the XRD data (shown in fig. a and b) confirms the $P6_322$ structure. This structure comprises $[M_2TeO_6]^{4-}$ ($M = Co_{2-x}Mn_x$) honeycomb layers formed by edge-sharing octahedra of MO_6 and TeO_6[1]. Mn subtitution affects the lattice along the c-axis, increasing the lattice constant along the c-direction from 11.214 Å to 11.254 Å. FESEM analysis reveals uniform grain morphology preserved across all doping levels, while EDX confirms stoichiometric elemental composition. XPS spectra verify that both Co and Mn are stabilized in the +2-oxidation state. Fig. c and d depict magnetization measurements under zero-field-cooled (ZFC) and field-cooled (FC) protocols at 500 Oe for the parent compound and 0.2 substitutions repsctively. It further shows that Mn doping suppresses the Néel temperature (T_N) from 26.8 K (x = 0.0) to 24 K (x = 0.2), indicating that the strength of magnetic interactions decreases within the honeycomb lattice [2].

Keywords: Honeycomb lattice oxides; XRD, Antiferromagnetism; Solid-state synthesis.

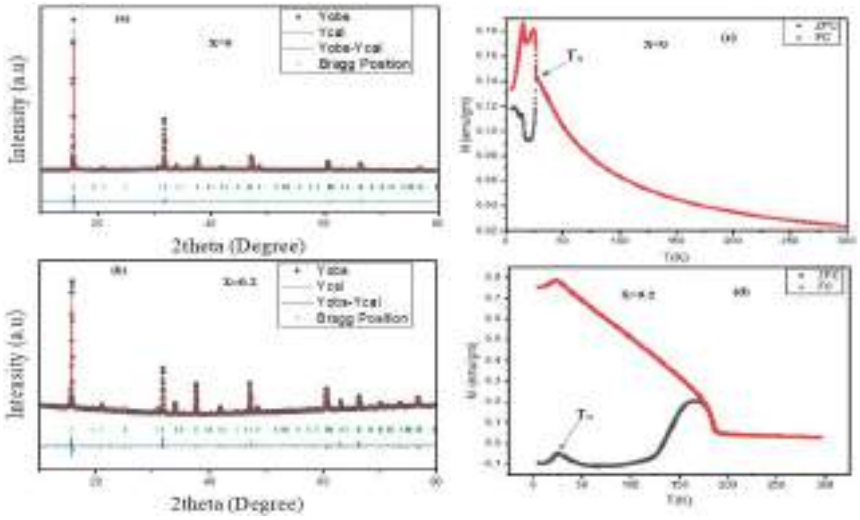


Fig. 1: (a), (b) XRD pattern of $Na_2Co_{2-x}Mn_xTeO_6$ (x=0,0.2) and (c), (d) Temperature dependence of magnetization measured at 500Oe for $Na_2Co_{2-x}Mn_xTeO_6$ (x=0,0.2).

References:

[1] L. Viciu et al .,Eur. Phys. *J. B*, vol. 86, 2013.

[2] Yadav et al., J. Phys. Chem. Solid, 163(2022),110559.

Abstract ID: 257

EFFECT OF DEPOSITION TEMPERATURE ON STRUCTURAL AND MAGNETIC PROPERTIES OF Co_2MnSi THIN FILMS

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Abstract: Heusler compounds are magnetic intermetallic with an FCC structure, classified as half-Heusler (XYZ) or full-Heusler (X_2YZ). X and Y are transition metals, and Z is a semiconductor or insulator. They are expected to show half-metallic ferromagnetism, making them promising for spintronic applications, but even slight antisite disorder can destroy this property, emphasising the importance of characterising samples for disorder. In this work, Co_2MnSi thin films were deposited on C-plane sapphire substrates by DC magnetron sputtering from an alloy target at various substrate temperatures to achieve an ordered structure. X-ray diffraction (XRD) analysis confirms the formation of the $L2_1$ phase in the film grown at 400 °C. Correspondingly, vibrating sample magnetometry (VSM) showed a systematic variation of saturation magnetisation with deposition temperature, underscoring the sensitivity of the magnetic moment to atomic ordering[1]. To explore the dynamic response, ferromagnetic resonance (FMR) measurements were performed, revealing not only the uniform precession mode but also an additional resonance mode, identified as the perpendicular standing spin wave (PSSW) mode. The PSSW mode dependence on deposition temperature highlights the link between structural ordering and magnetic properties of Co_2MnSi thin films [2].

Keywords: Heusler alloy, half metallic, structural ordering, magnetisation, Perpendicular standing spin wave.

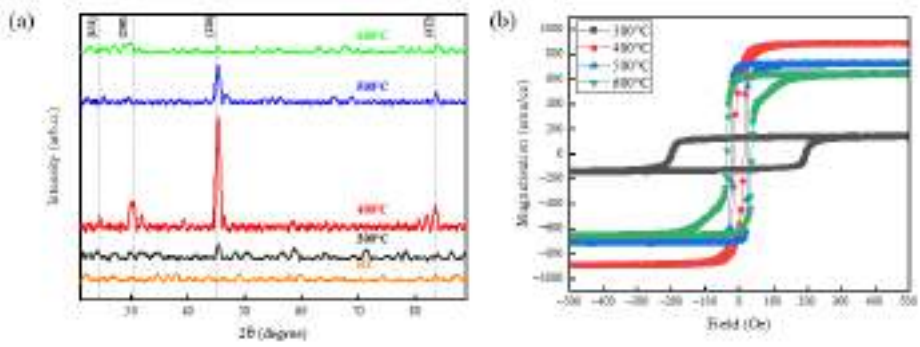


Fig. 1: (a) GI-XRD for the room temperature and high temperature deposited samples and (b) M-H loops from VSM.

References:

[1] H. Liu, M. Tang, B. L. Guo, C. Jin, P. Li, and H. L. Bai, *Appl Phys A Mater Sci Process*, vol. 121, no. 1, pp. 141–148, Oct. 2015, doi: 10.1007/s00339-015-9397-4

[2] B. Samantaray, A. K. Singh, C. Banerjee, A. Barman, A. Perumal, and P. Mandal, *IEEE Trans Magn*, vol. 52, no. 7, Jul. 2016, doi: 10.1109/TMAG.2016.2520981

Abstract ID: 258

MULTIFUNCTIONAL INVESTIGATION OF RARE-EARTH IRON GARNETS

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Abstract: Among functional materials, garnets stand out for their structural versatility and multifunctional properties. Their enduring prominence arises from both their intrinsic physical richness and their adaptability to advancing technological demands. A prominent subclass, Rare Earth Iron Garnets (RIGs), described by $R_3Fe_5O_{12}$ (R = rare-earth element), has attracted sustained interest owing to its structurally tunable magnetic and electronic behavior. They possess an exceptional combination of low dielectric loss, high electrical resistivity, narrow ferromagnetic resonance linewidth, tunable magnetic compensation, pronounced magneto-optical response, and strong thermal and mechanical stability. In the present study, a series of RIG (R = Y, Eu, and Gd) were synthesized to systematically investigate their structural and magnetic characteristics. Substitution with rare-earth ions possessing partially filled $4f^n$ configurations introduces distinctive magnetic behavior arising from their localized electronic states. The 4f electrons are effectively shielded from the crystal field by the outer 5s, 5p, and 5d orbitals, thereby preserving strong spin–orbit coupling and contributing to unique magnetic responses. The samples were synthesized through a conventional solid-state reaction approach. Detailed structural analysis via X-ray diffraction (XRD), complemented by Rietveld refinement, confirmed the formation of a single-phase body-centered cubic garnet structure with space group *Ia–3d*. Room-temperature magnetic characterization was subsequently performed using a vibrating sample magnetometer (VSM), with magnetization evaluated under external magnetic fields up to 5000 Oe. The confirmed structural integrity and magnetic response highlight the synergistic properties that enable their widespread use in advanced microwave systems, precision filters, oscillators, spintronic applications, phase shifters, and magneto-optical technologies.

Keywords: Rare-Earth Iron Garnet, spin-orbit coupling, spintronics, magneto-optical technologies

Abstract ID: 259

Cr SUBSTITUTION-INDUCED CLUSTER-GLASS BEHAVIOR AND ENHANCED MAGNETOCALORIC RESPONSE IN LITHIUM SPINEL MANGANATE

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Abstract: We report a systematic investigation of the structural, electronic, magnetic, and magneto-caloric properties of polycrystalline $Li_{0.5}MnCr_{1.5}O_4$ synthesized via a conventional solid-state route. Rietveld refinement of room-temperature X-ray diffraction data confirms a single-phase cubic spinel structure (space group Fd-3m) [1], consistent with SAED results, indicating high crystallinity and phase purity. Williamson–Hall analysis yields an average crystallite size of ~98 nm with negligible microstrain, while FESEM micrographs reveal micron-sized grains characteristic of bulk polycrystalline materials. X-ray photoelectron spectroscopy establishes mixed Mn^{3+}/Mn^{4+} valence states and stable Cr^{3+} ions, suggesting charge compensation and partial cationic disorder within the spinel lattice. Optical absorption measurements indicate a direct band gap of 2.78 eV. Temperature-dependent resistivity exhibits insulating behavior at low temperatures and semiconducting characteristics above 215 K, following Mott's variable-range hopping mechanism, indicative of small-polaron transport. DC magnetization measurements reveal two magnetic transitions arising from competing super-exchange interactions, accompanied by pronounced ZFC–FCC irreversibility. The field dependence of the irreversibility temperature follows the de Almeida–Thouless line [2], supporting glassy magnetic dynamics. Frequency-dependent ac susceptibility, Mydosh parameter analysis, dynamic scaling, and stretched-exponential relaxation collectively confirm the formation of a cluster-glass state with a freezing temperature near 28.7 K. The magnetocaloric effect shows a maximum entropy change of ~2.01 J kg^{-1} K^{-1} and a relative cooling power of ~60 J kg^{-1} at 7 T. These results highlight the role of Cr substitution in stabilizing cluster-glass behavior and enabling tunable low-temperature magnetic refrigeration and spin-functional applications.

Keywords: Cluster-glass, Solid-state route, Magnetocaloric, SAED, Variable-range hopping.

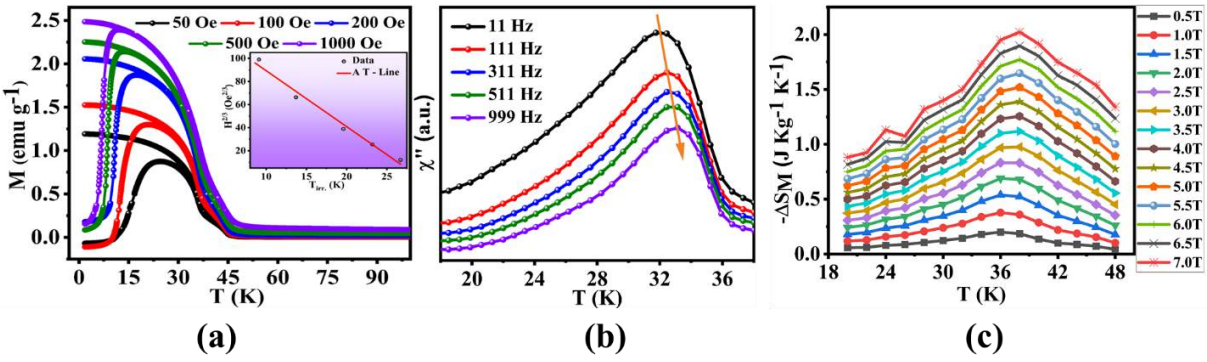


Fig. 1: (a) M-T plots at different field and inset shows A-T plot, (b) Temperature dependence of the ac susceptibility, (C) Temperature dependence of the magnetic entropy change.

References:

[1] M Ghanathe, AK Bera, A Kumar, SM Yusuf, ACS Applied Electronic Materials, *4*(1) (2022): 394-405.
[2] RC Sahoo, Y Takeuchi, A Ohtomo, Z Hossain, Physical Review B, *100*(21) (2019): 214436.

Abstract ID: 260

FIRST PRINCIPLE STUDY OF ALTERMAGNET BAND STRUCTURE SPIN-SPLITTING FOR SPINTRONIC APPLICATION

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Abstract: Recent developments have introduced a major breakthrough in the field of collinear magnetism named "altermagnetism." Unlike conventional magnetism, it breaks. Time-reversal symmetry, alternating spin splitting band structure, without having net magnetization. Altermagnetism combines the good qualities of both the ferromagnet and antiferromagnet, thereby facilitating phenomena and functionalities previously not achievable by these conventional categories. In this work, we have considered different materials with different Hubbard-U parameters and calculated the band structure with and without Spin-Orbit Coupling (SOC). The band structure without SOC shows momentum-dependent splitting. This unconventional splitting and degeneracy at certain k points are explained by the group theory analysis of the system. The Fermi surface result, the longitudinal spin current, and the transverse spin current can be used for spintronic applications.

Keywords: Altermagnetism, spintronics, Density-Functional Theory (DFT), Spin-splitting

References:

[1] L. Šmejkal, Jairo Sinova, Tomas Jungwirth, Physical Review X, 12, 040501 (2022).
[2] Pengfei Liu, Jiayu Li, Jingzhi Han, Xiangang Wan, Qihang Liu, Physical Review X, 12, 021016 (2022).

Abstract ID: 261

INVESTIGATION OF MAGNETODIELECTRIC EFFECT IN Y-TYPE BARIUM HEXAFERRITE VIA SOL-GEL METHOD

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Abstract: This paper examined the structural, electric, and magnetic characteristics of polycrystalline Y-type hexaferrite $Ba_2Mg_2Fe_{12}O_{22}$ (BMFO). A sol-gel auto-combustion process was used to prepare BMFO. Rietveld refinement of the X-ray diffraction pattern confirms the phase purity with the hexagonal crystal structure (*R*-3*m* space group). The temperature dependence of electrical resistivity suggested polaronic hopping conduction with an activation energy of 0.21 eV. A temperature-dependent magnetic study observed a phase change at 516 K (Curie temperature). At room temperature, BMFO behaves as a ferrimagnetic material with a magnetization of ~20 emu/g. As the temperature decreases, the material exhibits two types of spin reorientation transitions. It's a magnetic, mature transition from ferrimagnetic order to proper screw type (195 K) and from proper screw to longitudinal conical (35 K). In the BMFO a switching behavior of the dipole in the magnetic field is observed. The observed MD% at the highest magnetic field of 13 kOe is 0.1% at room temperature.

Reference:

[1] N. A. Hill, *J. Phys. Chem. B*, vol. 104, no. 29, pp. 6694–6709, Jul. 2000, doi: 10.1021/jp000114x.

Abstract ID: 262

ELECTRONIC AND PHYSICAL PROPERTIES OF TOPOLOGICAL NODAL-LINE SEMIMETAL CANDIDATE CoSbTe

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Abstract: In recent years, topological materials have attracted significant attention in condensed matter physics due to their exotic physical properties arising from unique, non-trivial topological band structures [1]. Single crystals of CoSbTe were investigated through comprehensive experimental and theoretical studies, including first-principles density functional theory calculations, magnetization, heat capacity, magnetotransport, neutron diffraction, and Mössbauer spectroscopy measurements. The electronic structure calculations reveal band inversion with nodal-line–semimetal-like crossings near the Fermi level, while surface spectral function analysis confirms the presence of topological surface states, indicating a non-trivial bulk topology. Magnetic measurements demonstrate a non-magnetic ground state with minor paramagnetic contributions arising from trace Co^{2+} impurities. Neutron diffraction and Mössbauer results further confirm the absence of long- or short-range magnetic ordering down to liquid helium temperatures. Electrical resistivity exhibits metallic behavior with a large residual resistivity and low residual resistivity ratio. At low temperatures, the resistivity deviates from conventional T^2 Fermi-liquid behavior, likely due to significant structural disorder or defects. Transverse magnetoresistance shows a small, non-saturating, quasi-linear field dependence, and Hall measurements indicate electron-dominated charge transport [2]. These results establish CoSbTe as a promising topological nodal-line semimetal candidate, offering potential for future exploration of topological phenomena and spintronic applications.

Keywords: Single crystal,topological nodal semimetal, band inversion, Fermi level.

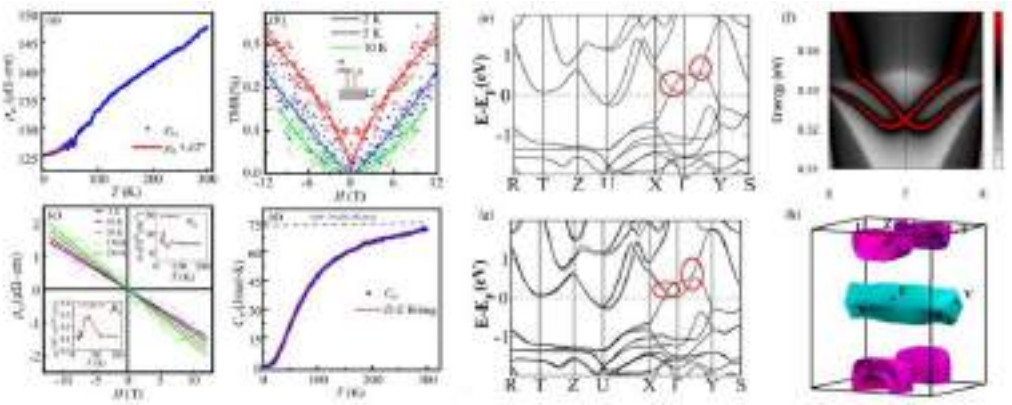


Fig. 1: (a-d) Magnetotransport and heat capacity measurements of CoSbTe. (e-h) Density functional theory results established topological nodal line semimetal.

References:

[1] B. Yan, C. Felser, Annual Review of Condensed Matter Physics 8, 337 (2017).
[2] V. K.Tiwari, A. Choudhury, et al., *Phys. Rev. B* (accepted); 2026.

Abstract ID: 263

TUNEABLE PHOTON-MAGNON HYBRIDIZATION IN A PLANAR SPLIT-RING RESONATOR-YIG ARCHITECTURE

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Abstract: In the last two decades, researchers' interest in utilizing the complementary properties of individual components in hybrid quantum systems for developing new technologies and quantum devices such as quantum sensors, memories, logic gates, and nonreciprocal devices has increased enormously. A photon-magnon hybrid system is one such example, usually implemented with yttrium iron garnet (YIG) and a microwave cavity that can be either a 3D cavity or a planar 2D resonator. In our work, we have studied photon-magnon coupling using a planar split-ring resonator and YIG thin-film system excited by travelling microwave photons in a microstrip line. The schematic diagram of the experimental setup is presented in the Figure 1(a). Coupling strength of the hybrid system was studied using $|S_{21}|$ transmission spectra and compared to the configuration where only one YIG film was placed on one arm of the resonator. The frequency versus magnetic field graph clearly indicated reduced and shifted coherent coupling in the system, as shown in Figure 1(b). For the simulation and optimization work the CST Microwave studio was used. Further, the change in coupling strength was studied at different angles of the applied static magnetic field. A comprehensive theoretical quantum model is presented explaining the observed coherent photon-magnon coupling (PMC). This study can further be extended for observing nonreciprocal behavior and potential applications.

Keywords: Hybrid quantum system, photon-magnon coupling, coherent coupling, nonreciprocal.

(a) (b)

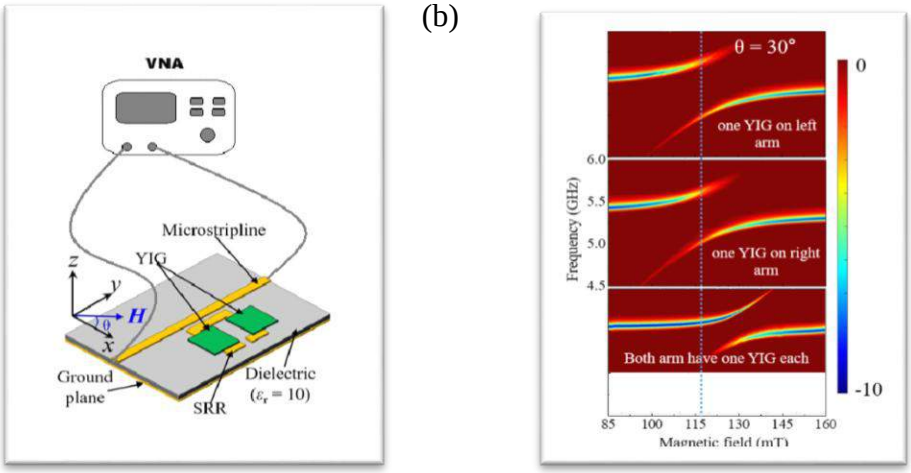


Fig. 1: (a) Schematic representation of experimental setup. (b) $|S_{21}|$ transmission spectra comparing PMC in single YIG and dual YIG configuration.

Abstract ID: 264

EFFECT OF SODIUM PERCHLORATE ADDITIVE ON SOFT MAGNETIC PROPERTIES AND MAGNETOIMPEDANCE RESPONSE OF ELECTRODEPOSITED NiFe/Cu COMPOSITE WIRES

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Abstract: The magnetoimpedance (MI) effect, characterized by the variation of electrical impedance of a soft magnetic conductor under an external magnetic field, has gained significant attention due to its promising applications in magnetic sensing technologies. Since its discovery in amorphous ferromagnetic wires, MI behaviour has been extensively investigated in thin films and composite wire systems where impedance variation is governed by magnetic-field-dependent skin depth controlled by transverse magnetic permeability [1,2]. Improvement in MI performance is strongly associated with enhanced magnetic softness and optimized domain dynamics, which can be effectively tuned through electrolyte engineering during electrodeposition. In this work, sodium perchlorate ($NaClO_4$) is introduced as an inorganic additive in the electroplating bath to modify the structural and magnetic properties of electrodeposited NiFe coatings on copper wire substrates. The presence of perchlorate ions improves ion transport and deposition uniformity, leading to favorable microstructural evolution and enhanced transverse permeability arising from domain wall motion and spin rotation mechanisms. As a result, significant enhancement in magnetoimpedance ratio and magnetic field sensitivity is achieved at an optimum additive concentration. The study demonstrates that sodium perchlorate-assisted electrodeposition provides an effective pathway for tailoring MI response, making NiFe/Cu composite wires suitable for low-field magnetic sensor applications.

Keywords: Magnetoimpedance, Electrodeposition, NiFe thin films, Sodium perchlorate, Magnetic sensors.

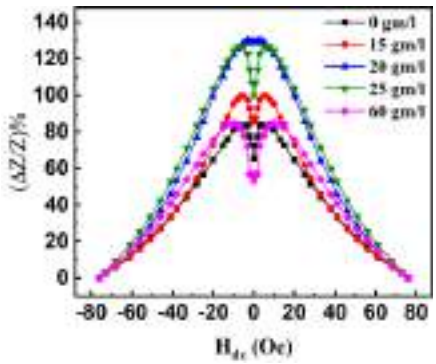


Figure 1: Magnetoimpedance response of electrodeposited NiFe/Cu composite wires with varying sodium perchlorate concentrations measured at an excitation frequency of 200 kHz.

References:

[1] N.Usov, A.Antonov, A. Lagarkov, Theory of giant magneto-impedance effect in amorphous wireswith different types of magnetic anisotropy, Journal of Magnetism and Magnetic Materials 185 (1998) 159–173.
[2] M. H. Phan, H. X. Peng, Giant magnetoimpedance materials: Fundamentals and applications, Progress in Materials Science 53 (2008) 323–420.

Abstract ID: 265

STRUCTURAL, MICROSTRUCTUAL AND FERROELECTRIC PROPERTIES OF POLYCRYSTALLINE $BiFeO_3$ THIN FILMS

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Abstract: In this work, the structural, microstructural, and ferroelectric properties of polycrystalline $BiFeO_3$ (BFO) thin films grown using RF sputtering deposition method are systematically explored. Quasi-static current-voltage (I-V), dynamic polarisation – electric field, and leakage current measurements, magnetoresistance were used to explain the ferroelectric properties with respect to electric field amplitude, frequency, and magnetic field. Further, the applicability of the BFO thin films for controlling w.r.t electric field and magnetic field in exchange-biased spin valves will be presented. While epitaxial BFO heterostructures have been widely explored, exchange-biased spin valve architectures employing polycrystalline BFO remain largely unexplored. In this work, we also propose and investigate novel spin valve structures of Co/BFO/Co and Co/PVDF/BFO/Co, where BFO is deposited as a polycrystalline thin film via RF sputtering. Further, interfacial exchange coupling between ferromagnetic Co and antiferromagnetic BFO, the possibility of electric-field modulation of magnetoresistance through ferroelectric polarization switching is addressed. In Co/PVDF/BFO/Co configuration, the inclusion of ferroelectric Polyvinylidene fluoride (PVDF) is expected to enhance spin filtering and enable additional polarization control over interfacial spin alignment. The results could open pathways toward electrically tunable exchange-biased spintronic devices operating at room temperature.

Keywords: Multiferroic, Magnetoresistance, Spintronic device, Exchange bias

References:

[1] A. Hirohata, K. Yamada, Y. Nakatani, Review on spintronics: Principles and device applications, J. Magn. Magn. Mater. 509 (2020) 166711

[2] G. Catalan, J.F. Scott, Physics and applications of bismuth ferrite, Adv. Mater. 21 (2009) 2463–2485

[3] S.A.Wolf, D.D. Awschalom, R.A. Buhrman, J.M. Daughton, S.von Molnár, M.L.Roukes, A.Y. Chtchelkanova, D.M. Treger, Spintronics: A spin-based electronics vision for the future, Science 294 (2001) 1488–1495.

[4] P. Ravi Teja, Ferroelectric influence upon magnetoresistance in Ag/Co/PVDF/Co spin valves, J. Appl. Phys. 105 (2009) 07C713

Abstract ID: 266

ANGULAR TUNABILITY OF SPIN WAVE DYNAMICS IN NANOSCALE BICOMPONENT MAGNETIC FRACTALS

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Abstract: Quasiperiodic magnonic crystals, unlike their periodic counterparts, lack strict periodicity which gives rise to complex and localized spin-wave spectra characterized by numerous band gaps [1]. Fractals, with their self-similar structures across different length scales exemplifying dilation symmetry, are observed in nature through examples like thunderstorm lightning, snowflakes. The magnetostatic mode formation in an artificial magnetic fractal structure is related to their geometric scaling. Moreover, the spin-wave dynamics in Sierpinski triangle show the appearance of frequency gap with iteration number and its tunability with the orientation and strength of the external magnetic field, proposing their application in magnonic filters [2]. However, to achieve the spin-wave propagation in such magnetic fractals it is important to enhance the exchange coupling at the interface by introducing two different ferromagnetic materials. In this work, we have studied the magnetization dynamics of the bicomponent Sierpinski square structure consisting of CoFe inclusions within a NiFe matrix by solving the Landau-Lifshitz-Gilbert equation using micromagnetic simulations. The time domain magnetization data shows the presence of multiple small and wide frequency gaps. Additionally, the spatial profile of the spin-wave mode exhibits spin-wave channelling extended along the entire length of the structure, which was further fine-tuned by varying the azimuthal angle of external magnetic field, shown in figure 1(a & b). The inverse participation ratio was calculated to quantify spin-wave localization. These findings demonstrate the dependence of spin-wave propagation on iteration number and magnetic field orientation, highlighting the potential application of bicomponent Sierpinski square structure in reconfigurable magnonic devices [3].

Keywords: Magnetization dynamics, Spin-wave, Quasiperiodic, Magnonic Fractals

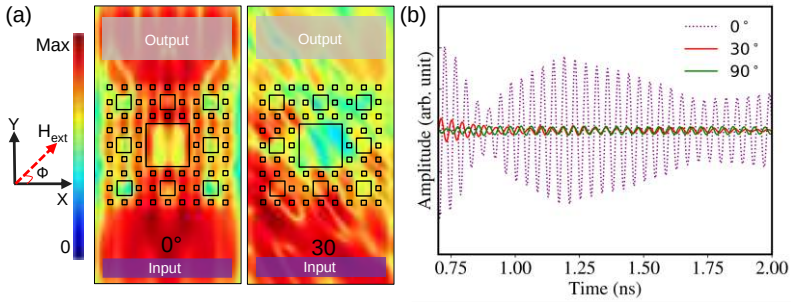


Fig. 1: (a) The simulated power profile of maximum intense spin-wave mode for third iteration and (b) the simulated amplitude of oscillation of spin-wave calculated at gery end.

References:

[1] R. Mehta, B. Rana, S. Saha, *J. Phys.: Condens. Matter* 36 (2024) 443003.
[2] R. Mehta, M. Moalic, M. Krawczyk, S. Saha, *J. Phys.: Condens. Matter* 35 (2023) 324002.
[3] R. Mehta, S. Saha, *Physical Rev. Applied 24 (2025) 054034.*

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Abstract ID: 267

ANGULAR DEPENDENCE OF PURE SPIN CURRENT ON THERMAL MAGNONS, MEASURED DIRECTLY USING MICRO-BLS

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Abstract: Manipulation and amplification of spin waves are crucial for advancing magnonic networks, which are key to next-generation data processing. In this study, we examine how pure spin current affects thermal magnons in a Permalloy (Py)/Tungsten (W) bilayer microwire, focusing on magnetic damping as a function of the angle between the applied DC current and the external magnetic field. A 20 mA current increases thermal magnon intensity by 26% and reduces the linewidth from 1.3 GHz (0 mA) to 1.0 GHz, indicating suppressed magnetic damping. The integral intensity–current relationship confirms that spin current modulates damping and enhances magnon population. Moreover, varying the angle (φ) between current and field from 0º to 90º causes the linewidth to decrease linearly from 1.75 GHz to 1.03 GHz at 20 mA. The relative linewidth difference between +20 mA and –20 mA grows from 7% at 0º to 26% at 90º, highlighting the angular dependence of spin-wave damping—an important insight for designing magnonic circuits.

Keywords: Magnons, Spin waves, Spintronics, Spin-orbit torque, Micro-Brillouin light scattering

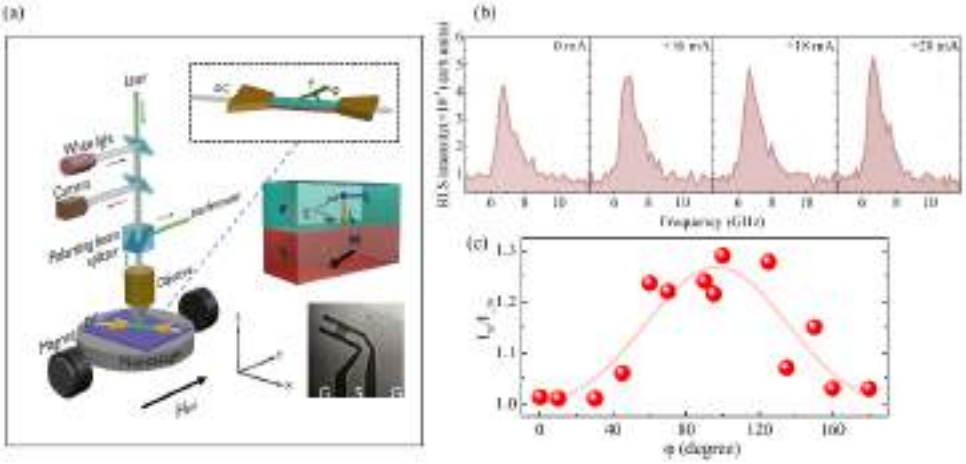


Fig. 1. a) schematic of the micro-BLS setup with sample geometry, and an optical image of the device, b) variation of BLS intensity with DC current, and c) the change in intensity ratio at +20 mA and –20 mA current with the angle φ.

Abstract ID: 268

THE ELECTRONIC AND MAGNETIC PROPERTIES OF TRANSITION METAL DOPED 2D In_2O_3 MONOLAYER FROM FIRST-PRINCIPLES CALCULATION

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Abstract: We present a systematic density functional theory (DFT) investigation of the effects of vacancy defects, and transition-metal (TM) doping on the electronic and magnetic properties of two-dimensional (2D) In_2O_3 monolayers. Pristine In_2O_3 is found to be a semiconductor with a band gap of 1.74 eV. Vacancy defects, although structurally destabilizing, significantly modify the magnetic response: indium vacancy induce localized magnetic moments of 3 μ_B, whereas oxygen vacancies lead to n-type conductivity without magnetism. In contrast, substitutional doping with 4d transition metals (Mo, Tc, Ru, Ag, and Cd) stabilizes the lattice and induces magnetism with magnetic moments of 1 μ_B, 2.66 μ_B, 1.22 μ_B, 2 μ_B, and 0.73 μ_B, respectively, while Pd-, Nb-, and Zr-doped systems exhibit metallic behavior. Spin-polarized electronic structure analysis reveals that Mo- and Cd-doped In_2O_3monolayers act as up-spin electron injectors, Ru-doped systems favor down-spin injection, and Tc- and Ag-doped monolayers function as up-spin hole injectors. The formation energy, Molecular Dynamics (MD), and phonon calculations confirm the stability of the monolayer with TM doping. These results demonstrate that controlled defect engineering, and TM doping provide effective pathways for tuning carrier type and magnetism in 2D In_2O_3, highlighting its potential for spintronic applications.

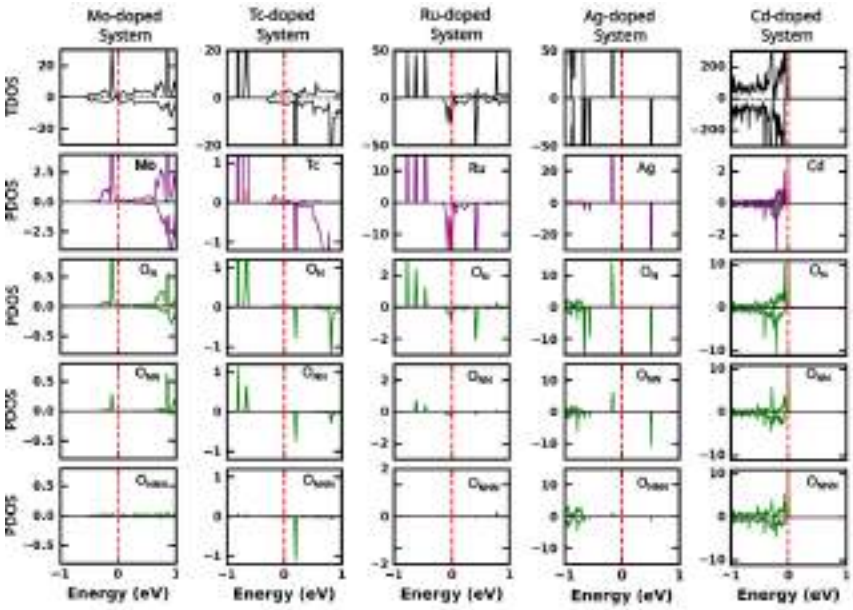


Fig. 1: Total and projected density of states of TM substituted In_2O_3 monolayer with magnetic moment. Density of states plot for (a) Cd, (b) Ru, (c) Tc, (d) Mo, (e) Ag dopants.

References:

[1] Hoang Van Ngoc et.al, RSC Advances, 2025, 15, 1020-1032.

Abstract ID: 269

ENHANCED MAGNETIC PROPERTIES THROUGH TAILORING OF MORPHOLOGY OF ELECTROSPUN STRONTIUM HEXAFERRITE NANOFIBERS

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Abstract: Hard hexaferrite based permanent magnets can be potential alternatives to rare-earth magnets in certain applications because of their wide availability, lower cost, and superior corrosion resistance. However, a critical challenge remains in the enhancement of remanent magnetization (M_r) and coercivity (H_c) to improve their magnetic performance for permanent magnet applications. One of the promising approaches to enhance the coercivity of magnetic materials is through the synthesis of anisotropic morphologies. This work presents an effective strategy for tailoring the morphology of M-type strontium hexaferrite ($SrFe_{12}O_{19}$, SFO) particles embedded within nanofiber structure. SFO were synthesized using a polymer–sol assisted electrospinning technique followed by subsequent calcination. XRD analysis confirms the formation of nearly phase-pure SFO with only minute traces of a secondary hematite phase. FESEM observations reveal a broad range of nanofiber morphologies, along with significant variation in the shape of nanoparticles embedded within the fibers, ranging from irregular to platelet-like structures (Figure 1). These results demonstrate that the morphology of both the nanofibers and the constituent nanoparticles can be effectively tailored by controlling two key processing parameters, namely the calcination temperature and the heating rate. Room temperature magnetic hysteresis measurements reveal that the sample calcined at 800 °C with a heating rate of 10 °C/min exhibits superior magnetic properties, having M_s and H_c values of 76.79 emu/g, 5.77 kOe compared to samples calcined at 600 °C and 950 °C. Overall, this study establishes an effective route for the fabrication of nanofibers with tunable and well-controlled morphological characteristics.

Keywords: Morphology, Electrospinning, Nanofibers, Strontium hexaferrite.

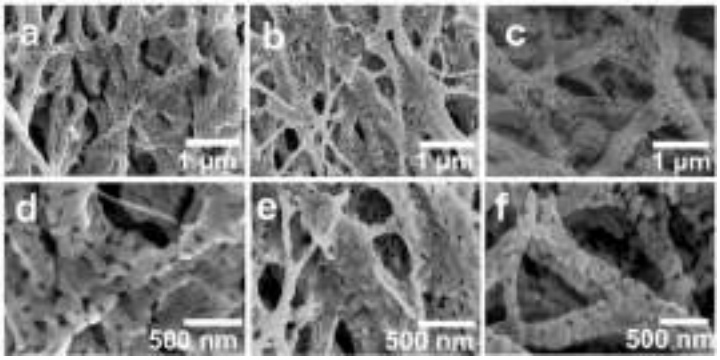


Fig. 1: FESEM images of SFO nanofibers at calcination temperature of 800 °C with heating rate of (a,d) 2 °C/min (b,e) 6 °C/min, and (c,f) 10 °C/min.

Abstract ID: 270

INTERFACIAL CHARGE REDISTRIBUTION DRIVEN EXCHANGE BIAS IN OXIDE HETEROSTRUCTURES

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Abstract: Double perovskites (AA′BB′O6), where A-site or B-site cations are ordered, are known for properties like spin-state ordering and metal-insulator transitions. $RBaCo2O_{5.5}$ (R = rare earth element) is notable for phenomena such as FM to AFM transitions, large Magneto resistance (MR), and spin-crossover-induced metal-insulator transitions. Recent studies on thin films, especially $GdBaCo_2O_{5.5}$(GBCO), have shown that lattice strain from different substrates can alter magnetic and electronic properties, including AFM to FM and insulator to metal transitions via changes in oxygen content. However, all these studies were on single layer GBCO films, Studies on multilayers still lacking. We study the magnetic properties of epitaxial thin films of $SrRuO_3$ (SRO) and GBCO, and their heterostructures of 10- and 60-unit cells (uc) thickness on $SrTiO_3$ (001) substrates prepared using Pulse Laser Deposition (PLD) technique. Magnetic susceptibility measurements indicate an antiferromagnetic ordering at the interface and ferromagnetic ordering in the separate SRO and GBCO layers, resulting in an exchange-bias effect. This was evidenced by a shifted M-H hysteresis loop in the FC cycle compared to the ZFC cycle at 5 K. The exchange-bias field (HEB), defined as $HEB = |H_+ + H_-|/2$, where H_+ and H_- are the right and left values of the coercivity respectively, as M goes to zero, is estimated to be 190 Oe. The orbital control of the interfacial magnetic exchange interaction shows a way to electronically control the interfacial properties in such heterostructures toward the novel spintronic devices.

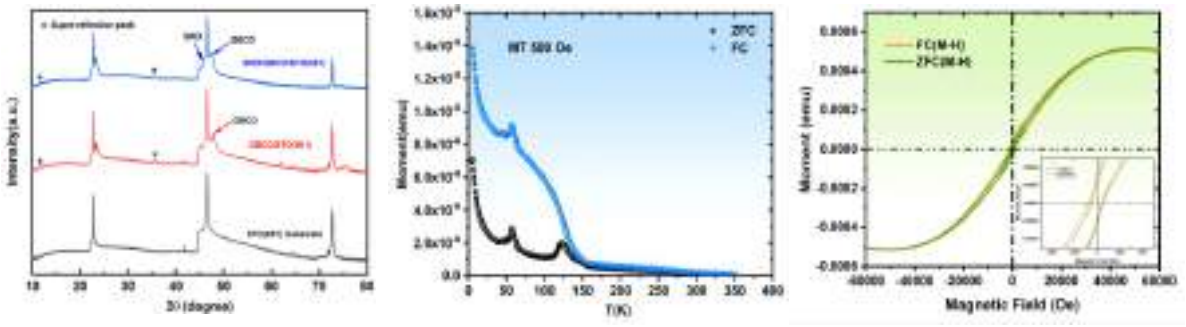


Fig. 1: (a) X-ray diffraction data showing phase purity of the grown films and orientation along the 001 direction (b) Temperature dependent magnetization demonstrating the magnetic transition occurring at 128K and 70K and (c) M−H hysteresis curves at 5 K in the zero-field cooled (ZFC) and the FC (5 K at H = 7T) cycles. The inset shows the zoomed-in view around H = 0 Oe.

References:

1. I. O. Troyanchuk, et. Al. PRB 5, 58 (1998)
2. Tsukasa Katayama et. Al. Chem. Mater. 33, 5675−5680 (2021)

Abstract ID: 271

STRAIN-CONTROLLED COMPETING GROUND STATES AND METAMAGNETISM IN SQUARE LATTICE RUTHENATE

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Abstract: Materials hosting non-trivial relativistic spin-orbit coupling (SOC) have attracted sustained attention since the report of superconductivity in Sr_2RuO_4. The ground states of 4*d* /5*d* transition-metal oxides provide a fertile platform for emergent phenomena such as orbital ordering, negative thermal expansion, Higgs amplitude modes, metamagnetic transitions, metal–insulator transitions, and unconventional superconductivity [1-3]. Square-lattice iridates and ruthenates are celebrated systems for exploring spin-orbit-entangled magnetism. In 5*d* systems such as Sr_2IrO_4, the ground state is largely governed by strong SOC, stabilizing a J_{eff} = 1/2 state, whereas 4*d* ruthenates exhibit intermediate SOC where the magnetic ground state arises from a competition among SOC, electronic correlations, and lattice distortions [4]. we report a detailed investigation of chemically doped Ca_2RuO_4 using magnetization, neutron diffraction, and neutron depolarization measurements to elucidate its magnetic ground state. Our results reveal competing A-centered and B-centered magnetic phases, both characterized by antiferromagnetic ground states. The A-centered configuration exhibits a metamagnetic transition, whereas the B-centered phase develops an intrinsic ferromagnetic component due to spin canting. We show that orthorhombic strain, arising from structural distortions, drives the transition from the A-centered to the B-centered configuration by modifying the interlayer exchange interactions, thereby tuning the magnetic ground state.

Keywords: Spin–orbit coupling, Orthorhombic strain, Metamagnetism, Neutron diffraction, Antiferromagnetism.

References:

[1] A. Jain, M. Krautloher, J. Porras, G. H. Ryu, D. P. Chen, D. L. Abernathy, J. T. Park, A. Ivanov, J. Chaloupka, G. Khaliullin, B. Keimer, B. J. Kim, Nat Phys **13**(7) 633-637 (2017).
[2] M. Braden, G. André, S. Nakatsuji, Y. Maeno, Phys Rev B **58**(2), 847-861 (1998).
[3] A. Jain, S. M. Souliou, M. Krautloher, J. Porras, G. H. Ryu, D. P. Chen, D. L.Abernathy, J. T. Park, A. Ivanov, J. Chaloupka, G. Khaliullin, B. Keimer, B. J. Kim, Phys Rev. Lett. **119**(6): 067201(2017).
[4] N. Budania, A. Jain, M. Madaan, I. Da Silva, S. M. Yusuf, Phys Rev B **113**(5), 054433 (2026).

Abstract ID: 272

MACHINE LEARNING BASED SOFT MAGNETIC MATERIAL OPTIMIZATION

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Abstract: The growing demand for advanced electrical steels and nanocrystalline alloys in high-efficiency motors requires optimizing competing properties: high yield strength, excellent ductility, higher electrical resistivity, and high saturation magnetization (B_{sat}). To overcome this, we propose a machine learning (ML) optimized framework for discovering highly stable phase compositions. CALPHAD computations are done to evaluate thermodynamic phase equilibria, solid-solution limits, and evolution of thermal processing pathways. Transfer learning is used to link different datasets of magnetic properties. The ML models are trained on CALPHAD datasets to capture elemental interactions, and fine-tuned via multi-source experimental databases containing magnetic and mechanical metrics. We introduce an inverse learning framework that generates the inverse of composition-processing-structure-property relationship, i.e. generates compositions and processing condition for a given property. This approach is utilized for composition-process-structure optimization of electrical steels and nanocrystalline alloys. In summary, this data driven approach bridges the gap between thermodynamic stability and macroscopic electromechanical performance, accelerating the discovery of soft magnetic materials reducing expensive empirical testing.

Keywords: CALPHAD, Machine Learning, Soft magnetic Alloy, PSP, Material design.

References:

[1] Jha, Rajesh, Nirupam Chakraborti, David R. Diercks, Aaron P. Stebner, and Cristian V. Ciobanu. *Computational Materials Science* 150 (2018): 202-211.
[2] Xiong, Wei, Qing Chen, Pavel A. Korzhavyi, and Malin Selleby. *Calphad* 39 (2012): 11-20.
[3] Shen, Chen. *Computational Materials Science* 258 (2025): 113970.

Abstract ID: 273

NUMERICAL MODELING OF GALFENOL MAGNETOSTRICTIVE TRANSDUCERS FOR SELF-POWERED LEAK DETECTION ACROSS WATER PIPELINES

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Abstract: Battery-dependent wireless sensor nodes pose a critical constraint in continuous leak monitoring of remote transmission pipelines where replacement access is logistically prohibitive, environmental consequences of undetected leakage are severe, and wired power infrastructure is absent. While Galfenol-magnetostrictive transducers have been individually studied for harvesting and structural inspection in prior literature, no unified open-source numerical framework exists that models the complete energy conversion chain from pipe-wall mechanical excitation through power conditioning, storage, and into wireless IoT node power sufficiency assessment under vibration conditions representative of pressurized industrial pipeline operation. This work proposes a Python-based end-to-end numerical simulation structured across four coupled subsystems: (i) a Villari-effect constitutive transducer model parameterized with published Galfenol material constants (piezomagnetic coefficient d_{33}, elastic compliance s^H, permeability μ^T, saturation magnetostriction ~200–400 ppm) driven by synthetic pipe-wall acceleration profiles; (ii) a full-wave rectification and impedance-matched power conditioning stage; (iii) a supercapacitor storage element governed by RC charging dynamics; and (iv) a duty-cycled wireless node parameterized against published BLE power consumption figures. Performance is mapped across excitation frequency (5–200 Hz), load resistance (100 Ω–10 kΩ), and vibration amplitude (0.1g–2.0g) to identify peak power output. Leak versus no-leak conditions are then discriminated through harvested waveform differences, with classifier accuracy and false positive rate as evaluation metrics. Energy sufficiency is assessed against IoT node transmission demand. This framework establishes a reproducible, parameter-transparent numerical basis for evaluating Galfenol magnetostrictive transducers as viable candidates for batteryless leak detection in industrial pipeline infrastructure prior to physical prototyping.

Keywords: Galfenol, magnetistrictive energy harvesting, pipeline leak detection.

Abstract ID: 274

EFFECT OF ANNEALING ON ELECTRICAL TRANSPORT IN Co-Ru-Fe-Si QUATERNARY HEUSLER ALLOY FILMS

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Abstract: In the wake of novel spintronics applications, Co-based Heusler compounds gained significant attention in the context of half-metallicity, high T_C & magnetization [1]. Doping of 4d- transition elements reduce anti-side disorder due to different ionic size and electro-negativity of the constituent elements [2]. Off-stoichiometric $CoRu_{0.5}FeSi_{1.5}$ (CRFS) thin films of 200 nm thickness, were co-sputtered from equiatomic targets of CoFeSi alloy and Ruthenium using DC magnetron sputtering technique at RT on Si (100) substrate. The films were annealed in-situ at 350°C(A-350), 500 °C (A-500) and 550 °C (A-550) for 20 minutes and capped using tantalum at RT to prevent oxidation. GI-XRD data shows the presence of A2 disorder. Figs.1 and 2 show $\rho(T)$ measured from 5-390 K both in heating and cooling cycles at $H = 0$ & $8T$ for RT & A-550 films respectively. $\rho(T)$ shows negative TCR for RT & A-350 CRFS films whereas positive TCR for A-500 & A-550 films, reflecting the effect of annealing temperature (AT) on disorder. All CRFS films demonstrate thermal hysteresis for T_B>230 K, where T_B increases with increase in AT, indicating the structural transformation. The disordered CRFS films (RT and A-350) mimics spin gapless semiconductor (SGS) [3] like behavior in 50-230 K temperature range whereas in 5-50 K range, the scattering is dominated by defects considering residual, electron-diffuson and weak localization contributions. $\rho(T)$ for A-500 & A-550 (inset fig.-1(b)) can be explained by Matthiessen rule [4] in 5-300 K temperature range. The study reveals the tunability of TCR of CRFS films through disorder making them useful for practical applications.

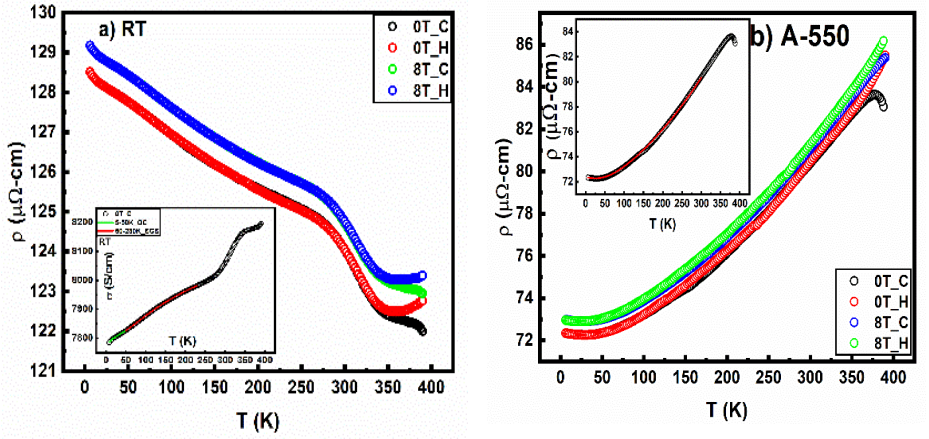


Fig. 1. a) Temperature dependent Resistivity in both heating and cooling cycles at $H = 0$ & $8T$ for the disordered A-RT CRFS films. Inset shows the zero-field conductivity (black open circles) with theoretical fit corresponding to Quantum corrections (Green) and SGS behavior (Red) [5]. b) Temperature dependent Resistivity in both heating and cooling cycles at $H = 0$ & $8T$ for the ordered A-550 CRFS films. Inset shows the zero-field data (black open circles) with theoretical fit (red solid line).

References:

[1] C. Felser et al., Chem. Int. Ed. 46(5), 668 (2007)
[2] S. S. P. Parkin et al., J. Appl. Phys. 85(8), 5828 (1999).
[3] K. G Suresh et.al., Phys. Rev B 105, 144409 (2022)
[4] Longchar, L. A., et al., Journal of Magnetism and Magnetic Materials, 569, 170439 (2023).

Abstract ID: 275

ELECTRONIC AND MAGNETIC GROUND STATE OF $4d^3$ DOUBLE PEROVSKITE RUTHENATES AND THE EFFECT OF SPIN-ORBIT COUPLING IN THEM

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Abstract: 4d transition metal oxides (TMOs) lie at the crossover regime of strong spin orbit interaction (SOI) and electron-electron correlation (U). An exotic array of quantum phases emerges from these interactions [1]. Double perovskites (DP) TMOs with a single 4d transition metal is an ideal platform to systematically investigate these interactions and ground states, owing to their site-tunability. Among them, $4d^3/5d^3$ systems lie at the intermediate region of LS and JJ coupling where the effects of SOI are unpredictable [2]. In our work we explored the electronic and magnetic ground state of the less investigated $4d^3$ DP ruthenates A_2LaRuO_6 (A = Ca, Ba) and Ca_2ScRuO_6[3,4]. The bulk magnetic, specific heat measurements and density functional theory (DFT) calculations indicate a Mott insulating classical spin-only magnetic ground state (S = 3/2) for these materials with negligible SOI. Magnetization measurements show that A_2LaRuO_6 have a long range antiferromagnetic order with high degree of magnetic frustration ($f \approx 13$-15) and Ca_2ScRuO_6 exhibits a long range antiferromagnetic order coexisting with ferrimagnetic like small magnetic clusters. Interestingly, a near T^2- behavior is observed in low-T magnetic heat capacity measurement indicating the presence of low-dimensional spin-wave excitation in all the materials. The temperature dependent resistivity measurements and electronic band structure calculations confirm a conventional Mott insulating ground state in these systems. Our experimental investigation and DFT calculations also highlight the reason for the nonexistence of Sr_2LaRuO_6.

Keywords: Double perovskite transition metal oxides, magnetic frustration, spin orbit interaction, electron - electron interaction.

References:

[1] W. Witczak-Krempa, G. Chen, Y. B. Kim, and L. Balents, Annu. Rev. Condens.Matter Phys. 5(2014) 57–82.

[2] H. Matsuura and K. Miyake, Journal of the Physical Society of Japan. 82(2013) 073703.

[3] A. A. Abraham, R. Roy, R. Kulkarni, S. Kanungo, and S. Manni. Journal of Physics: Condensed Matter. 37(2025) 355602.

[4] A. A. Abraham, A. Kumari, M. A. Hossain, S. K. Mahatha, S. Das, A. Bera, and S. Manni. arXiv preprint arXiv:2601.00085, 2025.

Abstract ID: 276

MAGNETIC DISORDER DRIVEN METAL TO INSULATOR TRANSITION IN CORRELATED SEMICONDUCTOR $Fe_{1-x}Cr_xSi$

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Abstract: In general, conduction electron doping into an insulator matrix leads to band filling and results in temperature driven metal-to-insulator transition (MIT) at low temperature. In constrast, *d*-itinernat electron doping adds a magnetic flavour besides enhanced conducting properities. In addition, the correlated electrons cause renormalization of mass leading to enhanced specific heat at low temperatures. In such scenario, it is crucial to distinguish whether the metallic state below T_{MIT} (MIT temeprature) is due to simple imputiry band conduction (band-filling) or fluctuating yet not-completely correlated magnetic disorder [1]. In this report, we address the emergence of magnetic fluctation driven metallic state and an unconventiaonl transport behaviour below T_{MIT} in a magnetically minmally doped hybridized correlated semiconductor $Fe_{1-x}Cr_xSi$. These alloys are synthesized through arc-melting method and annealed at 880 ^oC for one week. X-ray diffraction confirms single phase and crystallization in B20 cubic structure. Modified Curie-Weiss analysis reveals a negative Weiss temperature (θ_W) and Pauli paramgnetic contribution χ_0. Unformed magnetic cusp near/below Weiss temperature along with frequency-independent ac-susceptibility rules out the formation of magnetic clusters, and thereby spin glass. Non-linear $M(H)$ at 2 K is indicative of weak magnetic interactions below T_{MIT} (≈ 150 K). Specific heat (C/T) exhibits a pronounced upturn below 20 K leading to electron mass enhancement. Resistivity exhibits MIT below 150 K along with low-temperautre upturn below 20 K. Overal, our study highlights how disorder, spin fluctuations, and electronic correlations conspire to generate emergent metallicity in doped narrow-gap systems.

Keywords: Band filling, Magnetic fluctuations, Metal to insulator transition, Correlated metal

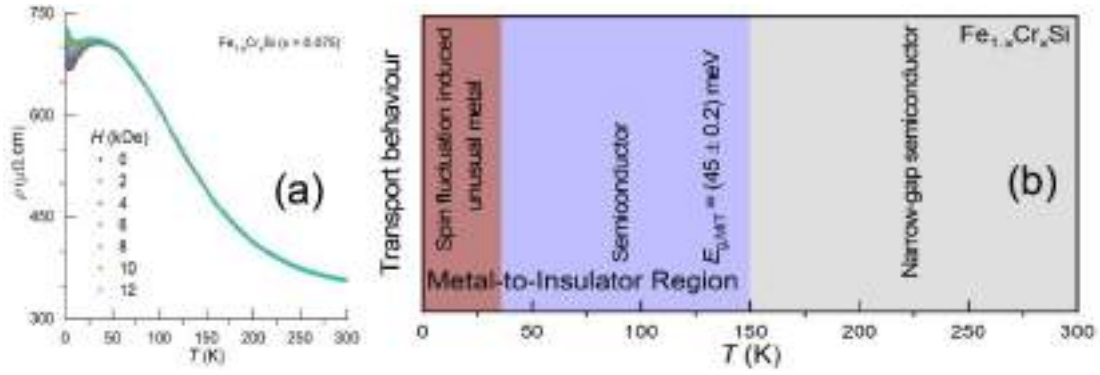


Fig. 1: (a) Temperature dependent electrical resistivity in different applied fields. (b) Phase diagram depicting temperature dependent variation of electrical transpor behaviour of $Fe_{1-x}Cr_xSi$.

Abstract ID: 277

STRUCTURAL AND MAGNETIC PROPERTIES OF CHROMIUM-BASED LOW, MEDIUM, AND HIGH ENTROPY SPINEL OXIDES

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Abstract: The emergence of high-entropy oxides has spurred significant research interest in recent times. These compounds exhibit exotic functional properties that often transcend simple linear combinations of their constituent elements. Herein, we present a new series of Cr-based low, medium, and high entropy spinel oxides with composition $NiCr_2O_4$, $[Ni_{0.5}Mn_{0.5}]Cr_2O_4$, $[Ni_{0.33}Mn_{0.33}Co_{0.33}]Cr_2O_4$, $[Ni_{0.25}Mn_{0.25}Co_{0.25}Cu_{0.25}]Cr_2O_4$, and $[Ni_{0.2}Mn_{0.2}Co_{0.2}Cu_{0.2}Zn_{0.2}]Cr_2O_4$. We conducted detailed structural (X-ray and temperature-dependent neutron diffraction), microstructural, Raman spectroscopy, and magnetic measurements on these materials. Our study reveals that the incorporation of multiple cations at the A-site of the structure (AB2O4) significantly modulates the magnetic properties. These compounds exhibit transitions from complex ferrimagnetic ($[Ni_{0.5}Mn_{0.5}]Cr_2O_4$) to antiferromagnetic ($[Ni_{0.2}Mn_{0.2}Co_{0.2}Cu_{0.2}Zn_{0.2}]Cr_2O_4$) states, with remarkable variations in coercivity, demonstrating the ability to tailor magnetic responses through compositional design. Our findings highlight the versatility and promise of high-entropy spinel oxides in engineering materials with customized magnetic properties for diverse technological applications.

Keywords: High Entropy, Spinel Chromite, Magnetism, Neutron Powder Diffraction

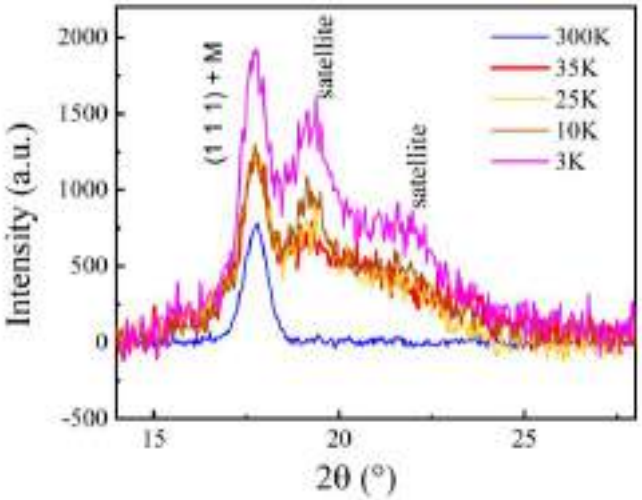


Fig. 1: Temperature-dependent neutron diffraction of $(Mn_{0.2}Co_{0.2}Ni_{0.2}Cu_{0.2}Zn_{0.2})Cr_2O_4$ shows the emergence and growth of magnetic Bragg (satellite) peaks below T_C, confirming long-range antiferromagnetic order.

Abstract ID: 278

ML BASED PERMANENT MAGNETIC MATERIAL DESIGN

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Abstract: The transition toward sustainable energy technologies heavily relies on high-performance NdFeB permanent magnets. However, supply chain vulnerabilities and the high costs associated with heavy rare earth elements (HREEs) necessitate the development of reduced-HREE or light rare earth element (LREE: La, Ce) substituted alternatives. Discovering optimal compositions that maintain high coercivity is a complex, multidimensional challenge. Targeting eutectic compositions offers a metallurgical pathway to engineer low-melting-temperature grain boundary phases, which are important for magnetic decoupling and coercivity enhancement. This study proposes a machine learning (ML) optimized framework[1],[2] to accelerate the discovery of these eutectic compositions and reduced-HREE magnets within the NdFeB system. We use CALPHAD computations to evaluate phase equilibria, Gibbs free energy surfaces and solidification pathways for LREE-substituted alloys [3],[4]. This approach links thermodynamic phase stability and macroscopic magnetic performance. The ML driven methodology gives a predictive, cost-effective pipeline for designing NdFeB magnets with minimized experimental trials, accelerating advancements in permanent magnet engineering.

Keywords: CALPHAD, Machine Learning, Grain boundary, Eutectic, Coercivity

References:

[1] Chen Shen, The synergy of machine learning and CALPHAD: Revitalizing traditional approaches, Computational Materials Science, Volume 258, 2025, 113970, ISSN 0927-0256.

[2] Rajesh Jha, Nirupam Chakraborti, David R. Diercks, Aaron P. Stebner, Cristian V. Ciobanu, Combined machine learning and CALPHAD approach for discovering processing-structure relationships in soft magnetic alloys, Computational Materials Science, Volume 150, 2018, Pages 202-211, ISSN 0927-0256.

[3] Dai Z, Li K, Wang Z, Liu W, Zhang Z. Magnetic-Property Assessment on Dy-Nd-Fe-B Permanent Magnet by Thermodynamic Calculation and Micromagnetic Simulation. Materials (Basel). 2022 Oct 31;15(21):7648. 10.3390/ma15217648

[4] Abe T, Morishita M, Chen Y, Saengdeejing A, Hashimoto K, Kobayashi Y, Ohnuma I, Koyama T, Hirosawa S. Development of a prototype thermodynamic database for Nd-Fe-B permanent magnets. Sci Technol Adv Mater. 2021 Jun 4;22(1):557-570. doi: 10.1080/14686996.2021.1936627

Abstract ID: 279

EXCHANGE COUPLED HYBRID MODES FOR ENHANCED SPIN PUMPING IN $Y_3Fe_5O_{12}/CO_{20}Fe_{60}B_{20}$/Cu HETEROSTRUCTURE

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Abstract: Spin pumping plays a crucial role in spintronics as an efficient mechanism for generating pure spin currents [1]. In this work, we present efficient transfer of spin angular momentum across magnetic interfaces is central to advancing magnonic and spin-orbitronic technologies. Here we investigate ferromagnetic-resonance-driven spin pumping in YIG/CoFeB/Cu heterostructure with a fixed YIG layer and variable CoFeB thickness. The heterostructure exhibits clear inverse spin Hall voltage signatures originating from both magnetic subsystems, with power-dependent measurements confirming the characteristic symmetry expected for spin-pumping–induced inverse spin Hall effect (ISHE). The YIG contribution to the spin pumping voltage decreases monotonically with increasing CoFeB thickness, showing that spin-transfer efficiency is governed by the evolution of the hybrid magnon spectrum rather than by magnetic volume alone. Temperature-dependent ferromagnetic resonance further shows a strong enhancement of YIG damping upon cooling, leading to a maximum in the extracted spin mixing conductance at 100K. Analysis of the mode structure indicates that a CoFeB perpendicular standing spin-wave mode approaches the YIG uniform mode under specific thickness and temperature conditions, enabling hybridized excitations that enhance the interfacial exchange torque and, in turn, enhanced spin-current generation. These results establish YIG/CoFeB heterostructure as a versatile platform for engineering interfacial magnon hybridization and amplifying coherent spin pumping, offering new opportunities for long-range magnon transport and spin-based device architectures [3].

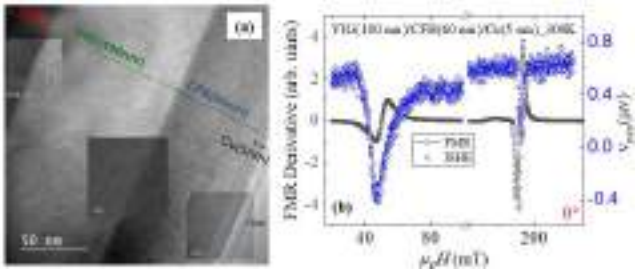


Fig 1: (a) HRTEM of the YIG(100 nm)/CoFeB(60 nm)/Cu(5 nm) showing sharp interfaces (b) Simultaneous FMR and ISHE signals of it, resolving CoFeB and YIG resonance modes

References:

[1] S. D. Bader and S. S. P. Parkin, *Annual Review of Condensed Matter Physics*, Vol. 1, pp. 71–88, 2010.
[2] Y. Li, W. Zhang, V. Tyberkevych, et al., *Journal of Applied Physics*, Vol. 128, 130902, 2020.
[3] A. Swain*, K. S. Rathore*, P. Gupta, et al., *Applied Physics Letters*, Vol. 125, 012406, 2024.
[4] K. S. Rathore, A. Swain, P. Gupta, et al., PHYSICAL REVIEW APPLIED 25, 024036 (2026),” 2025.

Abstract ID: 280

EFFECT OF GADOLINIUM DOPING ON THE MAGNETOIMPEDANCE RESPONSE OF NiFe-BASED MAGNETIC MATERIALS

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Abstract: Soft ferromagnetic thin-film electrodeposition has attracted a lot of interest in recent years because of its numerous technical uses in a variety of sectors [1]. These materials are notable for their ability to change electrical impedance in response to an external static magnetic field, a phenomenon called the magnetoimpedance (MI) effect [2]. This work investigates the effects of gadolinium (Gd) inclusion on the soft magnetic characteristics and MI impact of NiFeGd thin films electrodeposited onto copper microwires. Selecting the ideal Gd concentration for improved MI performance in the electroplating bath is the primary goal. Different Gd ion concentrations were used to make NiFeGd films by direct current electrodeposition. XRD, FESEM, AFM, VSM, and impedance measurements were used to characterise the films' structural, morphological, magnetic, and electrical characteristics. The findings show that raising Gd concentration up to 0.08 mM improves magnetic softness and circumferential permeability by reducing crystallite size, surface roughness, and coercivity. For the film deposited at a concentration of 0.08 mM Gd, a maximum MI ratio of 304% and sensitivity of 16.1%/Oe were obtained at 100 kHz. Grain growth and increased anisotropy caused the magnetic and MI characteristics to deteriorate with increasing Gd concentration. The experimental findings are supported by analytical modelling of permeability and impedance.

Keywords: Magnetoimpedance, Thin-film, Surface roughness, Coercivity, Crystallite size

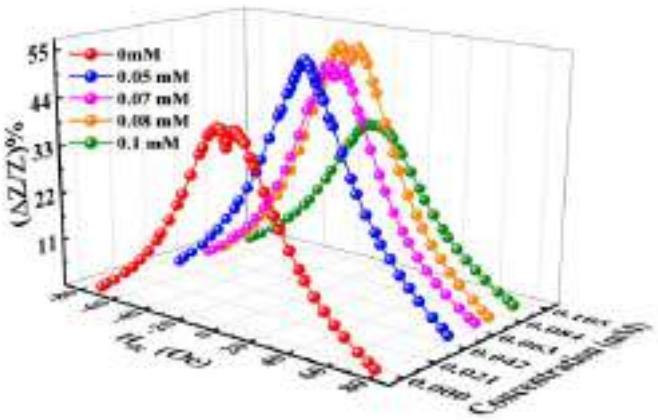


Fig. 1. Magnetoimpedance as a function of external magnetic field for various NiFeGd/Cu samples at 100 kHz.

References:

[1] V. Torabinejad, M. Aliofkhazraei, S. Assareh, M. Allahyarzadeh, A.S. Rouhaghdam, Electrodeposition of Ni-Fe alloys, composites, and nano coatings–A review,J. Alloys Compd. 691 (2017) 841–859.

[2] M.H. Phan, H.X. Peng, Giant magnetoimpedance materials: Fundamentals and applications, Prog. Mater. Sci. 53 (2008) 323–420.

Abstract ID: 281

LOW-FIELD MAGNETIC COMPENSATION AND EXCHANGE BIAS PHENOMENA IN $SmMn_{1-x}Fe_xO_3$ PEROVSKITE OXIDES

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Abstract: Rare-earth (Re) Perovskites ($ReAO_3$) comprising Fe as the key transition metal (A) exhibiting sign-reversal exchange bias (H_{eb}) phenomena and antiferromagnetic (AFM) behaviour are quite unique and scarce in the literature. Samarium (Sm) as the Re element, with the combination of A = Fe and Mn, as are the interesting family of compounds that belongs to the above-mentioned category of systems, which also exhibit low temperature field-induced metamagnetic transitions. In the present work, we report such unique phenomena, including the low-field magnetization switching and compensation effect in a series of $SmMn_{1-x}Fe_xO_3$ ($0 \leq x \leq 1$) bulk perovskites. Pristine composition $x = 0$ ($SmMnO_3$) exhibits AFM ordering below the Néel temperature (T_N) ~ 55.6 K, driven by antiparallel alignment of Mn^{3+} spins. At lower temperatures, the Sm^{3+} sublattice develops a weak canted ferromagnetic component, leading to a spin-reorientation (SR) transition associated with Sm-sublattice ordering at T_{SR}/T_C^{Sm} ~4.3 K. For $T < T_{SR}$, magnetization measured under low applied fields (H ~ 50 Oe) shows a sign reversal in both zero-field-cooled-warming (ZFCW) and field-cooled-warming (FCW) protocols exhibiting a magnetic compensation effect at T_{Comp} ~ 3.8 K. At this temperature, both the sublattice magnetizations of the Mn and Sm balance each other, leading to net zero magnetization. The evolution of T_N, T_{SR}, and H_{eb} with Fe substitution alters the Mn-O-Mn super exchange interaction and Sm-Mn (*f-d*) coupling, eventually promoting the interfacial exchange anisotropy and stabilizes the exchange-biased state. These results establish $SmMn_{1-x}Fe_xO_3$ as a model system for tuning low-field magnetization switching and exchange bias in compensated perovskite oxides.

Keywords: Magnetic Compensation, Exchange-bias effect, Perovskites, and Antiferromagnetism.

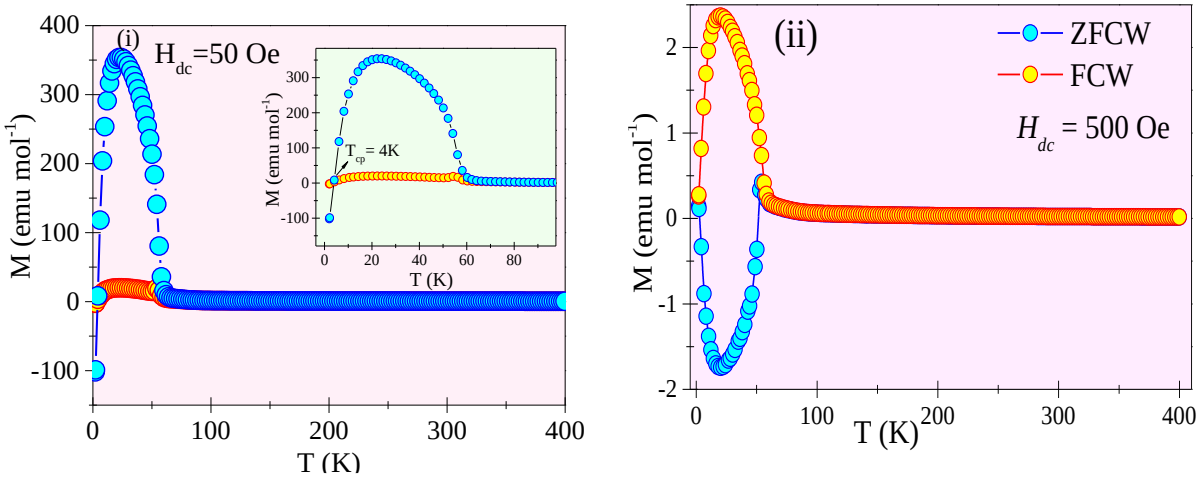


Fig. (i): Temperature dependent magnetization (M-T) for $SmMnO_3$ measured under an applied field of H_{dc}=50 Oe. **(ii)** Temperature dependent magnetization (M-T) for $SmMnO_3$ measured under an applied field of H_{dc}=500 Oe, under protocols of ZFCW/FCW magnetic ordering characteristics.

Abstract ID: 282

MANGETIC CRITICALITY AND UNIVERSALITY CLASS OF A SOFT FERROMAGNET $Mn_{0.7}Rh_{0.3}NiGe$

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Abstract: Despite the intensifying focus on the technological applications of Heusler alloys, investigating their fundamental physical properties remains a highly topical pursuit. These materials are uniquely characterized by a complex interplay of magnetic, electrical, and structural functionalities. The present study examines $Mn_{0.7}Rh_{0.3}NiGe$ as a counterpart to the $Mn_{0.7}Fe_{0.3}NiGe$ system. The parent compound, MnNiGe, is known to undergo a structural transition from a hexagonal ($P6_3/mmc$) to an orthorhombic ($Pnma$) phase at 470 K, followed by magnetic transitions at 346 K (antiferromagnetic) and 205 K (ferromagnetic) [1]. While both doped compositions maintain a hexagonal structure at room temperature, they demonstrate contrasting magnetic ground states: $Mn_{0.7}Fe_{0.3}NiGe$ behaves as a spin glass [2], whereas $Mn_{0.7}Rh_{0.3}NiGe$ exhibits soft ferromagnetism. The emergence of a ferromagnetic state in the Rh-substituted system is particularly intriguing given the absence of traditional ferromagnetic dopants. To elucidate the underlying physics, we analyze the critical magnetic behavior of $Mn_{0.7}Rh_{0.3}NiGe$ across its phase transition temperature ($T_C \approx 122$ K). By utilizing temperature- and field-dependent magnetization data, we determine the magnetic entropy chagne and the critical exponents β, γ, and δ. These parameters allow for the classification of the universality class, the range of magnetic interactions, and the correlation strength. Resistivity measurements are employed to examine the relationship between caloric and electrical properties.

Keywords: Heusler alloy, Soft ferromagnet, Critical exponents, Universality class

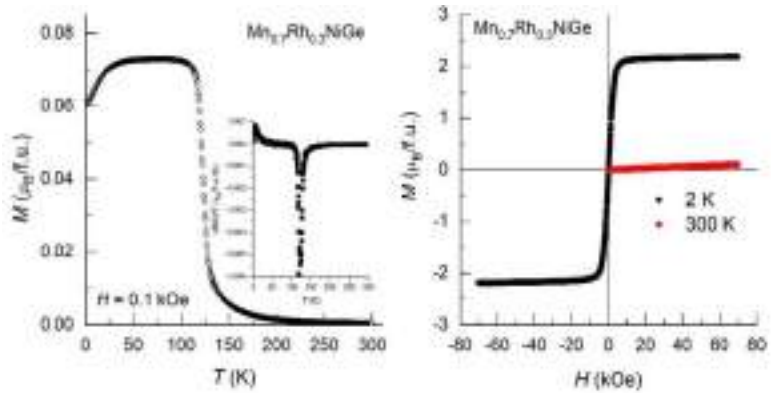


Fig. 1: (a) Temperature dependent magnetization exhibiting a transition at 122 K. Inset: *dM/dT* vs *T*. (b) Magnetization isotherm at 2 K (ferromagnetic) and 300 K (paramagnetic).

References:

[1] W. Bazela, A. Szytu la, J. Todorovic, et al., physica status solidi(a), 38, (1976) 721.
[2] S Shanmukharao Samatham , Akhilesh Kumar Patel, et al., J. Phys.: Condens. Matter 31 (2019) 495804

Abstract ID: 283

THICKNESS AND FIELD-DEPENDENT EVOLUTION OF MAGNETIC DOMAINS IN FERRIMAGNETIC TbFe THIN FILMS

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Abstract: Ferrimagnetic rare-earth–transition-metal thin films combine complex magnetic domain structures with tunable perpendicular magnetic anisotropy (PMA), making them promising candidates for next-generation spintronic and magnetic memory devices [1]. In this work, we systematically explored the interplay between thickness and externally applied magnetic field on domain evolution and magnetization reversal in single-layer TbFe ferrimagnetic thin films. While multilayer engineering typically controls domain behaviour, our study demonstrates that the extent to which thickness alone can tune domain evolution and reversal pathways in single-layer ferrimagnetic thin films. TbFe films with thicknesses of 30 and 100 nm were fabricated via electron-beam evaporation and systematically investigated using vibrating-sample magnetometry (VSM) and magnetic force microscopy (MFM). Both films showed strong PMA with wasp-waisted out-of-plane (OOP) hysteresis loops, which are characteristic of exchange-coupled subsystems. The films exhibited labyrinth-like domain patterns in MFM. Under an applied positive OOP magnetic field, films showed complete magnetization reversal, with distinct reversal dynamics. The 30 nm TbFe film showed abrupt reversal with a narrow, symmetric switching-field distribution, contrasting the 100 nm film's gradual reversal via viscous domains and broad distribution. Field-dependent MFM imaging further reveals distinct, asymmetric domain evolution consistent with Kondorsky-type reversal, in which domain-wall motion and pinning govern switching. While conventional approaches to controlling magnetic domain behavior in rare-earth-transition-metal thin films rely on complex multilayer engineering or interface design, our study unveils a novel, simple strategy that tunes domain evolution and reversal pathways in single-layer TbFe ferrimagnets.

Keywords: Ferrimagnetic thin films, Perpendicular magnetic anisotropy, Magnetic domain imaging, Field evolution of domains.

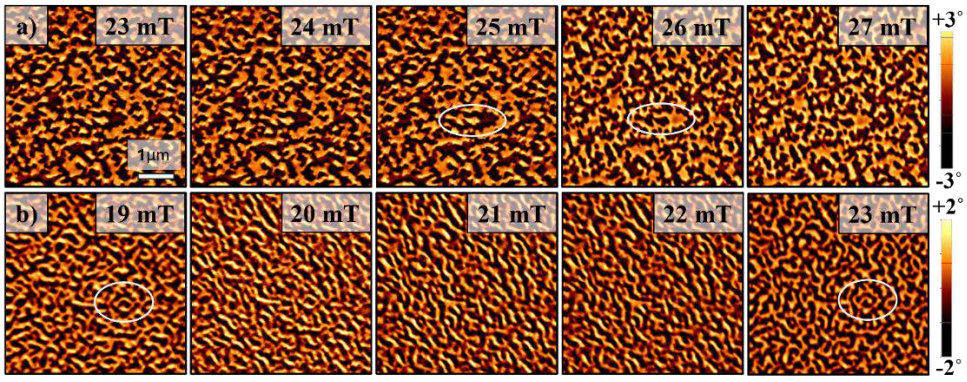


Fig. 1: MFM images showing domain reversal as a function of applied OOP magnetic field for TbFe films of thickness a) 30 nm and b) 100 nm.

References:

[1] Basumatary, H., Chelvane, J.A., Rao, D.S., Talapatra, A., Mohanty, J., Kumar, D., Singh, V., Kamat, S.V. and Ranjan, J. Alloys Compd 869 (2021) 159571.

Abstract ID: 284

FABRICATION AND TUNING OF MAGNETIC Co-Pt-Ni TERNARY ALLOY THIN FILMS VIA LOW COST FABRICATION ROUTE

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Abstract: Bimetallic magnetic materials composed of transition 3d elements (M = Fe, Co, Ni) and platinum (M-Pt) have been a subject of interest from researchers across the world, and in this regard $L1_0$ ordered FePt and CoPt binary alloy thin films has been well recognized as the most promising hard ferromagnetic materials due to their exceptional as well as tuneable magnetic properties. However, the cost-expensive nature of Platinum (Pt)-based thin film or alloy fabrication has always been a problem, Pt has consistently been a valuable metal in material science because of its use in numerous interdisciplinary fields, which raises questions about how to fabricate it economically. In this work, we have demonstrated an optimized novel and cost effective method for the fabrication of platinum based thin films employing DC/RF magnetron sputtering up to near equiatomic elemental composition. Instead of using a standard size (2 or 3-inch targets with thickness of 3 mm) platinum target, our adopted method utilizes a 5-gm platinum bar that comes at an affordable expense of nearly 20000 INR. This method not only minimizes the cost-expensive issue of platinum but also resulted efficient material usage and less wastage along with controlled atomic composition. Once optimization process is done, we incorporate Ni onto CoPt by co-sputtering to fabricate Co-Pt-Ni ternary alloy thin films and the structutal and magnetic properties of the films has been thoroughly investigated for the spintronics applications.

Keywords: Thin films, CoPt alloy, Ferromagnetism, Post annealing.

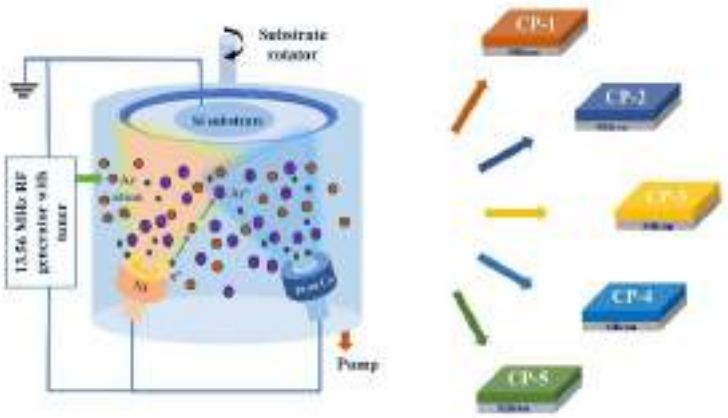


Fig. 1: Schematic representation of magnetron sputtered deposition of compositionally varied CoPt and CoPtNi alloy thin films.

References:

[1] N.L. Lethole, P. Mukumba, G. Makaka, Journal of Magnetism and Magnetic Materials, 565 (2023) 170298.

Abstract ID: 285

ENHANCED SPIN-TO-CHARGE CONVERSION IN CoFeB/β-W VIA MnPc INTERFACIAL ENGINEERING

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Abstract: The development of power-efficient spintronic devices has drawn a lot of attention in recent time, as spin-based information processing harnesses the electron's spin degree of freedom rather than charge transport. It thereby enable non-volatility, minimum Joule dissipation, and reduced standby power consumption. In this context, interfacial spin engineering has emerged as a powerful strategy to optimize spin current generation and conversion efficiencies. Hybrid heterostructures combining ferromagnets such as CoFeB with strong spin-orbit materials like β-W provide an effective platform for spin pumping and spin-to-charge conversion. Incorporation of magnetic molecular layers such as Manganese(II) phthalocyanine has opened new avenues for tailoring interfacial spin transparency, suppressing spin memory loss, and enhancing spin-orbit conversion efficiency through spin-dependent orbital hybridization. We have studied two heterostructures : CFB/ β-W/Ta and CFB/ β-W/MnPc/Ta , where simultaneous increase in symmetric spin pumping voltage (V-sym) and reduction in the Gilbert damping constant (α) observed. This indicates suppressed interfacial spin memory loss and reduced spin backflow, likely due to spin-selective orbital hybridization at the MnPc/β-W interface. Such molecularly engineered spinterfaces offer a promising route toward low-dissipation, high-efficiency spintronic devices beyond conventional charge-based electronics.

Keywords: Spinterface, Phthalocyanines, Spin-to-charge conversion.

Abstract ID: 286

FIELD-CONTROLLED ELECTRONIC AND MAGNETIC PROPERTIES OF GAUSSIAN QUANTUM DOTS

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Abstract: We present a theoretical study on the role of external magnetic, electric, and Aharonov–Bohm flux fields in tailoring the physical properties of a parabolic and Gaussian quantum dot. Within the effective-mass approximation, the Schrödinger equation is solved analytically to determine the modified energy spectrum and wave functions under the combined influence of these fields. The magnetic field induces Landau quantisation and Zeeman splitting, significantly altering the electronic structure and magnetic response of the system. The applied electric field modifies the confinement profile, resulting in tunable energy-level spacing and charge redistribution. Furthermore, the AB flux introduces phase-dependent quantum interference effects, giving rise to oscillatory behaviour in persistent current and transport characteristics. The thermodynamic behaviour is examined through magnetisation and magnetic susceptibility using the canonical ensemble formalism, revealing strong field-dependent variations. Numerical analysis demonstrates that the interplay of external fields provides efficient control over the electronic and magnetic responses of the quantum dot. These findings suggest that Gaussian quantum dots offer promising platforms for externally tunable nanoscale electronic and spintronic device applications.

Keywords: Parabolic; Gaussian quantum dots; External field effects; Aharonov–Bohm flux; Magnetization.

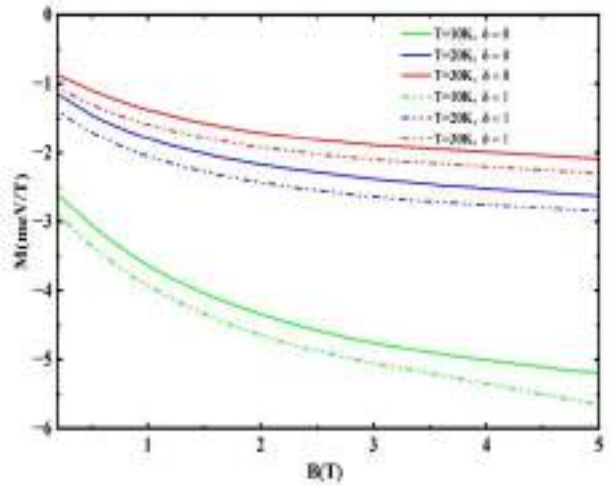


Fig. 1 Magnetization as a function of magnetic field for different temperatures $T = 10,20,30$K for a fixed values of $F = 100$ kV/m, $V_0 = 5$ meV, $R = 5$ nm, $\alpha = 2$, $\delta = 0$, and $\delta = 1$. The figure illustrates the Magnetisation and magnetic field with defferent temperatures magnetisation shows confirming that the system exhibits a purely diamagnetic response.With increasing magnetic field B.

References:

[1] M.S. Atoyan, E.M. Kazaryan, H.A. Sarkisyan, Physica E 22 (2004) 860.
[2] M.S. Atoyan, E.M. Kazaryan, H.A. Sarkisyan, Physica E 31 (2006) 83.
[3] Boda Aalu, Physica B 575 (2019) 411699.
[4] B. Boyacioglu, A. Chatterjee J. Mod. Phys. B26(2012) 1250018.
[5] G. Bastard, et al., Phys. Rev. B 28(1983) 3241.

Abstract ID: 287

INFLUENCE OF SPIN INJECTING ELECTRODES AND FERROELECTRIC POLARIZATION ON SPIN TRANSPORT IN Co/PVDF/(Co, NiFe, Fe_3O_4) MULTIFERROIC SPIN VALVE DEVICES

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Abstract: The present work investigates the role of spin polarized electrodes and ferroelectricity upon the spin transport properties of Co/PVDF/(Co, NiFe, Fe_3O_4) multiferroic spin valve (MFSV) devices. We systematically demonstrate that employing highly spin polarized electrodes can significantly enhance the device performance. Devices with bottom Fe_3O_4 spin injecting electrode exhibit larger magnetoresistance of 3 to 6 times compared to the MFSVs with Co or NiFe electrodes, which can be attributed to improved spin injection efficiency with highly spin polarized Fe_3O_4 electrode [1]. The poly(vinylidene fluoride) (PVDF) spacer layer is initially in an unpoled state and is subsequently polarized by applying a high electric field during the study. The ferroelectric polarization of PVDF generates an internal electric field that modifies the interfacial potential at the ferromagnet/PVDF interfaces. Current-voltage and magnetoresistance (MR) measurements of the devices were carried out in the unpoled and electrically poled states of the PVDF layer. A significant change in the MR is observed between unpoled and poled states for devices with Co and NiFe electrodes. Interestingly, a sign reversal of the MR is detected after poling, indicating modification of the ferroelectric/ferromagnetic interface induced by electric polarization [2]. Devices with Fe_3O_4 electrode also show clear difference in MR upon polarization switching, confirming the influence of ferroelectric polarization on spin transport. These results demonstrate that both the choice of spin-polarized electrode and the ferroelectric states of PVDF play a key role in determining magneto-transport behaviour in organic MFSVs.

Keywords: Organic spin valve, spin-transport, multiferroic junction, polarization.

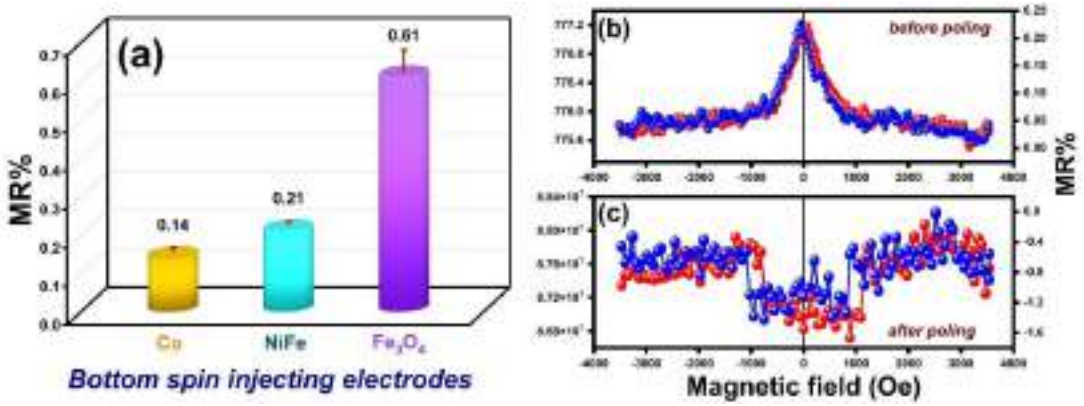


Fig. 1: (a) Comparison in MR among the MFSVs w.r.to different spin polarized bottom electrodes. Recorded MR loops of Co/PVDF/NiFe device (b) before and (c) after electrical poling.

References:

[1] J. Roy, P. Ravi Teja, Devadarsan S, A.K. Alna, R.B. Gangineni, J. Phys. D: Appl. Phys. 59 (2026) 025003.

[2] S. Liang, H. Yang, H. Yang, B. Tao, A. Djeffal, M. Chshiev, W. Huang, X. Li, A. Ferri, R. Desfeux, S. Mangin, D. Lacour, M. Hehn, O. Copie, K. Dumesnil, Y. Lu, Adv. Mater. 28 (2016) 10204–10210.

Abstract ID: 288

FREQUENCY AND TEMPERATURE DEPENDENT DIELECTRIC BEHAVIOUR OF $SrFe_{12}O_{19}$ SYNTHESIZED VIA MICROWAVE REFLUXING METHOD

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Abstract: The monophasic M-type $SrFe_{12}O_{19}$ was prepared by microwave refluxing technique followed by sintered at 900 °C for 6 h. The microwave exposure to the material facilitated its formation at lower temperature in lesser time compared to the conventional processes. The XRD analysis suggests its monophasic nature whereas EDS analysis shows nearly equal compositions of the constituents as that of the formula. The saturation magnetization (M_S) value was found to be 50.3 emu/g with M_r and H_C values of 27.6 emu/g and 5.20 kOe respectively for the single phase sample. The dielectric, electrical transport, and impedance-related studies have been performed as a function of the frequency ranging from 20 Hz to 10 MHz and the temperature between 25 to 500 °C. This dielectric exhibit Debye-like dipolar response which was confirmed from dielectric and impedance results. Continuous rise in the ac conductivity with increased frequency and temperature was noticed. Nevertheless, the effect of temperature was relatively higher than the frequency. The real part of the dielectric modulus suggests an increase in the charge carrier mobility with increased temperature and frequency. In contrast, the imaginary part exhibits relaxation peak which reflects the shifting of mobility of the charge carriers from long to short range order.

Keywords: Hard magnets; strontium hexaferrite; microwave refluxing; dielectric behaviour; impedance spectroscopy.

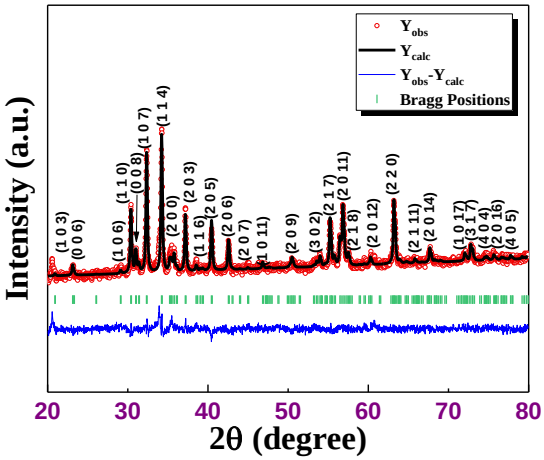


Fig. 1: Rietveld refinement of the XRD pattern of the monophasic strontium hexaferrite prepared via microwave refluxing method.

References:

[1] C. Mohapatra, S.K. Shaw, N.S. Anuraag, R. Sain, D. Kumar, D. Sarkar, C. Upadhaya, and N.K. Prasad, Journal of Alloys and Compounds 1031, 181058, 2025.

Abstract ID: 289

GEOMETRY-DRIVEN MAGNETIZATION REVERSAL IN ARTIFICIALLY PATTERNED AND CHEMICALLY SYNTHESIZED MAGNETIC NANOSTRUCTURES

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Abstract: Magnetization reversal in magnetic nanostructures is governed by geometric confinement, surface morphology, and collective magnetic interactions, making it central to the design of nanoscale functional materials for data storage and biomedical applications. In this work, we present a unified study of magnetization reversal in two complementary systems: artificially patterned magnetic lattices fabricated by nanosphere lithography and chemically synthesized chains of nickel nanostars.Micromagnetic simulations are carried out on a hexagonally symmetric artificial magnetic lattice composed of curved triangular cobalt elements, representative of thin-film structures formed via normal-incidence shadow mask deposition. Hysteresis loops, spin configurations, and individual energy contributions are systematically analyzed for film thicknesses ranging from 4 to 8 nm. The results reveal strong thickness-dependent variations in the reversal mechanism. In particular, the evolution of the total magnetic energy is primarily governed by changes in the Zeeman energy, which are attributed to thickness-driven modifications in spin canting and nonuniform magnetization states during reversal.Complementing this top-down approach, we experimentally investigate magnetization reversal in chemically synthesized nickel nanostar chains, focusing on the effects of surface roughness and structural assembly. The spike-like surface morphology significantly alters the local magnetic energy landscape, while self-assembled chain configurations generate pronounced dipolar interactions that strongly influence collective switching behavior and hysteresis characteristics.Together, these findings demonstrate how geometric design, surface structure, and assembly pathways dictate spin textures and energy landscapes across distinct fabrication strategies, providing a comprehensive framework for tailoring magnetization reversal in nanoscale magnetic systems.

Keywords: Magnetization reversal, Magnetic nanostructures, Micromagnetic simulations, Artificial magnetic lattices, Nickel nanostars, Dipolar interactions.

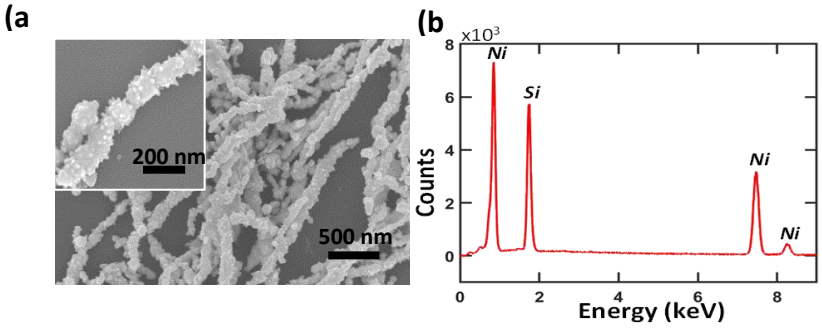


Fig. 1: (a) SEM image and (b) EDX analysis of Ni nanostar chains.

References:

[1] Ravichandran, S., et al., Nanotechnol. Rev., 14(1), 20250223,(2025).
[2] Ravichandran, S., et al., Mater. Lett., 383, 137922, (2025).
[3] A. Vansteenkiste., et al., AIP Adv.,4, 107133,(2014).

Abstract ID: 290

DUAL-FUNCTION MAGNETIC DOUBLE PEROVSKITE HYBRID FOR HEAVY-METAL ADSORPTION WITH REGENERATION-ENABLED WATER SPLITTING

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Abstract: Magnetically separable functional materials that couple wastewater remediation with energy conversion offer a sustainable route toward circular water–energy technologies. Herein, we develop a core–shell hybrid consisting of ferrimagnetic double perovskite $Sr_2FeMoO_{6-\delta}$ (SFMO) as a conductive and magnetically recoverable core, coated with an FeOOH shell that provides abundant surface hydroxyl sites for heavy-metal adsorption and transforms into an active oxyhydroxide surface under alkaline polarization. The SFMO@FeOOH hybrid enables rapid magnetic separation after adsorption, achieving efficient removal of model heavy-metal ions from aqueous media and maintaining adsorption capacity over repeated adsorption–regeneration cycles. After regeneration, the same material functions as a robust electrocatalyst in alkaline electrolyte, delivering improved charge transfer and stable activity for water splitting. Importantly, electrochemical performance is further demonstrated using KOH prepared with metal-removed water, highlighting operational tolerance toward practical water matrices while retaining controlled benchmarking conditions. This work presents a recyclable, magnetically retrievable platform that bridges pollutant capture and hydrogen generation within a single materials framework.

Keywords: Magnetic double perovskite, Magnetic separation, Alkaline electrolysis.

References:

[1] Chmaissem, O., Kruk, R., Dabrowski, B., Brown, D. E., Xiong, X., Kolesnik, S., Jorgensen, J. D., Kimball, C. W. (2000) Structural phase transition and the electronic and magnetic properties of Sr2FeMoO6. *Physical Review. B, Condensed Matter*, *62*(21), 14197–14206. https://doi.org/10.1103/physrevb.62.14197

Abstract ID: 291

GROWTH OF Mn_3Sn KAGOME LATTICE VIA SEED LAYER ENGINEERING: STRAIN ENGINEERING OF PIEZO-MAGNETISM

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Abstract: The growth of strain-engineered Kagome lattices, such as the non-collinear antiferromagnet Mn_3Sn, is a prime material candidate for room-temperature piezomagnetism. However, a large lattice mismatch between Mn_3Sn and the substrate, such as Al_2O_3, impedes epitaxial growth without a seed layer. In addition, strain transfer from the seed layer to Mn_3Sn requires a critical thickness regime where strain transfer can be engineered. Here, we investigate a systematic study by employing Ru as a seed layer as a function of its deposition temperature and thickness. From our preliminary XRD results, it is observed that Ru grows epitaxially with a minimum temperature of 250℃. The thickness-dependent results show that below 5 nm, Ru exhibits coherent growth with a bulk out-of-plane strain of +2% due to in-plane compression. The reciprocal space mapping (RSM) of Al_2O_3 and Ru directly proves the XRD observations. Based on the strained seed Ru layer, Mn_3Sn is sputter-deposited at room temperature and annealed below the Ru deposition temperature. Preliminary transmission electron microscopy images confirm that Mn_3Sn grows coherently on Ru, suggesting a strain-transfer mechanism. Our results show the potential for strain engineering via seed-layer thickness.

Keywords: non-collinear, anti-ferromagnets, epitaxial thin film, piezo-magnetism.

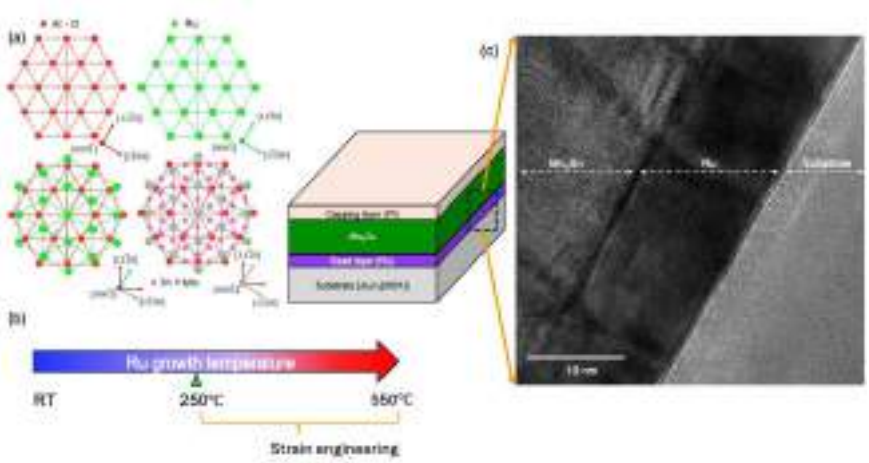


Fig. 1: (a) Modelling of epitaxial Mn_3Sn growth via seed Ru layer with rotational symmetry. (b) Representation of optimum growth and annealing temperature for Ru and Mn_3Sn, respectively. (c) cross-sectional HRTEM image of the epitaxial Al_2O_3/Ru/Mn_3Sn stack.

References:

[1] Jungwirth, T.; Marti, X.; Wadley, P.; Wunderlich, J. Antiferromagnetic Spintronics. *Nat Nanotechnol* 2016, *11* (3), 231–241.

Abstract ID: 292

ANGULAR FLUX COUPLING AND MAGNETIC ANISOTROPY IN EPITAXIAL YIG NANOSTRUCTURES PROBED BY μ-SQUID

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Abstract: We grew 40 nm thick epitaxial $Y_3Fe_5O_{12}$ (YIG) films by RF sputtering in three different crystallographic orientations—(111), (110), and (100)—on $Gd_3Ga_5O_{12}$ (GGG) substrates. The films were patterned and placed in the vicinity of μ-SQUID loops using focused ion beam (FIB) techniques, enabling efficient nanoscale magnetic flux detection. The sample placement and the in-plane external magnetic field configuration are illustrated in Fig. 1. We investigate angular flux coupling between μ-SQUIDs and epitaxial YIG thin films with different crystallographic orientations, and the anisotropy dependence of this coupling. Angularly resolved magnetization hysteresis loops were measured under rotating in-plane magnetic fields at low temperatures. For YIG (111), the coupling shows a sinusoidal angular dependence, principally determined by the geometric projection of the magnetization onto the SQUID loop, consistent with its weak in-plane anisotropy. In contrast, YIG (110) and YIG (100) show clear deviations from sinusoidal behavior due to two-fold and four-fold magnetocrystalline anisotropy, respectively. In YIG (100), abrupt changes in coupling occur as the field crosses hard axes. Furthermore, rotational hysteresis is observed in YIG(100), attributed to exchange-bias-like effects arising from a spin-frustrated interfacial layer at the YIG/GGG interface [1]. A modified Stoner–Wohlfarth model incorporating cubic anisotropy and interfacial exchange captures the main experimental features. These results demonstrate that angular μ-SQUID flux coupling provides a sensitive probe of anisotropy and interfacial spin disorder in nanoscale magnetic systems.

Keywords: μ-SQUID, YIG, Magnetocrystalline Anisotropy, Rotational hysteresis.

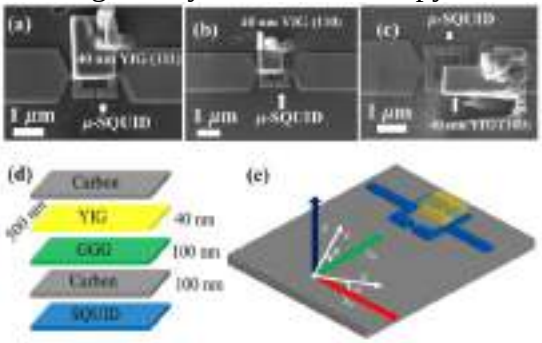


Fig. 1: (a-c) show the YIG (111), YIG (110), and YIG (100) placed on top of the μ-SQUID using FIB technique respectively, (d) Schematic illustrating all the layers used to position the sample on μ-SQUID, and (e) shows the alignment of the magnetic field with the μ-SQUID and YIG samples.

References:

[1] U. Thuwal, S. Maity, R. Pervin, R. Medwal et al., *arXiv preprint arXiv:2507.14493* (2025).

Abstract ID: 293

HIGH-GAIN ON-CHIP MAGNETIC FLUX CONCENTRATOR FOR ULTRA-SENSITIVE TMR SENSORS

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Abstract: An on-chip Magnetic flux concentrator (MFC) is an effective approach for enhancing the sensitivity of magnetoresistive sensors while maintaining a compact device footprint in millimeters[1]. In this report, the influence of size parameters on the external field amplification was systematically studied for a trumpet-shaped MFC using the Finite Element Method (FEM). The analysis conducted for a 1µm-thick trumpet MFC (Fig.(a)) made from permalloy (μ_r = 1000) with the outer width, inner width, length, and air gap separation of 4400 µm, 100 µm, 2150 µm, and 10 µm, respectively, resulted in a magnetic gain of 107 (Fig.(b)). It was observed that the magnetic gain is inversely proportional to the air gap (inset of Fig.(b)) [1]. The presence of air introduces a high reluctance in the flux's path, thereby limiting the achievable gain to below 110. In an effort to further enhance magnetic gain, the trumpet-shaped MFC was reconfigured with a 200 µm separation and stepped down toward a 20 nm-thick MTJ pillar (9 µm × 15 µm) through a 100 nm-thick rectangular MFC (95.5 µm × 50 µm). The efficacy of this configuration lies in eliminating the high reluctance magnetic path imposed by the air gap and establishing a closed-loop path of zero magnetic reluctance, thereby achieving a gain of the order of 10^4. Experimental validation is in progress, targeting a sensitivity of the order of 10^3%/mT, thereby pushing the detectivity into the pT-fT regime at low frequencies for biomedical applications [2].

Keywords: Magnetic Flux Concentrator, Flux amplification, Magnetic gain, Magnetic sensor.

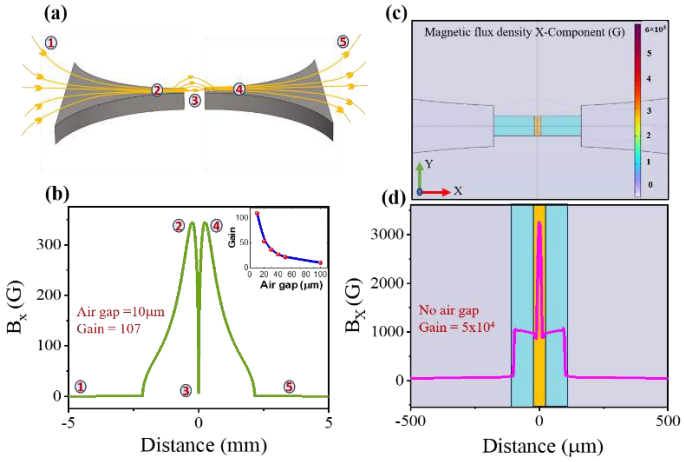


Fig. 1: (a),(b) Trumpet MFC with air gap and corresponding 1D field profile ;(c),(d) 2D and 1D field profile of modified MFC design without air gap.

References:

[1] C. T. Gopika *et al.*, "Enhancement of spin valve GMR sensor 's sensitivity with [Ta / NiFe] *n* on-chip magnetic flux concentrator," *J. Magn. Magn. Mater.* 616(2024).

[2] M. Oogane *et al.*, "Sub-pT magnetic field detection by tunnel magneto-resistive sensors," *Appl. Phys. Express*, 14 (2021).

Abstract ID: 294

TUNABLE SKYRMION STABILITY AND TRANSPORT IN W/CoFeB

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Abstract: Magnetic skyrmions, topologically protected spin textures, have emerged as promising nanoscale information carriers for next-generation spintronic devices. While high Dzyaloshinskii–Moriya interaction (DMI) systems are widely known to enable efficient skyrmion motion via spin–orbit torques, understanding skyrmion behavior in low-DMI structures remains crucial for practical device engineering. In this work, we investigate skyrmion formation and dynamics in a W/CoFeB heterostructure using micromagnetic simulations performed with MuMax^3. The system is discretized into 256 × 256 × 1 cells with a cell size of 2 × 2 × 1 nm³, employing material parameters from [1]. In the absence of an out-of-plane bias field, the system stabilizes into stripe domains. Upon applying an external field, these stripes progressively transform into skyrmions, reaching maximum density at 140 mT before complete annihilation at 220 mT. A field-dependent shrinkage of skyrmion size is observed, decreasing from 81 nm at 40 mT to 26 nm at 200 mT. Furthermore, skyrmion velocity is strongly influenced by current density: a low critical current density of 5×10^{10} A/m² enables nucleation, while increasing it to 1×10^{13} A/m² drives skyrmions at velocities up to 56 m/s. Ongoing investigations include the effects of in-plane magnetic fields, magnetic anisotropy, and DMI strength. This study provides key insights into skyrmion stabilization and controllable dynamics in low-DMI systems, offering practical design guidance for future heavy metal/ferromagnet-based skyrmionic devices.

Keywords: Magnetic skyrmions, Spin-orbit torque, W/CoFeB heterostructure.

References:

[1] Cheng, T.C., Zhang, L., Kurokawa, Y., Satone, R., Tokunaga, K. and Yuasa, H., 2025. Computational study of skyrmion stability and transport on W/CoFeB. *Scientific reports*, *15*(1), p.7708.

Abstract ID: 295

INFLUENCE OF GRAPHENE AND ANTIMONY UNDERLAYERS ON MAGNETIZATION DYNAMICS IN $Fe_{85}Co_{15}$ THIN FILMS

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Abstract: The magnetic properties of thin films are essential for driving advancements in spintronics, data storage, and other emerging magnetic technologies. Among these, FeCo thin films are particularly noteworthy due to their high saturation magnetization and ultra-low intrinsic Gilbert damping, making them ideal candidates for high-performance magnetic applications. One can tune the magnetic properties or make novel functionalities via interface engineering. In this context, two-dimensional (2D) materials such as graphene and antimony have garnered significant attention for their ability to influence thin-film properties through their unique physical and electronic characteristics. These atomically thin materials offer a platform to modulate magnetic interactions at the interface, where the strength of atomic interactions both among the deposited atoms and between the film and substrate plays a critical role in determining the structural and magnetic properties of thin films. In this context, we have studied Fe85Co15 (FeCo) thin films deposited on graphene, antimony, and graphene/antimony bilayer substrates. The presence of these underlayers was confirmed through Raman spectroscopy. One key observation is the variation in coercivity among the different heterostructures. Specifically, FeCo films grown on antimony layers exhibit higher coercivity compared to those grown on graphene or graphene/antimony bilayers. Further insights were obtained through ferromagnetic resonance (FMR) studies, which revealed the presence of two-magnon scattering in the systems. An enhancement in Gilbert damping was observed in the bilayer structures compared to the reference FeCo films without underlayers. This interaction highlights the role of 2D materials in influencing dynamic magnetic properties and demonstrates their potential in fine-tuning damping and spin-transfer effects for spintronic applications.

Keywords: 2D materials, Graphene, Interface, Magnetization dynamics

Abstract ID: 296

PERPENDICULARLY MAGNETIZED SYNTHETIC ANTIFERROMAGNETS FOR BENDABLE SPINTRONIC DEVICES

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Abstract: Synthetic antiferromagnets (SAFs), consisting of ferromagnetic (FM) layers separated by non-magnetic spacers, are essential building blocks for next-generation spintronic devices due to their low stray fields, rapid switching dynamics, and enhanced robustness against external perturbations. The antiferromagnetic alignment in these systems originates from Ruderman–Kittel–Kasuya–Yosida (RKKY) interlayer exchange coupling (IEC). While most flexible magnetoelectronic devices have traditionally relied on in-plane magnetized giant magnetoresistance architectures, materials with perpendicular magnetic anisotropy (PMA) are more suitable for scalability and thermal stability for high-density memory applications. In this work, we investigate the tunability of RKKY-type IEC in PMA-based SAF multilayers with a Pt/CoFeB/Pt/Ru/Pt/CoFeB/Pt architecture, fabricated on both rigid and flexible substrates. The insertion of an ultrathin Pt dusting layer between the Ru spacer and CoFeB stabilizes PMA in ultrathin CoFeB layers while enabling controlled modulation of the IEC strength. Furthermore, we examine the effect of externally applied tensile strain on the magnetic coupling and domain evolution. Remarkably, tensile strain induces a transition from antiferromagnetic to ferromagnetic coupling, accompanied by domain reversal. These findings provide important insights into mechanically tunable SAF systems and open new pathways toward flexible and strain-engineered spintronic devices.

Keywords: Ruderman – Kittel – Kasuya – Yosida (RKKY) Coupling, strain, synthetic antiferomagnets.

Abstract ID: 297

FUNCTIONAL PROPERTY ENGINEERING OF COBALT MAGNESIUM FERRITE BY Al^{3+}/Cr^{3+} Co-SUBSTITUTION

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Abstract: $Co_{0.5}Mg_{0.5}Fe_{2-2x}Al_xCr_xO_4$ (x = 0.00 - 0.25) spinel ferrite series has been synthesized by the sol-gel method and sintered at 1100 °C. XPS confirms mixed valence states of Co, Cr and Fe (Co^{2+}/Co^{3+}, Cr^{2+}/Cr^{3+} and Fe^{2+}/Fe^{3+}), while Al and Mg remain predominantly as Al^{3+} and Mg^{2+}. Rietveld-refined XRD establishes a single-phase cubic spinel structure and FTIR verifies cation distribution over tetrahedral (A) and octahedral (B) sites. SEM reveals grain size variation with co-substitution. Cation distribution analysis supported by magnetic trends, indicates progressive replacement of Fe^{3+} by Al^{3+}/Cr^{3+} at B sites and migration of Co^{2+} to A sites with increasing co-substitution. Room-temperature magnetization shows a systematic decrease in coercivity (H_C) from 496 Oe (x = 0.00) to 216 Oe (x = 0.25), driven by reduction in magnetocrystalline anisotropy (K_1) due to Co^{2+} migration from B to A sites. Saturation magnetization (M_S) decreases steadily owing to magnetic dilution by nonmagnetic Al^{3+}, lower magnetic moment of Cr^{3+} and weakened A-B superexchange interactions from cation redistribution. Dielectric constant and loss exhibit non-monotonic behavior, peaking at x = 0.10 and minimizing at x = 0.15, governed by microstructure, porosity and polarization mechanisms. The enhanced high-frequency stability at x = 0.15 makes it suitable for miniaturized filters and resonators. Structural, dielectric and magnetic correlations demonstrate tunable multifunctionality of Al^{3+}/Cr^{3+} co-substituted Co-Mg ferrites for sustainable device applications.

Keywords: Spinel ferrite, Cobalt magnesium ferrite, Cation redistribution, Magnetocrystalline anisotropy

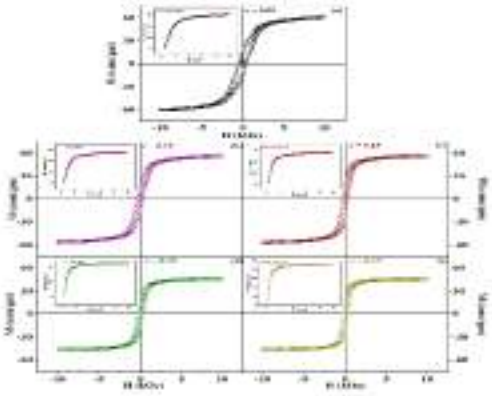


Fig. 1. (a-e) M-H loops at room temperature for $Co_{0.5}Mg_{0.5}Fe_{2-2x}Al_xCr_xO_4$ (x = 0.0 - 0.25) samples; the inset shows the initial curve fitted to LA.

References:

[1] S. J. Salih, W. M. Mahmood, Review on magnetic spinel ferrite (MFe_2O_4) nanoparticles: From synthesis to application, Heliyon. 9 (2023) e16601.

[2] V. Jeseentharani, M. George, B. Jeyaraj, A. Dayalan, K. S. Nagaraja, Synthesis of metal ferrite (MFe_2O_4, M = Co, Cu, Mg, Ni, Zn) nanoparticles as humidity sensor materials, J. Exp. Nanosci. 8 (2012) 358 - 370.

[3] P. A. M. Vitor, J. Venturini, J. B. M. da Cunha, C. P. Bergmann, J. Alloys Compd. 851 (2021) 156799.

Abstract ID: 298

ADVANCED MAGNETOCALORIC MATERIALS FOR SOLID-STATE MAGNETIC REFRIGERATION: PROPERTIES, PERFORMANCE ANALYSIS, AND SUSTAINABLE COOLING APPLICATIONS

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Abstract: Traditional refrigeration systems uses vapour-compresion method for cooling. This is harmful to the environment as it uses fluoro-carbon-based gases, viz., HCFCs, CFCs, etc. They are greenhouse gases, thus it increases the global warming. Hence, it is essential to find an alternative solution to this traditional method. An alternative method is magnetic refrigeration, which is environmentally friendly. This uses the magnetocaloric effect (MCE). MCE is an energy-efficient and eco-friendly [1]. MCE uses the reversible temperature change concept. Certain magnetic materials, such as gadolinium and its alloy, havea significant entropy change at room temperature [2,3]. Thus, it is a suitable material for soil-state cooling applications. Magnetocaloric materials parameters, like thermodynamic principles, material properties, and performance related to refrigeration cooling systems was analyzed in this study [4,5]. Coefficient of Performance (COP) and the environmental impact of both magnetic cooling methods and traditional cooling methods are compared. In domestic appliance cooling and medical storage cooling, the MCE method of cooling shows a strong potential. Thus, the outcome of the study emphasizes the future possibilities of magnetic cooling systems. This concept reduces global warming and improves energy efficiency.

Keywords: Magnetocaloric effect, Gadolinium, cryogenic applications, magnetic cooling systems, coefficient of performance (COP).

References:

[1] Pecharsky, V. K., & Gschneidner Jr, K. A. (1997). Giant magnetocaloric effect in gd 5 (si 2 ge 2). Physical review letters, 78(23), 4494.

[2] Pecharsky, V. K., & Gschneidner Jr, K. A. (1999). Magnetocaloric effect and magnetic refrigeration. Journal of magnetism and magnetic materials, 200(1-3), 44-56.

[3] Brown, G. V. (1976). Magnetic heat pumping near room temperature. Journal of Applied Physics, 47(8), 3673-3680.

[4] Zarkevich, N. A., & Zverev, V. I. (2020). Viable materials with a giant magnetocaloric effect. Crystals, 10(9), 815.

[5] O. Tegus, E. Brück, K.H.J. Buschow, F.R. de Boer, Nature 415 (2002) 150–152

Abstract ID: 299

EVIDENCE FOR GRIFFITHS PHASE: MAGNETIZATION VS ELECTRON PARAMAGNETIC RESONANCE

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Abstract: The presence of quenched disorder in a paramagnetic material undergoing a transition to either an antiferromagnetic or a ferromagnetic phase can lead to Griffiths-like Phase (GP) characterized by formation of clusters of the ordered phase above the transition temperature [1]. A downward deviation from the Curie-Wiess behavior in the paramagnetic phase in the temperature dependence of the inverse susceptibility ($1/\chi$) is taken to provide the signature of GP. This deviation is field dependent, being more pronounced for lower fields and decreasing with increasing fields. However, this criterion is questioned in the light of formation of ferromagnetic polarons also leading to similar result [2]. Concomitantly, Electron Paramagnetic Resonance (EPR) through the occurrence of ferromagnetic resonance signal whose intensity variation with temperature is similar to that of magnetic susceptibility is provided as evidence for the formation of GP in many studies [3]. In this work we examine the validity of these criteria in detail by analyzing the magnetization and EPR results on nano samples of $Sm_{0.35}Ca_{0.65}MnO_3$ (dia 15 nm) [4] where non-GP deviation (upward from CW law) is observed at higher temperatures, but for lower temperatures the surface ferromagnetism results in GP-like (downward from CW law) deviation.

Keywords: Griffith's phase, quenched disorder, susceptibility, Electron Paramagnetic Resonance, ferromagnetic polarons.

References:

[1] J. Deisenhofer et al., Phys. Rev. Lett. 95(12), 257202 (2005)
[2] J. A. Souza[1,*],J. J. Neumeier,[1] and Yi-Kuo Yu[2], PHYSICAL REVIEW B 78, (2008) 014436
[3] R.M. Eremina Applied Magnetic Resonance (2025) 56:559–579
[4] Lora Rita Goveas, Bhagyashree K. S., Anuradha K.N., S.V. Bhat. AIP Advances, 11, (2021) 025313

Abstract ID: 300

HYDROTHERMALLY SYNTHESIZED MAGNETIC $NiCo_2O_4/CoMoO_4$ HETEROSTRUCTURE FOR EFFICIENT VISIBLE-LIGHT PHOTOCATALYTIC WASTEWATER TREATMENT

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Abstract: Developing sustainable and effective photocatalysts is essential for solving environmental issues related to organic pollution remediation and wastewater treatment. In this study, a magnetic spinel-type $NiCo_2O_4$-decorated $CoMoO_4$ nanocomposite was successfully synthesised via a hydrothermal method. The synthesised materials were evaluated for their crystalline structure, surface morphology, and optical properties. The $NiCo_2O_4/CoMoO_4$ heterostructure outperformed pure $NiCo_2O_4$ and $CoMoO_4$ in the photocatalytic degradation of Methyl Red (MR) dye under visible-light irradiation, achieving a significant elimination efficiency after 60 min. The improved photocatalytic activity of the catalysts was attributed to the enhanced separation of photogenerated charge carriers, optimized band alignment, reduced band gap, increased number of available active sites, and enhanced redox capacity at the heterojunction interfaces [1]. The intrinsic magnetic properties of $NiCo_2O_4$ facilitate the recovery and reuse of the catalysts after chemical reactions. Finally, the $NiCo_2O_4$ and $CoMoO_4$ nanocomposite is a low-cost, easily synthesized, stable, and eco-friendly material with great potential as a sustainable, practical option for wastewater treatment [2].

Keywords: Sustainable, hydrothermal, magnetic heterojunction, photocatalyst, wastewater remediation.

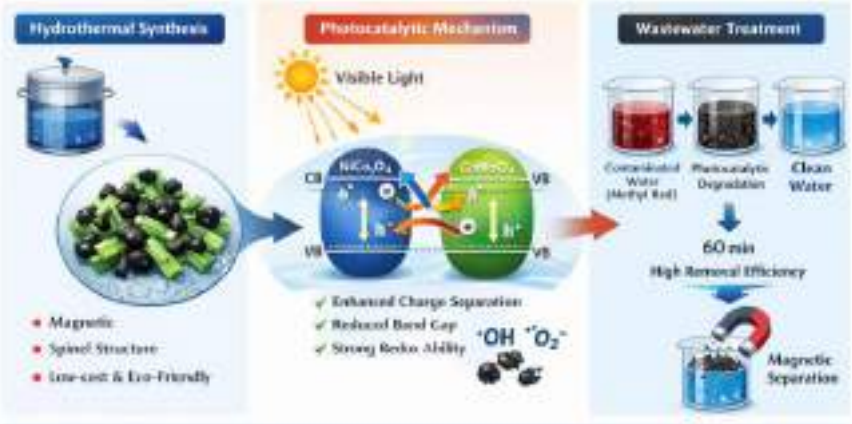


Fig. 1: Magnetically recoverable $NiCo_2O_4/CoMoO_4$ heterostructure for dye degradation under visible light

References:

[1] Linfeng Jin et al, A perspective on $NiCo_2O_4$-based photocatalysts: from fundamentals, modification strategies to applications (2025).

[2] Prathibha C.P. et al, Synthesis of binary $NiCo_2O_4/ZnO$ composites as efficient photocatalysts for methylene blue degradation under visible light (2025).

Abstract ID: 301

DEVELOPMENT AND CHARACTERIZATION OF EXCHANGE COUPLED MnAl/CoNi MAGNETIC BILAYER THIN FILMS

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Abstract: The binary Mn-alloys system like MnAl, MnGa, MnBi has drawn more attention as a substitute towards permanent magnet, made of non-rare earth elements [1]. Among rare-earth free permanent magnets, $L1_0$-MnAl(τ-phase) alloys show promise due to their strong magnetocrystalline anisotropy, high maximum magnetic energy density, and high coercivity [2]. Recently exchange coupled hard/soft magnetic bi-layers were considered to improve the overall magnetic properties of MnAl thin film [3].An exchange-coupled hard-soft permanent magnet is a composite material in which hard and soft phases are intimately mixed at the nanoscale and are coupled via interfacial exchange interactions, which allows the soft phase to share its high magnetic moment with the hard phase. The CoNi thin film shows soft ferromagnetic behavior when deposited on Si substrate [4]. This work presents a systematic investigation of the magnetic properties of MnAl/CoNi bilayer thin films corelation with its crystal structure, thickness and surface roughness.We deposited MnAl/CoNi thin films on a Si(100) substrate by using RF and DC magnetron sputtering system. A 3D optical profilometer was used to measure the deposited thin film's thickness and surface roughness. X-ray diffractometers (XRD) was used to examine the crystal structure and the magnetic properties were investigated through VSM. With proper tuning of the deposition conditions and layer thickness, a strong magnetic exchange coupling was achieved between the MnAl and CoNi thin films. The findings presented in this research may be applied to improve MnAl thin-film magnetic performance.

Keywords: Thin film, Magnetic Anisotropy, Permanent Magnet, Exchange Coupled

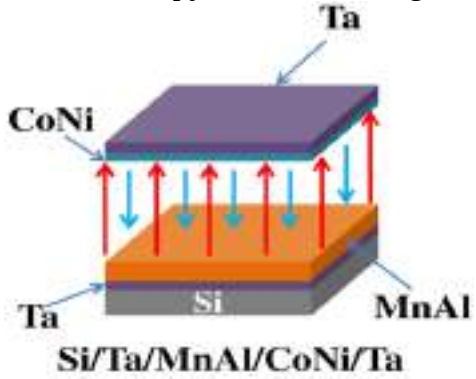


Fig. 1: Figure shows the exchange coupled between MnAl and CoNi layer thin film

References:

[1] D. Rajbanshi, N. Deka, S. Sarkar, S. K. Srivastava, Journal of Alloys and Compounds.1037(2025)182388.
[2] S. H. Nie, L. J. Zhu, J. Lu, D. Pan, H. L. Wang, X. Z. Yu, J. X. Xiao, and J. H. Zhaoa, Applied Physics Letters.102(2013)152405.
[3] Junhua You, Yaozu Guo, Journal of Alloys and Compounds.758(2018)116.
[4] Subrata Sarkar, Rafikul Hussain, Dhananjoy Rajbanshi, Sandeep Kumar Srivastava, Metal Mat. 1 (2024) e29.

Abstract ID: 302

TUNING THE PHYSICAL PROPERTIES OF CHROMIUM TELLURIDE SYSTEM VIA Cr SELF-INTERCALATION

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Abstract: Quasi-two dimensional (2D) magnetic van der Waals materials have gained emerging attention in the field of spintronics. Chromium telluride (Cr-Te) system belongs to this family of materials, which is known for its intrinsic ferromagnetism and tunability of properties. A series of single crystals of Cr-Te system represented by $Cr_{1+\delta}Te_2$ with $0<\delta<1$, were grown by using flux and the chemical vapour transport method. Here δ is the fraction of the Cr atom self-intercalated in the van der Waals gap formed by the two Te layers in the Cr-Te system. Irrespective of the crystal growth method employed, the growth direction of the Cr-Te system was found to be along the c-axis. The magnetisation measurements revealed the coexistence and competition between ferromagnetic and antiferromagnetic exchange interactions due to the presence of the intercalated Cr layers in these system. A series of diverse magnetic transitions is exhibited by these crystals. A few members of the series are also found to exhibit signatures of hosting skyrmions. Furthermore, concomitant to their magnetic transitions, anomalies were observed in the temperature-dependent Raman spectra of crystals having lower d, evidencing a strong spin-charge-phonon coupling effect intrinsic to them. With increasing δ from 0 to 1, a shift in the magnetic anisotropy from out of plane to in-plane and an enhancement in the Curie temperature to near room temperature was observed. Therefore, the intercalated Cr-layer provides a tuning knob to alter the physical properties of the Cr-Te system for the technological applications [1].

Keywords: Transition metal chalcogenides, 2D-Magnetism, Cr self-intercalation, Spin-charge-phonon coupling effect

References:

[1] V Gayathri, M Sathishkumar, Sandip Kumar Kuila, Vikash Kumar, B Abhidev, Reshna Elsa Philip, Partha Pratim Jana, Soham Manni, arXiv:2507.13760 (2025).

Abstract ID: 303

PHOTOVOLTAIC PERFORMANCE ANALYSIS OF PEROVSKITE SOLAR CELLS EMPLOYING $HoFeO_3$ AS ELECTRON TRANSPORT LAYER: A COMBINED DFT & SCAPS-1D SIMULATION STUDY

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Abstract: Perovskite solar cells have gained significant attention due to their high power conversion efficiencies and economically less expensive manufacturing compared to traditional silicon-based solar cells. In this study, the photovoltaic performance of a perovskite solar cell is investigated by varying different hole transport layers (HTLs) such as Spiro-OMeTAD, PTAA, P3HT, PEDOT:PSS, Poly-TPD, NiO, Cu_2O, CuSCN, MoO_3, and V_2O_5, while keeping the electron transport layer (ETL) fixed as Holmium Ferrite Oxide ($HoFeO_3$). $HoFeO_3$ is selected because of its suitable band gap, good structural and chemical stability, and promising ETL characteristics. Its wide band gap provides high transparency, allowing more light to reach the perovskite layer. It promotes efficient electron transport while blocking holes, which helps reduce interfacial recombination. In addition, its proper band alignment make it suitable for stable and efficient device performance. The electronic properties of $HoFeO_3$ were analyzed using DFT to confirm its effectiveness as an ETL material. The perovskite device structure was further explored using SCAPS-1D simulation to study different characteristics such as current-voltage (I-V) curves, temperature effects, series and shunt resistance, defect density, HTLs variation, thickness optimization, and different metal work functions. By keeping the ETL constant, the effect of each HTL on key performance parameters such as open-circuit voltage (Voc), short-circuit current density (Jsc), fill factor (FF), and power conversion efficiency (PCE) was examined. This work confirms the suitability of $HoFeO_3$ as an efficient and stable ETL for perovskite solar cell performance and highlights its potential for next-generation high efficiency photovoltaic application.

Keywords: Perovskite Solar Cell, Power Conversion Efficiency, Electron Transport Layer, Photovoltaic performance.

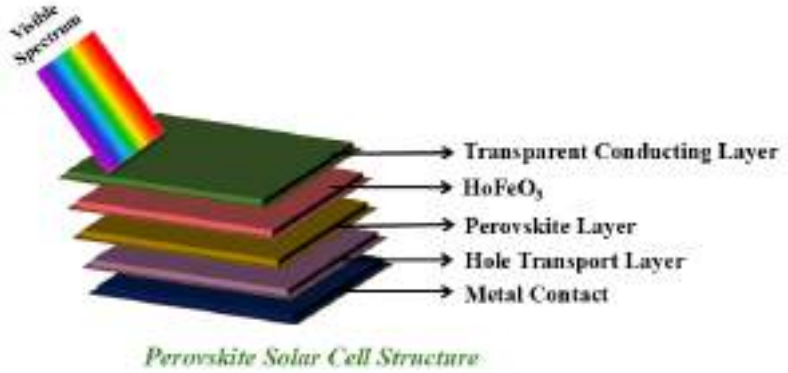


Fig. 1: Illustrates the perovskite solar cell structure.

References:

[1] A. Bouhenna, K. Benyahia, A. Aissat, H. Soufi, N. Beloufa, **J. Indian Chem. Soc.** 102 (2025) 102087.

Abstract ID: 304

CONTROLLING ORBITAL CURRENT DETECTION VIA ENGINEERING OF LAYER FOR ORBITAL-SPIN CONVERSION

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Abstract: Electrons possess both spin and orbital angular momentum (OAM). While spintronics has primarily exploited the spin degree of freedom, recent studies have demonstrated that OAM can actively participate in transport phenomena in solids. In particular, the Orbital Hall Effect (OHE), which generates a transverse orbital current under an applied electric field, can occur even in the absence of spin-orbit coupling (SOC)[1,2]. Consequently, several low-SOC transition metals such as Cr exhibit exceptionally large orbital Hall conductivity, positioning orbital currents as a promising resource for spintronic applications. Here, we investigate orbital current generation, conversion, and detection using $Co_{40}Fe_{40}B_{20}$ (CFB) as the source and Cr as the orbital current sink. A substantial enhancement of the detected signal is observed in Cr/CFB bilayers upon insertion of a thin Pt layer (1.6 nm), which acts as an efficient orbital-spin conversion medium. Thickness-dependent measurements reveal that the inverse spin–orbital Hall effect (IS-OHE) signal increases with Cr thickness up-to 10 nm, indicating efficient orbital angular momentum absorption[3]. Furthermore, introducing a W layer on the opposite side of CFB enables orbital-spin conversion at both interfaces. Despite the opposite SOC signs of Pt and W, a modest signal enhancement is observed at higher Cr thicknesses, suggesting cumulative orbital current contributions. These results demonstrate that conversion layer engineering provides a viable route for controlling orbital-current-mediated spin transport.

Keywords: Orbital Hall Effect, Orbital Current, Spin Current, Spin-orbit Coupling

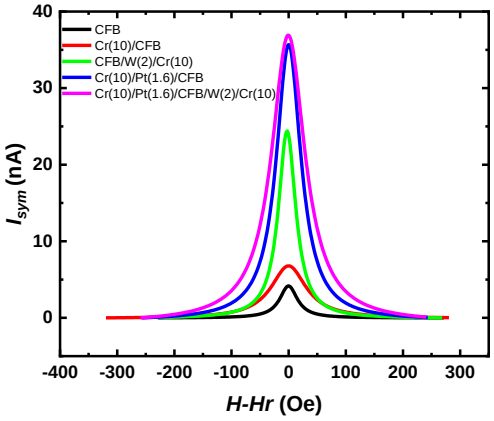


Fig. 1: IS-OHE signal of different samples.

References:
[1] D Go et al., Phys. Rev. Lett. 2018, 121, 086602
[2] L. Salemi et al., Phys. Rev. Materials 2022, 6, 095001
[3] H. Hayashi et al., Nature Electronics 2024, 7, 646–652

Abstract ID: 305

SHAPE-INDUCED ANISOTROPY IN BULK AND COMPOSITE FREE LAYER FOR ENHANCED LINEAR MAGNETIC RESPONSE

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Abstract: The control of magnetization reversal in the the free layers (FLs) of magnetic tunnel junctions (MTJs) is crucial in linear sensing spintronic device applications. In this work, we investigate the magnetization behaviour of composite free layer (CFL) structures patterned into elliptical and circular pillar geometries, as shown in Fig.1(a) and (d), using longitudinal magneto-optical Kerr effect (MOKE) measurements. The CFL consists of CoFeB coupled through a spacer layer with (i) NiFe (bulk CFL) and (ii) [FM/NM/FM] (ferromagnetic/non-magnetic spacer/ferromagnetic) multilayer structure. While the circular CFL films exhibits a symmetric hysteresis loop with negligible shape anisotropy (as shown in Row2 of Fig.1), the elliptical structure CFLs demonstrate a pronounced shape-induced anisotropy ($H_K=|H_{\parallel}-H_{\perp}|$), leading to a distinct easy and hard axes switching behaviour (as shown in Row1 of Fig.1). Furthermore, the bulk CFL samles demonstrate an abrupt switching with limited linear region, shown in Fig.1(b) and (e). In contrast, the multilayer CFL structures exhibit reduced coercivity with gradual magnetic FL rotation leading to an extended linear region, shown in Fig.1(c) and (f). This enhanced linearity can be attributed to interlayer exchange coupling and modified anisotropy within the multilayer CFL stack. This leads to the suppression of abrupt reversal of magnetization and promotes cohoerent rotation-dominated reversal. The study highlights the combined effect of controlled shape anisotropy and multilayer coupling in FL to achieve a linear magnetic response, providing an insight for the optimization of MTJ stack in spintronic and magnetic field sensing applications.

Keywords: Magnetic Sensors, Composite Free Layer, Shape Anisotropy, MOKE.

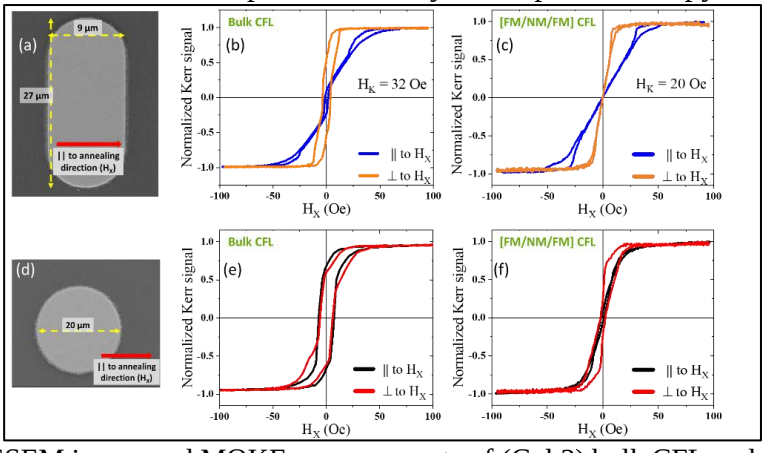


Fig. 1: (Col.1) FESEM image and MOKE measurements of (Col.2) bulk CFL and (Col.3) multilayer CFL of a single pillar in (Row1) elliptical and (Row2) circular shape, respectively.

References:

[1] L. Huang, Z. H. Yuan, B. S. Tao, C. H. Wan,et al., Journal of Applied Physics 122, (2017) 113903

Abstract ID: 306

SYNERGISTIC EFFECT OF SILVER NANOPARTICLE DOPED $NiZnFe_2O_4$-rGO/POLYINDOLE QUATERNARY NANOCOMPOSITE ON THE THERMAL, DIELECTRIC, AND MAGNETIC PROPERTIES

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Abstract: A simple two-step approach has been developed to synthesize silver nanoparticle doped $NiZnFe_2O_4$ coated reduced graphene oxide reinforced polyindole quaternary nanocomposite, which is utilized as an electrode material for supercapacitor applications. In this method, Ag@$NiZnFe_2O_4$ (Ag@NZF) nanoparticles are first anchored onto reduced graphene oxide (rGO) by sol-gel method, followed by the coating with polyindole (PIN) via in situ emulsion polymerization method. This combination of hybrid material has a favourable mesoporous structure that enables high exposure of active sites for fast electron transport for supercapacitor applications. The synthesized products are characterized by various sophisticated instruments like X-ray diffraction (XRD), X-ray spectroscopy (XPS), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), transmission electron microscopy (TEM), Raman spectroscopy, Fourier transform infrared spectroscopy (FTIR), and also study the thermal, dielectric and magnetic properties using TG-DSC, LCR meter and VSM.

Keywords: Nickel Zinc Ferrite, reduced graphene oxide, polyindole, nanocomposite.

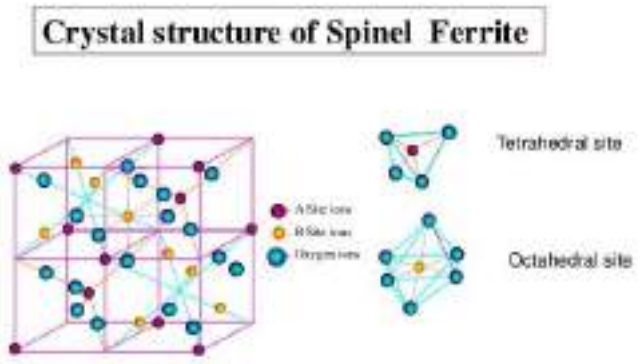


Fig. 1: Crystal structure of spinel ferrite.

References:

[1] A. Thadathil, Y.A. Ismail, P. Periyat. RSC advances. 11.57 (2021) 35828-35841.

Abstract ID: 307

UNVEILING MAGNETIC AND MAGNETOELECTRIC PROPERTIES OF La SUBSTITUTED M-TYPE BARIUM HEXAFERRITES

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Abstract: Emerging low-power, high speed memory technology require materials that operate under low magnetic field unlike conventional systems that consume high energy. M-type barium hexaferrites are attractive for next generation spintronic due to their robust ferrimagnetism, high transition temperature and structural stability. Rare-earth substitution effectively tailors magnetic and multiferroic properties by introducing lattice distortion, altering valance states and modifying super exchange interactions. In the present work, La substituted Barium hexaferrites, $Ba_{(1-x)}La_{(x)}Fe_{12}O_{19}$, ($x$=0.0-0.20), were systematically investigated to understand structural, morphological, chemical, magnetic, ferroelectric and magnetoelectric properties. The samples were synthesised using ball milling followed by heat treatment at 1150˚C. The Rietveld refinement of X-ray diffraction pattern confirms a single-phase magnetoplumbite structure of barium hexaferrite belong to $P6_3/mmc$ space group for all compositions. Morphological studies reveal irregular-sized, hexagonal plate-like grains with an average grain size of 3µm – 5µm. The Mossbauer spectroscopy suggests the charge neutrality is primarily maintained through oxygen vacancy formation. The magnetic measurements at 300K exhibit ferrimagnetic hysteresis loop with maximum saturatiration magentisation of 72 emu/g, remaining almost constant with La doping. Magentic transition temperature increases from 719K to 749K with La doping due to strengthened super-exchange interactions.Leaky ferroelectric P-E loops were observed. A large magnetoelectric coupling constant of 32mV/Oe.cm^{-1} was observed at room temperature for La content, x=0.0, and the same is decreased with La doping due to structural distortion in Fe-O_6 polyhedra. The prepared materials show potential for four state memory and ME switching/ sensor applications.

Keywords: M-type Barium hexaferrite, La-doping, Ball milling, Multiferroics, ME coupling.

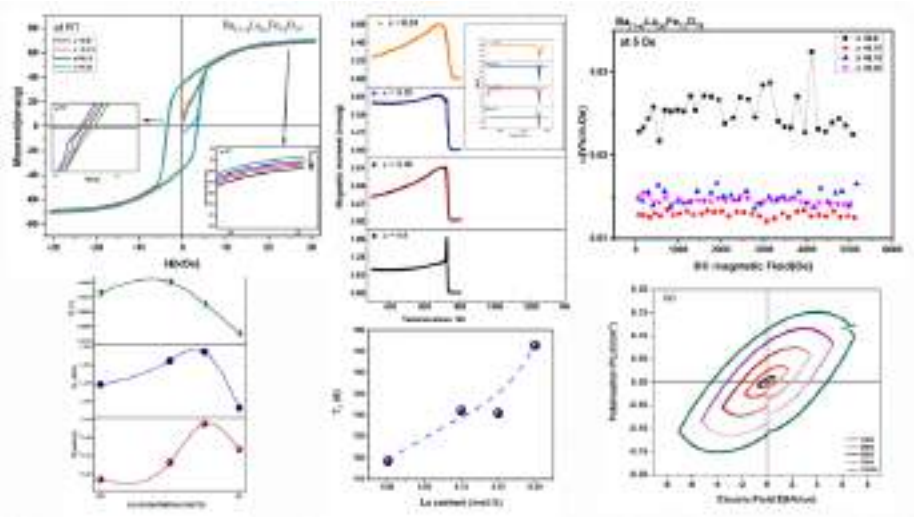


Fig. 1: Magnetic and multiferroic properties of La substituted Barium hexaferrite.

Abstract ID: 308

IMPACT OF GRAIN GROWTH ON MAGNETIZATION SWITCHING AND DIELECTRIC RESPONSE OF BARIUM HEXAFERRITE

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Abstract: This work investigates the evolution of magnetic and dielectric properties of M-type barium hexaferrite, $BaFe_{12}O_{19}$ (BFO), as a function of sintering temperature, focusing on magnetization switching, coercivity, magnetic energy product, and dielectric relaxation mechanisms. Polycrystalline BFO samples were synthesized via a citrate-based auto-combustion sol–gel route and sintered between 1100°C to 1350°C. X-ray diffraction confirmed phase purity, while scanning electron microscopy revealed systematic grain growth with increasing sintering temperature. A pronounced decrease in coercivity was observed, from 5520 Oe to 340 Oe with increasing sintering temperature. This reduction is attributed to changes in magnetization reversal behavior and magnetic anisotropy associated with grain growth. Switching field distribution and differential susceptibility (d*M*/d*H*) analyses indicate a transition from single-domain to multi-domain behavior, accompanied by a shift from pinning-controlled to nucleation-dominated magnetization switching [1]. The maximum energy product (BH_{max}) was also evaluated to assess permanent magnet performance. Dielectric spectroscopy reveals a clear modification in low-frequency relaxation mechanisms with increasing grain size. The smaller-grain (0.38-0.75 μm) samples exhibit modified Debye-type relaxation, whereas larger-grain (1.26-5.25 μm) samples display non-Debye behavior due to Maxwell-Wagner interfacial polarization. In high-grain samples, dielectric loss exceeds the dielectric constant in the low-frequency region owing to strong dispersion effects [2]. Variations in the electric modulus and Cole-Cole plots further corroborate the change in relaxation dynamics. These findings provide critical insight into microstructure-driven magnetic and dielectric tuning of BFO for high-frequency and energy-storage applications.

Keywords: Coercivity, Domain wall pinning, Susceptibility, Relaxation, Dielectric constant.

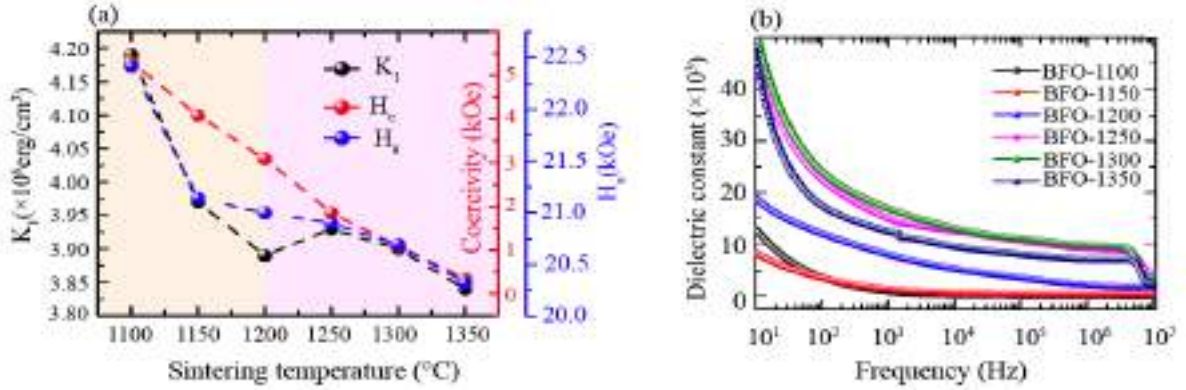


Fig 1: (a) Variation of magnetic parameters and (b) frequency dependence of dielectric constant for $BaFe_{12}O_{19}$ samples sintered at different temperatures.

References:

[1] G. Junaid, V. Gorige, J. Phys. D: Appl. Phys. 58 (2025) 325001(1)-325001(12)

[2] Ashima, S. Sanghi, A. Agarwal, Reetu, N. Ahlawat, Monica, J. Appl. Phys. 112 (2012) 014110(1)-014110(8).

Abstract ID: 309

SURFACE TERMINATION-ENHANCED MAGNETISM IN MAGNETIC INSULATORS (MI)/2D SPIN-TERFACES

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Abstract: With rising demand for ultra-low energy memory and logic devices, magnetic insulators (MIs) have emerged as a one of the key materials in spintronics. Free from Ohmic losses, they enable long-distance magnon transport, offering a highly efficient path for information flow. Moreover, by integrating these MIs with 2D materials, new functionalities and exotic phenomenon at MI/2D Spin-terfaces can be realized. Here, we demonstrated the fabrication of a highly ordered array of sub-200 nm 1-D nano-wires pattern of insulating spinel ferrite/$LaFeO_3$ composite by using e-beam lithography. Spinel ferrites are highly resistive MIs that exhibits ultra-low magnetic losses, making them ubiquitous material for designing a MI-based functional device in many emergent applications. While $LaFeO_3$ a G-type antiferromagnetic perovskite is a well-known ferroelastic material also reported to exhibit a ferroelectric-like hysteresis making it a unique material for any functional device. The FMR studies demonstrates the highly directional-dependent FMR properties in these nano-wires. Further, we have integrated the Mis with atomically thin 2 D materials namely Graphene and hBN. We have observed the the surface termination-enhanced magnetic properties in these MI/2D heterostructures. These results present ways for engineering strong interfacial magnetic effects in MIs/2D heterostructures, controlling magnetism by surface termination, and developing advanced spin-terfaces for applications in spin-caloritronics and spin-insulatronics.

Keywords: 2D materials, Magnetic Insulators, spintronics, electron-beam lithography, Magnons.

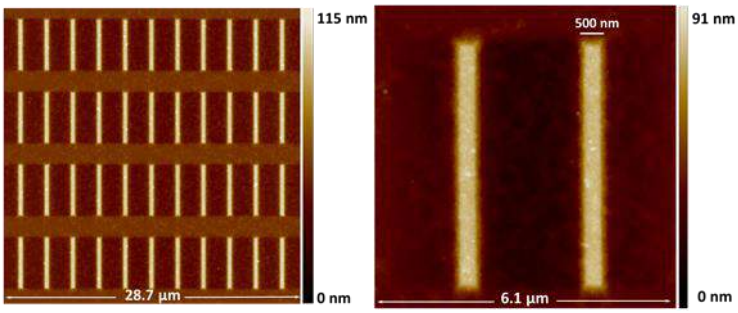


Fig. 1: AFM images of 500 nm wires of magnetic insulators.

References:

[1] Gopal, Datt et al.; ACS Appl. Mater. Interfaces., 2021, 13, 37500.
[2] Schulz, Noah; Amit Chanda; Gopal Datt; et al.; ACS Appl. Nano Materials, 2023, 6, 10402.

Abstract ID: 310

MAGNETIC, MAGNETOCALORIC, AND MAGNETOTRANSPORT PROPERTIES OF $DyPdSi_3$

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Abstract: The investigation of magnetocaloric materials operating in the liquid-helium temperature regime is of considerable importance for applications such as cryogenic refrigeration, space technology, superconducting magnets, hydrogen liquefaction, and low-temperature sensors. In particular, rare-earth–based intermetallic compounds are attractive candidates due to their large magnetic moments and strong magneto-thermodynamic response at low temperatures [1–3]. We report a comprehensive study of the magnetic, magnetocaloric, and magnetotransport properties of $DyPdSi_3$. $DyPdSi_3$ undergoes a ferrimagnetic and /or ferromagnetic-like second-order transition at ~9.5 K, followed by the development of antiferromagnetic correlations at lower temperatures. This behavior indicates competing ferro- and antiferromagnetic exchange interactions and a complex magnetic ground state governed by RKKY exchange among Dy moments. A significant magnetocaloric effect is observed around the second-order magnetic transition, with a maximum magnetic entropy change ($-\Delta S_M$) of ~11.4 J kg^{-1} K^{-1} and a relative cooling power (RCP) of ~272 J kg^{-1} for ΔH = 7 T, highlighting its potential for low-temperature magnetic refrigeration. Notably, no magnetic hysteresis is detected at 2 K, which is advantageous for efficient and reversible magnetic cooling cycles. The compound exhibits metallic behavior, accompanied by a low-temperature resistivity upturn, likely arising from the opening of a magnetic superzone gap associated with antiferromagnetic ordering. A notable magnetoresistance of ~6% further evidences strong coupling between charge transport and magnetism.

Keywords: Magnetic Properties, Magnetocaloric Effect, Magnetotransport, Intermetallic Compound, Cooling technology

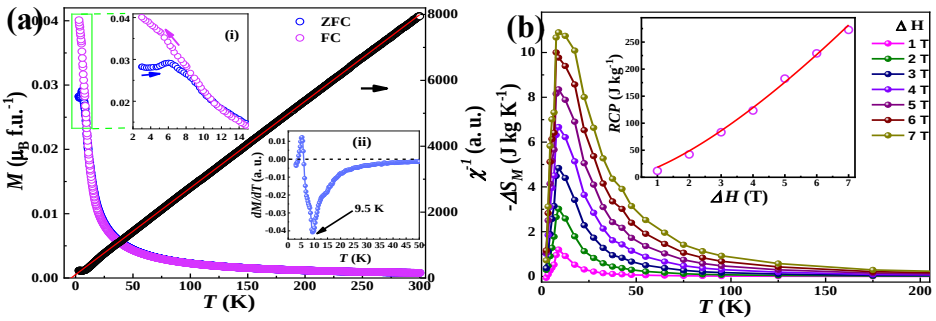


Fig. 1: (a) left axis- M vs. T, right axis- χ^{-1} vs. T; inset (i) enlarged view of M vs. T at low T, inset (ii) dM/dT vs. T. (b) $-\Delta S_M$ vs. T for ΔH = 1-7 T, inset variation of RCP with ΔH.

References:

[1] V. K. Pecharsky and K. A. Gschneidner Jr., *JMMM* **200**, 44 (1999).
[2] A. M. Tishin and Y. I. Spichkin, *The Magnetocaloric Effect and its Applications*, IOP Publishing (2003).
[3] K. A. Gschneidner Jr., V. K. Pecharsky, A. O. Tsokol, *Reports on Progress in Physics* **68**, 1479 (2005).

Abstract ID: 311

MANGANESE INDUCED ANTIFERROMAGNETIC TO FERROMAGNETIC TRANSFRMATION IN $LaNiO_3$ PEROVSKITES

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Abstract: A comprehensive study of the magnetic ordering in $LaNiO_3$, by systematically modifying through Mn substitution in $LaNi_{1-x}Mn_xO_3$ (x = 0.10, 0.20, 0.30, and 0.40), synthesized using sol-gel method is reported in this study. Rietveld refinement of X-ray Diffraction patterns demonstrates the rhombohedral R-3c structure, irrespective of Mn concentration, confirming stability along with lattice expansion with increase in Mn incorporation. From magnetic studies, we observe a paramagnetic state down to 5K in pristine $LaNiO_3$. Upon introducing Mn, the irreversibility temperature in ZFC-FC magnetization is observed at 160K for x = 0.10, which increases up to 242K when x = 0.40. Further, the negative Curie-Weiss temperature (θ_{cw}) obtained from the Curie-Weiss fitting confirms an antiferromagnetic ordering for x = 0.10 and 0.20, which converts to ferromagnetic ordering for x = 0.30 and 0.40, exhibiting a positive θ_{cw} shown in Fig. 1 (a-b). Thermomagnetic measurement shows evidence of a narrow hysteresis loop at low temperature for x = 0.01 and 0.02, which converts to saturated S-type loop for x = 0.3 and 0.4 as depicted in Fig. 1 (c-d). Combining these magnetic observations, we have discussed the structural evolution systematically in $LaNiO_3$ when Mn is substituted.

Keywords: Perovskite oxides, Curie-Weiss, Antiferromagnetism, Magnetic irreversibility

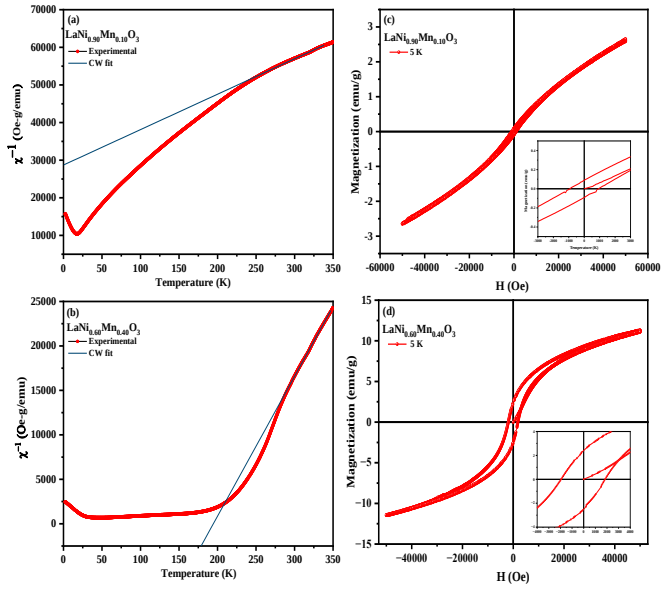


Fig. 1: (a, b) 1/χ vs temperature with Curie-Weiss fitting, and (c, d) field dependence of isothermal DC magnetization (M-H) at 5 K for $LaNi_{1-x}Mn_xO_3$ at x = 0.10 and 0.40.

Abstract ID: 312

EXPLORING LOCAL STRUCTURAL DISTORTION AND MAGNETOELECTRIC BEHAVIOR IN SKYRMION HOST Cu_2OSeO_3

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Abstract: Cu_2OSeO_3 (CSO) is an insulating multiferroic that hosts skyrmion and helical magnetic phases below $T_c \approx 59–60$ K [1]. Although it crystallizes in the chiral cubic space group $P2_13$, its collinear ferrimagnetic order remains incompatible with the metrically cubic structure reported down to 10 K [3]. This long-standing structural–magnetic mismatch motivates a renewed investigation of both its local structure and magnetoelectric (ME) behaviour. While ME coupling in single crystals is well documented [2], polycrystalline CSO exhibits inconsistent responses, including a dielectric anomaly at T_c reported only in the polycrystalline form . Notably, no pyrocurrent-based confirmation of ME coupling exists so far. Our magnetization measurements confirm $T_c \approx 58$ K and reveal thermal hysteresis at low field (H = 100 Oe), indicative of a possible structural distortion. Temperature-dependent X-ray diffraction shows broadening of low-angle Bragg peaks, suggesting local symmetry breaking without a global phase transition. Complementary EXAFS analysis at the Cu and Se K-edges reveals modifications in local Cu–O and Se–O coordination across T_c. Dielectric measurements show clear field-induced anomalies at 400–600 Oe near T_c, whereas zero-field data remain featureless. Pyrocurrent measurements do not show switching, though DC current displays subtle temperature-linked deviations. Together, these results point toward local symmetry lowering below T_c as a key factor influencing the ME response in polycrystalline CSO.

Keywords: Cu_2OSeO_3; EXAFS; Dielectric anomaly; Magneto-structural coupling.

References

[1] S. Seki et al. Science **336**,198-201(2012).
[2] E. Ruf et al. Sci. Rep. **5**, 15025 (2015).
[3] J.-W. G. Bos et al. Phys. Rev. B **78**, 094416 (2008).

Abstract ID: 314

ULTRAFAST CONTROL OF NON-COLLINEAR MAGNETISM VIA FIELD-DERIVATIVE TORQUE

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Abstract: Controlling non-collinear magnetization on sub-picosecond timescales has been a central challenge in modern spintronics. Field-derivative torque (FDT) emerges alongside Zeeman torque (ZT) when a material with high spin-orbit coupling, which in turn contributes to high Gilbert damping, is subjected to a THz pulse as an external time-dependent field [1,2]. The influence of FDT on magnetization dynamics has been thoroughly investigated on collinear systems, both theoretically and experimentally, recently [2-4]. In this work, we have investigated how a one-dimensional model of non-collinear magnetic texture can be controlled by using FDT to gain a clearer understanding of how to probe magnetic skyrmions with FDT, computationally. The results of our investigation identify a class of suitable real materials that can serve as hosts for magnetic skyrmions in energy-efficient ultrafast magnetic memory devices. Our results will also shed light on the effect of FDT on non-collinear magnetic systems, which will broaden the pathway of research in the advancement of futuristic technologies.

Keywords: Magnetic solitons, Ultrafast Spintronics, field-derivative torque, LLG equation.



Fig. 1: Ground state of non-collinear one-dimensional antiferromagnetic texture with 20 spins as a model system under investigation.

References:

[2] R Mondal, A Donges, U Ritzmann, PM Oppeneer, U Nowak, Physical Review B 100 (6), 060409 (R).
[3] A Dutta, C Tzschaschel, D Priyadarshi, K Mikuni, T Satoh, R Mondal, S Pal, Advanced Functional Materials 35 (7), 2414582.
[4] P Mukherjee, A Dutta, S Bhattacharjee, S Pal, R Mondal, Physical Review Materials 9 (10), 104405.
[5] P Mukherjee, R Mondal, Physical Review B 113 (5), 054407.

Abstract ID: 315

SPIN-SELECTIVE DNA LOGIC ON FERROMAGNETIC THIN FILMS

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Abstract: Ferromagnetic Heusler thin films with high intrinsic spin polarization offer a robust platform for implementing spin-based logic architectures. In this work, we demonstrate a spin-selective DNA logic gate realized on thermally deposited ferromagnetic Heusler thin films, where the magnetic layer functions as an efficient spin injector. Spin polarization (Ps) is quantified using frequency-resolved alternating current voltammetry, enabling precise extraction of spin-dependent charge-transfer signals. Molecular hybridization at the magnetic interface produces a pronounced increase in P_s (~12.6%) compared to non-hybridized states (<1%), establishing clear binary differentiation based on spin contrast. By engineering P_s threshold values, logical states (0 and 1) are encoded purely through magnetic spin injection and DNA hybridization, leading to the implementation of reconfigurable Boolean operations. A three-input AND gate (O = M·C·S) is successfully realized, exibiting a high spin ON/OFF contrast ratio of ~40:1, significantly exceeding conventional charge-based molecular logic systems. The logic operation arises from spin-selective transport at the ferromagnetic film–molecule interface, ensuring sharp state discrimination and enhanced signal robustness. This work establishes magnetic Heusler thin films as effective platforms for spintronic logic devices and demonstrates the feasibility of magnetically driven molecular computing architectures [1].

Keywords: Alternating current voltammetry, DNA hybridization, Ferromagnetic shape memory alloy, Heusler alloy, phase transition, spin-based logic gate



Fig. 1: Schematic illustration of spin-selective DNA hybridization on Heusler films showing CISS-mediated spin transport and frequency-resolved ACV and logic gate application [1].

References:

[1] M. Tiwari, P.K. Bhartiya, D. Mishra, Adv. Mater. Technol. (2026) e02247.

Abstract ID: 316

NITROGEN INSERTION AND TOPOTACTIC EXTRACTION DRIVEN DIFFUSION, STRUCTURAL, AND MAGNETIC EVOLUTION IN FeN/NiN MULTILAYERS

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Abstract: The recent rare-earth supply crisis has intensified the quest for manufacturing rare-earth-free permanent magnets based on earth-abundant materials, which are cost-effective, sustainable, and have a minimal environmental footprint [1]. In this context, $L1_0$-ordered FeNi (tetrataenite) exhibits a large saturation magnetization and a robust uniaxial magnetic anisotropy, making it a valuable gap magnet for permanent magnet applications. However, the laboratory synthesis of this phase is challenging because of the extremely sluggish interdiffusion of Fe and Ni below the order-disorder temperature ~ 600 K. In this work, a promising route toward the synthesis of $L1_0$-FeNi is investigated through a novel nitrogen insertion and topotactic extraction (NITE) approach, combined with Cu doping in Fe/Ni multilayer thin films fabricated by co- and reactive DC magnetron sputtering under a pure N atmosphere. The structural, diffusion, and magnetic properties of the post-annealed films were systematically investigated using X-ray diffraction (XRD), polarized neutron reflectivity (PNR), and SQUID-VSM magnetometry. During denitridation, combined analysis of nuclear and magnetic scattering length density profiles indicates a progressive transition from a nonmagnetic nitrogen-rich FeN/NiN multilayer state to a magnetically ordered FeNi phase, as shown in fig.1 (a,b). Also, the increase in perpendicular coercivity provides strong evidence for the formation of the hard $L1_0$-FeNi phase as shown in fig.1 (c,d). With the NITE approach, assisted by Cu doping, it is anticipated that the growth of the tetrataenite phase with a high-order parameter can be realized.

Keywords: $L1_0$-FeNi, nitrogen insertion and topotactic extraction, rare-earth-free permanent magnet, polarized neutron reflectivity, interdiffusion**.**

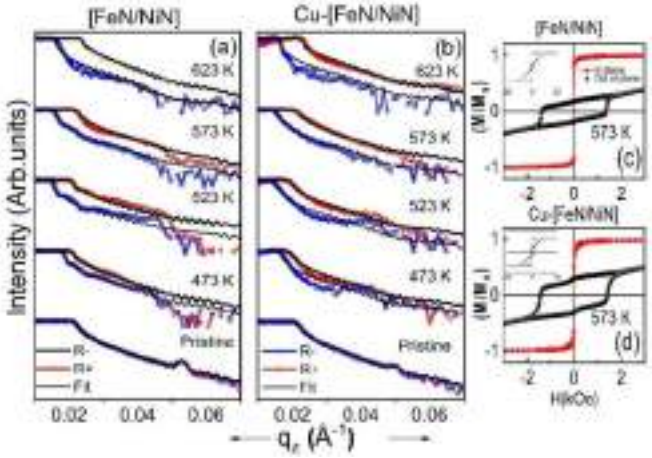


Fig. 1: PNR spectra of undoped (a) and Cu-doped (b) nitride Fe/Ni multilayers in the pristine state and after annealing, along with the corresponding M–H loops for the undoped (c) and Cu-doped (d) samples after annealing at 573 K.

References:

[1] J.M.D. Coey, IEEE Trans. Magn. 47 (2011) 4671–4681.

Abstract ID: 317

INVESTIGATIONS ON MAGNETIC, AND ELECTROMAGNETIC ABSORPTION PROPERTIES OF FERRITE NANOCOMPOSITES IN THE X-BAND REGION

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Abstract: The rapid expansion of high-frequency communication systems and wireless devices has increased the need for effective microwave-absorbing materials that can reduce electromagnetic interference. Ferrite-based nanocomposites efficiently reduce electromagnetic interference due to their magnetic and dielectric properties. This work fabricated a hard/soft ferrite nanocomposite consisting of $SrFe_{12}O_{19}$ and $Co_{0.5}Zn_{0.5}Fe_2O_4$ to enhance microwave absorption via exchange coupling interactions. The nanocomposites were synthesized in different ratios using the sol–gel auto-combustion method. The composites were characterized and analysed by using various characterization techniques. XRD analysis confirms the formation and coexistence of the SFO and CZFO phases in the synthesized nanocomposite. VSM was used to evaluate the magnetic characteristics of the samples, including saturation magnetization, coercivity, and remanence. The microwave absorption properties of the composites were analyzed using a Vector Network Analyzer (VNA) in the X-band frequency range.

Keywords: Hard/Soft ferrite nanocomposites, Sol-gel auto combustion technique, Reflection Loss, Exchange coupling interaction, Microwave absorption behaviour.

References:

[1] A. Garg, S. Goel, A. K. Dixit, M. K. Pandey, N. Kumari, S.Tyagi, Materials Chemistry and Physics 257 (2021) 123771, https://doi.org/10.1016/j.matchemphys.2020.123771.
[2] E. Ahilandeswari, R. Rajesh Kanna, K. Sakthipandi, Physica B 599 (2020) 412425, https://doi.org/10.1016/j.physb.2020.412425

Abstract ID: 318

TEMPERATURE DEPENDENT MAGNETIC PROPERTIES OF INDIUM SUBSTITUTED W-TYPE HEXAFERRITE

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Abstract: Single-phase $BaCo_2Fe_{16-x}In_xO_{27}$ (x = 0.0, 0.5, and 1.0) hexaferrites were synthesized by the conventional solid-state reaction method. XRD and Reitveld refinement analysis confirm the formation of single-phase W-type Hexaferrite. The lattice parameters increased systematically with Indium substitution, with 'a' changing from 5.9050 Å to 5.9304 Å and 'c' from 32.9226 Å to 33.1323 Å, showing successful incorporation of In^{3+} ions into the crystal lattice. Scanning electron microscopy showed densely packed hexagonal grains, and energy-dispersive X-ray analysis confirmed the presence of all elements in the expected proportions. Magnetic measurements showed that the Curie temperature decreased from 725 K to 631 K with increasing substitution, indicating weakened exchange interactions. A spin reorientation transition was observed for x = 0.0 and 0.5, with the transition temperature 542 K and 586 K respectively. Magnetic hysteresis loops measured between 10 and 300 K were analysed using the law of approach to saturation. Saturation magnetization and the magnetic anisotropy constant $K_1(T)$ decreased with increasing temperature and substitution level, while coercivity decreased with temperature but increased with Indium content. The temperature dependence of saturation magnetization followed Bloch's $T^{3/2}$ law. The Bloch constant decreases with substitution suggesting reduced exchange interaction strength [1], which is responsible for the observed decrease in the Curie temperature.

Keywords: Exchange Interaction, Curie Temperature, Spin Reorientation Transition, Bloch law, and Bloch constant.

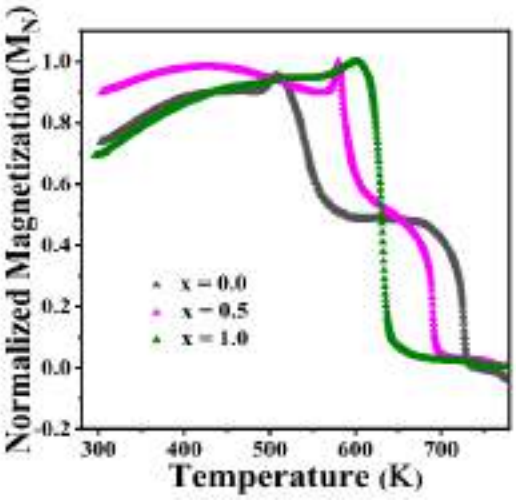


Fig. 1: M_N vs. Temperature plots for $BaCo_2Fe_{16-x}In_xO_{27}$ (x = 0.0, 0.5, and 1.0) measured under an applied magnetic field of 500 Oe.

References:

[1] P. Joshi, H. Abbas, T.R Karki, J. Mohapatra, J.P. Liu, AIP Advances 15, 035124 (2025).

Abstract ID: 319

THICKNESS-DEPENDENT STRUCTURAL AND INTERFACIAL PROPERTIES OF Cr/$SmCo_5$/CoFeB/Cr MULTILAYER THIN FILMS

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Abstract: Magnetic multilayer thin films with engineered interface coupling are promising for advanced spintronic and exchange-spring magnet applications. In this work, Cr/$SmCo_5$/CoFeB/Cr multilayer thin films with systematically varied CoFeB thickness were fabricated using magnetron sputtering. The structural, morphological, and interfacial properties were investigated using X-ray Reflectivity (XRR), Grazing Incidence X-ray Diffraction (GIXRD), and Atomic Force Microscopy (AFM). XRR measurements confirmed well-defined multilayer stacking with sharp interfaces and accurate thickness control, highlighting the role of Cr seed and capping layers in stabilizing the film structure. GIXRD analysis revealed the textured crystalline phase of the $SmCo_5$ hard magnetic layer, while the CoFeB layer exhibited thickness-dependent amorphous-to-nanocrystalline characteristics. AFM studies showed smooth surface morphology with low roughness, indicating uniform film growth and good interface quality. Variation in CoFeB thickness strongly influences interfacial exchange coupling and overall magnetic behavior. Thinner CoFeB layers are expected to enhance exchange-spring interaction with $SmCo_5$, whereas thicker layers promote soft magnetic response. These findings demonstrate that precise control of soft-layer thickness and interface engineering provides an effective route to tailor magnetic properties in $SmCo_5$-based multilayer thin films. The present study offers important insights for designing high-performance spintronic devices, magnetic sensors, and hybrid permanent magnet systems.

Abstract ID: 320

INVESTIGATION OF TERAHERTZ POLARIZATION AND FIELD-DEPENDENT SPIN DYNAMICS OF MULTIFERROIC $Co_4Nb_2O_9$ USING MAGNETO-TERAHERTZ SPECTROSCOPY

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Abstract: Multiferroic materials hosting coupled ferroic order parameters provide a promising platform for emergent low-energy collective excitations, governed by strong spin–orbit coupling and magnetic anisotropy. In such systems, the breaking of spatial inversion symmetry modifies the magnetic ground state and can lead to gapped spin-wave spectra, giving rise to a variety of low-energy spin excitations. Since the energies of these excitations lie in the terahertz (THz) range, where magnetic- and electric-dipole-active modes can coexist, THz spectroscopy becomes an indispensable tool to probe, excite, and manipulate these excitations. From a THz-magnonics perspective, interplay among these low-energy excitations offers promising opportunities for high-speed and low-dissipation information processing at sub-terahertz frequencies. The multiferroic compound $Co_4Nb_2O_9$ hosts a rich spectrum of low-energy spin excitations in the THz regime [1,2]. Although recent studies have reported [3] the presence of these modes, their microscopic origin, crystallographic orientation dependence, and coupling mechanisms remain unresolved. Here, we employ magneto–terahertz time-domain spectroscopy on a single crystal of $Co_4Nb_2O_9$ to investigate the polarization- and field-dependent spin dynamics. We observe pronounced crystallographic-direction dependence of the magnetic excitations and their coupling to both the electric and magnetic field components of THz radiation under external magnetic fields in Faraday and Voigt geometries. By analyzing the selection rules and polarization-dependent response, we demonstrate that certain modes are magnetic-dipole active, corresponding to pure magnons.

References:

[1] Khanh, N. D., Abe, N., Sagayama, H., Nakao, A., Hanashima, T., Kiyanagi, R., Arima, T. (2016). Physical Review B, 93(7), 075117.
[2] Ding, L., Lee, M., Hong, T., Dun, Z., Sinclair, R., Chi, S., Agrawal, H. K., Choi, E. S., Chakoumakos, B. C., Zhou, H., Cao, H. (2020). Physical Review B, 102(17), 174443.
[3] Dagar, R., Yadav, S., Kinha, M., Mehra, B. S., Rawat, R., Singh, K., Rana, D. S. (2022). Physical Review Materials, 6(7), 074409.

Abstract ID: 321

STUDY OF QUATERNARY HEUSLER ALLOY MnFeNiAl AND THE EFFECT OF Co ADDITION ON ITS STRUCTURAL AND MAGNETIC PROPERTIES

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Abstract: Spintronic multifunctional devices enable faster data transfer, storage at reduced dimensions. Half-metallicity which enable the generation of highly spin-polarized currents is an important requirement for spintronic materials, in addition to high magnetic moment and high Curie temperature. Quaternary Heusler alloys (QHA) prominnent materials used for spintronic device fabrication [1]. In this work we have synthesized MnFeNiAl QHA using melt-spinning technique, which ensures the formation of a homogeneous composition. To further enhance the magnetic properties, Co addition is tried in equiatomic composition MnFeCoNiAl, which makes it a high entropy alloy [2]. Structural characterization has been carried out using X-ray diffraction (XRD) and XAFS. Presence of a superlattice peak at 30.9^0 indicates partial B2 or $L2_1$ ordering. XAFS measurements suggest that Al and Ni occupy the body center position. SQUID measurements give a magnetic moment of 44.21 emu/g at 2K and a T_C below room temperature. Addition of Co leads to an increase in T_C to 526 K along with an enhancement in moment to 69.50 emu/g at 2K. However, both XRD and XAFS suggest introduction of significant structural disorder upon Co addition. Results of ^{57}Fe Mössbauer measurements are in agreement with SQUID measurements, and additionally provide information about local structure and magnetic properties of Fe atoms. It is planned to do thermal annealing at appropriate temperature in order to induce higher degree of ordering, which is essential for half-metallicity [3].

Keywords: Half-metallicity, Quaternary Heusler alloys, Mössbauer spectroscopy, XAFS.

References:

[1] L. Bainsla and K. G. Suresh, Appl. Phys. Rev. 3 (2016) 031101.
[2] Y.-F. Yang, F. Hu, T. Xia, R.-H. Li, J.-Y. Bai, J.-Q. Zhu, J.-Y. Xu, and G.-F. Zhang, J. Alloys Compd. 1010 (2025) 177691.
[3] Jiamin Chen, Y. Sakuraba, K. Masuda, Y. Miura, S. Li, S. Kasai, T. Furubayashi, and K. Hono, Appl. Phys. Lett. 110 (2017) 242401.

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Abstract ID: 322

FERMI SURFACE NESTING AND ANOMALOUS HALL EffECT IN MAGNETICALLY FRUSTRATED COMPENSATED FERRIMAGNET Mn_2PdIn

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Abstract: Noncollinear magnets with near-zero net magnetization and nontrivial bulk electronic topology are promising candidates for spintronic applications; however, their rarity calls for deliberate materials design strategies. In this work, we report a topologically nontrivial electronic structure in metallic Mn_2PdIn, which crystallizes in the inverse Heusler structure and exhibits a spin-glassy ground state with quenched magnetization. The electronic structure reveals Weyl-type band crossings in close proximity to the Fermi level and demonstrates a distinctive interplay among momentum-space nesting, orbital hybridization, and spin–orbit coupling. Comprehensive magnetotransport measurements uncover a pronounced anomalous Hall effect (AHE) in Mn_2PdIn. The quadratic scaling between the longitudinal and anomalous Hall resistivities indicates that the intrinsic Berry-curvature mechanism predominantly governs the AHE [1]. These findings identify inverse Heusler alloys as compelling platforms for realizing non-collinear magnets that host Weyl-type semi-metallic or metallic phases. By combining suppressed magnetization with robust electronic transport properties, such systems provide a promising route toward seamless integration into next-generation spintronic devices.

Keywords: Anomalous Hall Effect, Compensated Ferrimagnet, Spin Glass, Inverse Heusler Alloy, Fermi Surface Nesting

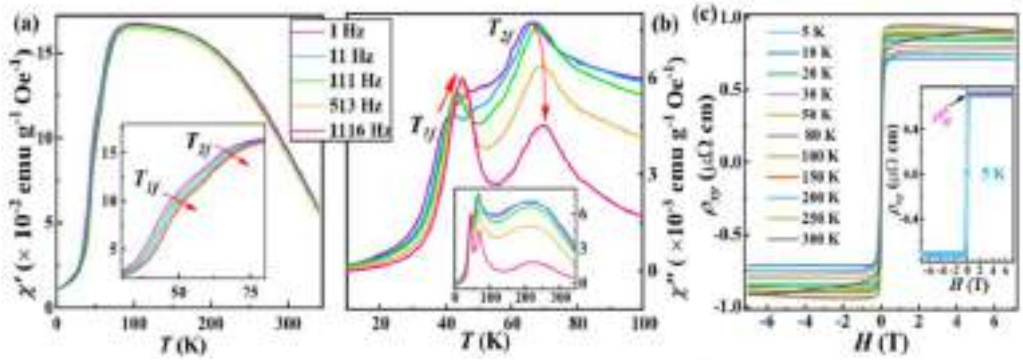


Fig.1 (a), (b) real (χ') and imaginary (χ'') parts of the ac susceptibility; insets- enlarged views of χ' and χ'' (2-350 K). (c) ρ_{xy} at various T; inset- high-field linear fit used to extract the AHE (ρ_{xy}^{A}).

References:

[1] Naoto Nagaosa *et al.* Reviews of Modern Physics **82**, 1539 (2010)

Abstract ID: 323

EVOLUTION OF TOPOLOGICAL SPIN TEXTURES IN Co/Tb/Co STRUCTURES – INFLUENCE OF THE NUMBER OF REPETITIONS AND Tb THICKNESS

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Abstract: Magnetic skyrmions are topologically non-trivial chiral spin textures stabilized by the Dzyaloshinskii–Moriya interaction (DMI), which favors a twisted alignment of neighboring spins. While heavy metal/ferromagnet heterostructures enable interfacial DMI through strong spin–orbit coupling, their practical implementation is hindered by the Skyrmion Hall effect (SkHE), leading to transverse motion and edge annihilation. Antiferromagnetic skyrmions suppress the SkHE via compensated gyrotropic forces, but their zero net magnetization makes detection and manipulation challenging. Ferrimagnets provide an effective bridge between these two systems, offering reduced SkHE due to antiparallel but unequal sublattice magnetizations while retaining finite magnetization for efficient readout (Mallick et al., 2024). Here, we demonstrate the stabilization of ferrimagnetic skyrmions in Pt-spaced Co/Tb/Co multilayers, where skyrmion formation emerges beyond a critical repetition number and can be independently tuned via Tb thickness. The use of Pt (1 nm) spacer layers promotes strong interfacial spin–orbit coupling and additive DMI across repetitions. By increasing the repetition number, we observe a systematic evolution of domain morphology from bubble domains (single repetition) to labyrinthine domains (three repetitions), and finally to stable skyrmions (five repetitions). The skyrmions exhibit a characteristic diameter of ~120 nm for five repetitions, which is further reduced to ~140 nm at an optimized Tb thickness of 0.85 nm. These results highlight multilayer engineering as an effective pathway for stabilizing tunable, nanoscale ferrimagnetic skyrmions suitable for future spintronic applications.

Keywords: Ferrimagnets, multilayers, skyrmions.

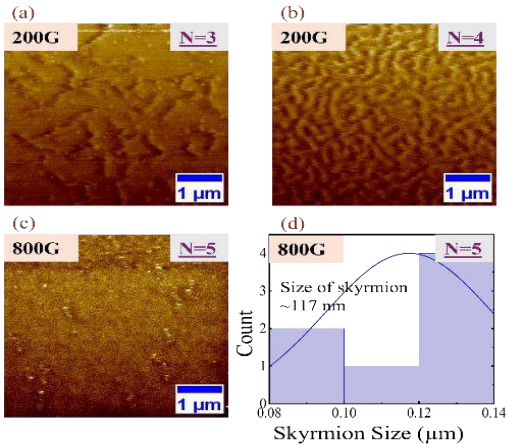


Fig. 3. The transition from labyrinthine domains in 3 and 4 repetitions to skyrmions in 5 repetitions.

References:

[1] Mallick, S. *et al. Driving Skyrmions in Flow Regime in Synthetic Ferrimagnets*. *Nat Commun* **15**, 8472 (2024).

Abstract ID: 324

DEVELOPMENT OF A MAGNETICALLY TUNABLE PVDF-HFP/CFO-BASED FLEXIBLE MAGNETOELECTRIC NANOGENERATOR FOR ENERGY HARVESTING AND MAGNETIC FIELD SENSING

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Abstract: In recent years, flexible magnetoelectric (ME) composites have emerged as promising candidates for energy harvesting and self-powered sensing applications [1]. In this work, we report the fabrication of an eco-friendly flexible magnetoelectric nanogenerator based on poly(vinylidene fluoride-hexafluoropropylene) (PVDF-HFP) and magnetostrictive cobalt ferrite ($CoFe_2O_4$, CFO) for energy harvesting and sensing applications. The flexible ME composite was fabricated using the solution-casting method by dispersing 10 wt% CFO nanopowder into the PVDF-HFP matrix. Structural and surface morphology analyses confirm the single-phase nature and uniform dispersion of CFO particles within the polymer matrix. The synthesized flexible ME composite exhibits a strong piezoelectric response, with a β-phase content of approximately 62% upon the addition of 10 wt% CFO, which is essential for energy harvesting applications. The polarization (P–E) and magnetization (M–H) hysteresis loops demonstrate the multiferroic behavior of the flexible PVDF-HFP/CFO composite. The energy harvesting capability of the fabricated ME nanogenerator was evaluated, and a maximum output voltage of 20 V was obtained under finger tapping. The magnetoelectric coupling was indirectly confirmed by measuring the output voltage under an external DC magnetic field up to 2 kG. When subjected to an external magnetic field, magnetostrictive strain is generated in the CFO phase and transferred to the piezoelectric polymer matrix, inducing an output voltage via the direct piezoelectric effect [2]. The observed voltage generation under a magnetic field confirms the presence of ME coupling in the flexible composite. Therefore, the eco-friendly PVDF-HFP/CFO-based flexible ME composite shows strong potential for energy harvesting and self-powered magnetic field sensing applications.

Keywords: Multiferroic; Flexible ME composite; Energy Harvesting; Magnetic sensor; ME Nano-generator.

References:

[1] Martins, Pedro, and Senentxu Lanceros-Méndez. "Polymer-based magnetoelectric materials." *Advanced Functional Materials* 23.27 (2013): 3371-3385.

[2] Pal, Munendra, Adiraj Srinivas, and Saket Asthana. "Enhanced magneto-electric properties and magnetodielectric effect in lead-free (1-x) 0.94 $Na_{0.5}Bi_{0.5}TiO_3$-0.06 $BaTiO_3$–x $CoFe_2O_4$ particulate composites." *Journal of Alloys and Compounds* 900 (2022): 163487.

Abstract ID: 325

MODULATED CHIRAL STRUCTURE AND MAGNETIC FRUSTRATION IN OFF-STOICHIOMETRIC $Fe_2Mn_{1.4}Si_{0.6}$

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Abstract: Symmetry plays an important role in determining the physical properties of materials. In particular, systems where inversion and mirror symmetries are broken, give rise to exotic magnetic ground states and electronic properties. In this study, we investigate the structural and magnetic evolution of Fe-rich $Fe_2Mn_{1.4}Si_{0.6}$, derived from the parent Fe_2MnSi cubic Heusler alloy, with emphasis on the role of Mn/Si off-stoichiometry and disorder. Polycrystalline $Fe_2Mn_{1.4}Si_{0.6}$ was characterized using x-ray diffraction (XRD), temperture- and field-dependent magnetization, electrical transport measurement, and neutron diffraction (ND). Preliminary XRD analysis suggests a β-Mn type ($P4_132$) chiral structure similar to other disorderd Heusler alloys [1,2]. However, detailed structural refinement using powder ND provides deeper insight into atomic ordering and symmetry lowering. The ND analysis reveals that $Fe_2Mn_{1.4}Si_{0.6}$ stablizes in a modulated cubic structure ($P4_3$) with modulation vector (0,0,0.151). This modulation reflects compositional disorder and competing interactions that are not resolvable by XRD alone due to similar scattering factors of Fe/Mn atoms. This alloy exhibit strong antiferromagnetic interaction with large frustration parameter, indicating the presence of competing magnetic interactions due to geometrical frustration. DC magnetization shows a pronounced cusp at ~32 K, along with bifurcation between zero-field-cooled and field-cooled. ND measurements down to 4.2 K show no magnetic Bragg peak, confirming the absence of long-range magnetic order. The semiconducting-like electrical transport further reflects enhanced disorder and magnetic scattering. These results establish $Fe_2Mn_{1.4}Si_{0.6}$ as a model system for understanding the influence of compositional disorder on crystal symmetry, magnetic frustration, and charge transport in off-stoichiometric Heusler alloys.

Keywords: Heusler Alloy, Chiral structure, Neutron-diffraction, Disorder.

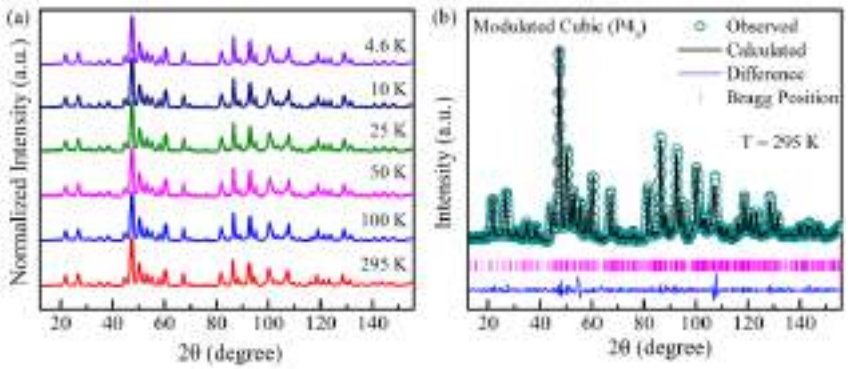


Fig. 1: (a) Temperature-dependent Neutron-diffraction data of $Fe_2Mn_{1.4}Si_{0.6}$. (b) Refinement with modulated Cubic structure using JANA 2020 software.

References:

[1] S. Dash, A. V. Lukoyanov, Nancy et al., J. Mag. Mag. Mater. 513 (2020) 167205-167214.
[2] J. Kroder, J. Gooth, W. Schnelle, G. H. Fecher, and C. Felser, AIP Adv. 9 (2019) 055327-1-055327-5.

Abstract ID: 326

SKYRMIONIUM BASED MAJORITY LOGIC GATE BY VOLTAGE CONTROLLED MAGNETIC ANISOTROPY IN NANOMAGNETIC DEVICE

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Abstract: Magnetic skyrmioniums have recently emerged as potential candidates for next-generation spintronic applications. Magnetic skyrmioniums are topologically distinct chiral spin textures. Unlike skyrmions, skyrmioniums have zero topological charge, which suppresses the skyrmion Hall effect, offering a controlled motion without any transverse deflection under applied current[1]. In this work, we explore the stabilization and controlled motion of skyrmioniums in ferromagnetic nanostructures through micromagnetic simulations using Mumax3. The influence of magnetic anisotropy and Dzyaloshinskii-Moriya interaction on the size and stability of the skyrmionium are systematically analyzed. By varying these parameters, distinct regimes of stability and distortion are found. Furthermore, we demonstrate the controlled motion of the skyrmionium along the nanotrack under applied current, validating their potential as information carriers. Based on these results, we propose and demonstrate a skyrmionium-based majority logic gate based on voltage-controlled skyrmionium dynamics using their controllable motion to realize logic operations. This work highlights the potential of skyrmioniums in next-generation spintronic logic architectures, bridging the fundamental magnetic interactions with functional device design[2].

Keywords: Skyrmionium, Magnetic Anisotropy, Dzyaloshinskii-Moriya Interaction, Skyrmion Hall effect, Spintronic Logic Architecture

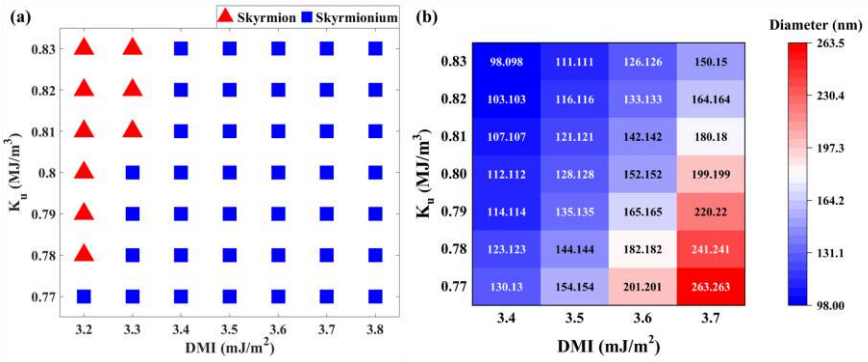


Fig. 1: (a) Phase diagram of magnetic textures as a function of DMI strengths and anisotropy constants, (b) Map showing the combined influence of DMI strength and anisotropy constant on skyrmionium diameter

References:

[1] B. Göbel, A. F. Schäffer, J. Berakdar, I. Mertig, and S. S. P. Parkin, "Electrical writing, deleting, reading, and moving of magnetic skyrmioniums in a racetrack device," *Sci Rep*, vol. 9, no. 1, p. 12119, 2019, 10.1038/s41598-019-48617-z

[2] B. Paikaray, "Skyrmionium-based reconfigurable logic via gate-tunable anisotropy in nanomagnetic devices," *J. Phys. D: Appl. Phys.*, vol. 58, no. 30, p. 305001, 2025, 10.1088/1361-6463/adeea3

Abstract ID: 327

FIELD-INDUCED METAMAGNETISM AND EMERGENT SPIN TEXTURES IN THE ANTIFERROMAGNETIC SEMIMETAL EuAuBi

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Abstract: In recent years, quantum materials coupled with magnetism have attracted significant attention due to their topological states and ability to tune them via spin degree of freedom for next-generation topo-spintronic applications. In this work, we present the Eu-based ternary compound EuAuBi, identified as a topological semimetal through DFT calculations. The single crystal of EuAuBi were grown using the flux-method. The system is anisotropic and displays three distinct magnetic phases at 4 K (T_{N1}), 3.5 K (T_{N2}), and 2.8 K (T_{N3}) as observed from magnetic and specific heat measurements. Field-dependent *ac* and *dc* magnetization measurements uncover field-induced non-trivial spin textures in the magnetic field range 1.5 to 3 T, manifested as a tilted plateau in the magnetization curves. The interplay between conduction carriers and these spin textures is further evidenced by unique features in the magnetic field-dependent longitudinal resistivity in the system. In addition, an extra contribution consistent with the topological Hall effect is also observed in similar field- and temperature regions. Based on these results, we present a comprehensive magnetic phase diagram of EuAuBi, revealing multiple field-induced spin configurations. These findings establish EuAuBi as a rare material system in which both momentum-space and real-space Berry curvature effects may coexist, offering an opportunity to investigate their interplay.

Keywords: Magnetotransport, Field-induced magnetic phases, Spin textures, Quantum materials.

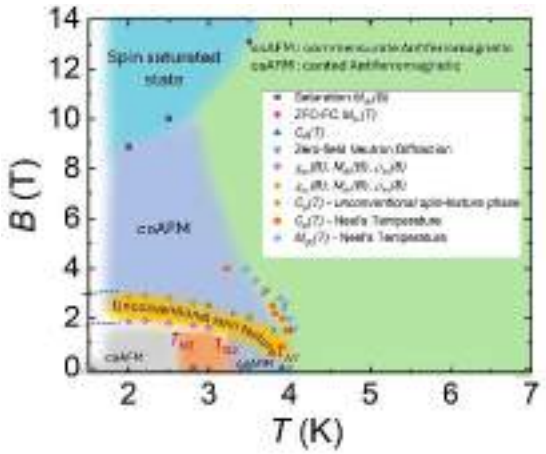


Fig. 1: Complex magnetic phase diagram of EuAuBi for B ⊥ *c*.

References:

[1] Lipika, Shobha Singh, Anyesh Saraswati et al, Physical review B, 2026, https://doi.org/10.48550/arXiv.2601.17475

[2] A. Bauer and C. Pfleiderer, Magnetic phase diagram of MnSi inferred from magnetization and ac susceptibility, Physical Review B 85 2012

Abstract: 328

DECIPHERING THE ORIGIN OF ANOMALOUS HYSTERESIS BEHAVIOR IN SPUTTER-DEPOSITED ULTRATHIN FILMS OF AMORPHOUS- CoFeB

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Abstract: CoFeB is known for its soft magnetic properties and high spin polarization, suitable for various spintronics applications.[1] Reduction of magnetic layer thickness below 10 nm is essential for scalability. However, such creates an anomaly in magnetic behaviors which is addressed in this study. Thin films of CoFeB (t_{CFB} = 0.7–10 nm) are deposited on p-type Si (100) substrates *via* rf magnetron sputtering. Crystalline properties and surface morphology of bare CoFeB films are characterized by using grazing-incidence X-ray diffraction technique and atomic force microscopy respectively. Magnetic properties are characterized by vibrating sample magnetometry. The 5 nm film is capped with tungsten (W) layer. Absence of any peak in the spectrum is indicative of the predominantly amorphous structure of CFB layers. However, few prominent peaks are observed for films having W layer with increasing W thickness.[2] The W is identified to be in $\alpha + \beta$ phase. Hysteresis measurements on these samples depict that 0.7-nm-thick film exhibits tilted magnetic anisotropy. As the film thickens, the magnetization does not orient abruptly in the in-plane direction. Rather, the interplay between interface, shape, growth-induced, stress-induced, volume anisotropies etc., creates an anomalous magnetization reversal trend that deviates from previously reported for CFB.[3] We have not observed stark modifications after capping the films with W. However, we anticipate that it reduces pinning centers, enhances interface smoothness etc. Thus, the coercivity is slightly lowered compared to the bare CFB film. This study offers new insights about magnetization reversal behavior in sputter-deposited CFB films with thickness in the ultrathin regime.

Keywords: Amorphous Alloy, Crystalline Heavy-metal, Magnetic Anisotropy, Ultrathin-films, Magnetic Hysteresis, Vibrating Sample Magnetometry.

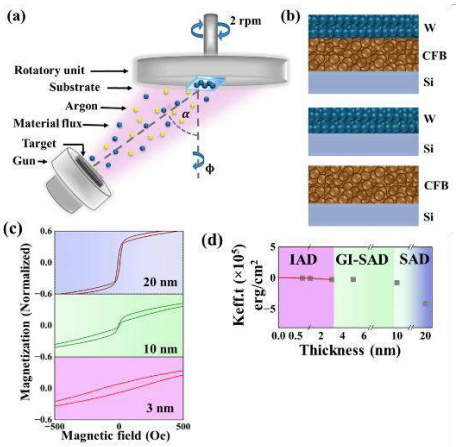


Fig. 1: (a-b) Schematic of deposition geometry and sample stack respectively. (c-d) In plane hysteresis loops for Si/CFB (t_{CFB}) and effective magnetic anisotropy values for Si/CFB (t_{CFB}).

References:

[1] N. Heiman, R. D. Hempstead, and N. Kazama, *J. Appl. Phys.* **49**, 5663 (1978).

[2] Sriram, K., Mondal, R., Pradhan, J., Haldar, A., Murapaka, C, The Journal of Physical Chemistry C, 127(46), 22704–22712 (2023).

[3] A. Gayen, G. K. Prasad, S. Mallik, S. Bedanta, A. Perumal, J. Alloys Compd. 694, 823–832 (2017).

Abstract ID: 329

TUNING OF MAGNETISM AND ELECTRON TRANSPORT IN A CORRELATED 4D ITINERANT FERROMAGNET THROUGH THE PROXIMITY OF A GEOMETRICALLY DESIGNED POLAR METAL

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Abstract: The functional properties of complex transition-metal oxides, such as magnetism and electronic transport, are governed by crystal structure and symmetry. Heteroepitaxial thin films provide a powerful route to tune spin, orbital, and lattice degrees of freedom [1]. In particular, distortions and tilts of BO_6 oxygen octahedral at epitaxial interfaces, driven by lattice mismatch or symmetry discontinuities, can profoundly influence magnetic anisotropy & electronic behavior [2].

Herein, we investigate the structural proximity effects in a heterostructures composed of a polar metal $NdNiO_3$ (NNO) [3] fabricated on $LaAlO_3$ substrate, serving as a buffer layer beneath an itinerant ferromagnetic $SrRuO_3$ (SRO). The trigonal distortion inherent to the (111)-oriented geometry [4], combined with the polar nature of NNO, induces significant structural modulation in the overlying SRO layer, as revealed by out-of-plane X-ray diffraction measurements. These changes are attributed to interfacial strain and octahedral distortions in the overlying SRO layer. SQUID magnetometry reveals a tunable ferromagnetic transition temperature and a thickness-dependent spin-state crossover in SRO, evolving from a high-spin to a low-spin configuration with decreasing NNO thickness. Intermediate spin states emerge at intermediate buffer thicknesses, accompanied by a switch in magnetic anisotropy. Magnetotransport measurements further show enhanced metallicity and an enlarged anomalous Hall response in thinner bilayers. Our findings demonstrate that geometric and interfacial design using polar metal buffer layers provides a versatile pathway to modulate spin states and magnetic anisotropy in complex oxide heterostructures.

Keywords: Structural modulation; Magnetic anisotropy; Spin-state transition; Anomlaous Hall effect.

References:

[1] A. Bhattacharya and S. J. May, *Annual Review of Materials Research* 2014, 44, 65.
[2] D. Kan, R. Aso, R. Sato, M. Haruta, H. Kurata, and Y. Shimakawa, *Nature materials* 2016, 15, 432.
[3] T. Kim, D. Puggioni, Y. Yuan, L. Xie, H. Zhou, *et al.*, *Nature* 2016, 533, 68.
[4] A. J. Grutter, F. J. Wong, E. Arenholz, A. Vailionis, and Y. Suzuki, *Phys. Rev. B* 2012, 85, 134429.

Abstract ID: 330

INFLUENCE OF MAGNETIC FIELD ON GAS-SOLID INTERACTION

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Abstract: Gas solid interaction involves physical and chemical changes in a solid. There are mainly two types of gas-solid interaction, which are absorption and adsorption. Further adsorption is divided into two categories chemisorption and physisorption. Based on this interaction due to the change in physical and chemical properties there are many applications. One of such application is gas sensing where due to chemisorption the resistance changes and gas detection happens. It has been found not only electronic properties change due to this kind of interaction magnetic properties of material also changes for example susceptibility of CuO increases due to adsorption of oxygen and M_s of Fe_3O_4 nanosphere increases due to adsorption NO [1]. Application of magnetic field has a great influence on gas solid interaction which has enhanced the application involving gas-solid interaction such as gas sensing, CO_2 interaction [2] etc. In this work we will understand how application of magnetic field influence interaction between Fe_2O_3 and different gases like NO_2 and H_2. Here we will show change in M_s of Fe_2O_3 nanorods due to adsorption of NO_2. Enhancement of sensing properties due to application of magnetic field has also been found. XRD, FESEM will be given for the phase and morphology confirmation.

Keywords: Gas-Solid, interaction, magnetic field, gas sensing,

References:

[1] T. T. Daniel, S. Majumder, V. K. S. Yadav, and R. Paily, IEEE Sens. J., vol. 20, no. 22(2020), 13341–13348

[2] R. Xiong et al., Sep. Purif. Technol., 358 (2025), 2024.130469.

Abstract ID: 331

SUBMICROSCOPIC SIZED MAGNETIC HIGH ENTROPY SPINEL OXIDE OF Mn, Fe, Co, Ni AND Zr FOR PHOTO-FENTON CATALYSIS APPLICATION

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Abstract: High-entropy oxides are promising for environmental catalysis owing to their configurational stability and multi-element redox chemistry. The spinel HEO having equiatomic concentration of Mn, Fe, Co, Ni and Zr was synthesized via a sol–gel route followed by calcination at ~700 °C. X-ray diffraction, transmission electron microscopy, scanning TEM–energy-dispersive X-ray spectroscopy, and X-ray photoelectron spectroscopy confirm its single phase, compositionally uniform nanostructure incorporating all the above-mentioned cations. The material exhibits ferrimagnetism (~21 $emug^{-1}$), enabling facile magnetic separation after the photo or photo-Fenton catalytic reaction. UV–Vis diffuse reflectance spectroscopy, Mott–Schottky analysis, and electrochemical impedance spectroscopy corroborate its activity for dye degradation via photocatalytic, Fenton, and photo-Fenton pathways. Under photo-Fenton conditions, methylene blue degradation reached 99% within 90 min. Mass spectrometry verified degradation of the dye during the photo-Fenton process. The synergy of multivalent cations and magnetic recoverability positions this HEO as robust, reusable catalyst for wastewater treatment.

Keywords: High entropy oxide; magnetic; Spinel oxide; MS; photo-Fenton.

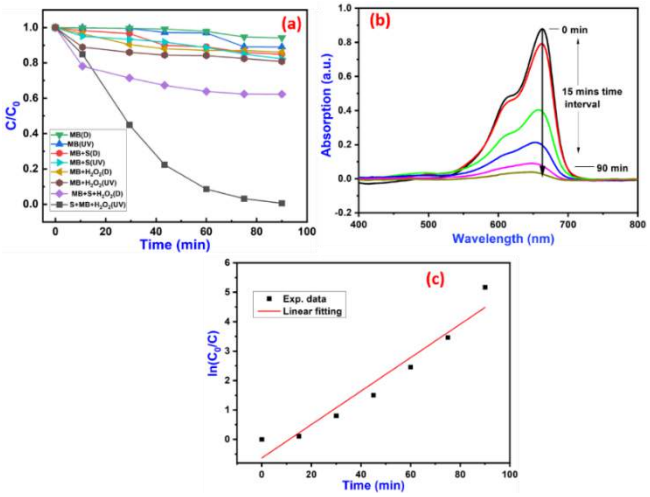


Figure 1: (a) MB degradation over HEO using Fenton, photo, and photo-Fenton processes; (b) Time-dependent absorption spectra of MB degradation under photo-Fenton conditions at t = 0 and 90 min. (c) The $\ln(C_0/C)$ versus time plot.

References:

[1] Y. Sun and S. Dai, "High-entropy materials for catalysis: A new frontier," 2021.

Abstract ID: 332

INFLUENCE OF ANTISITE DISORDER ON MAGNETIC ORDERING IN $Ga_{1-x}Al_xFeO_3$ STUDIED BY FERROMAGNETIC RESONANCE AND ^{57}Fe MÖSSBAUER SPECTROSCOPY

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Abstract: Ferrimagnetic oxides with competing exchange interactions and complex cation distributions provide an effective platform for exploring antiferromagnetic-like spin dynamics with finite net magnetization [1]. To explore this, the influence of Al substitution on the magnetic microstructure and spin dynamics of $Ga_{1-x}Al_xFeO_3$ ($0 \leq x \leq 0.3$) was systematically investigated using temperature-dependent ferromagnetic resonance and ^{57}Fe Mössbauer spectroscopy. Polycrystalline samples synthesized using the sol–gel method were studied using FMR (100–295 K, 9.45 GHz) and Mössbauer spectroscopy at 300 and 5 K under both zero and 5 T applied fields. At 295 K, the FMR spectrum shows a single paramagnetic resonance line that splits into four modes as the temperature decreases. The onset of mode splitting shifted systematically to higher temperatures with increasing Al content, consistent with the enhancement of the Néel temperature from ~208 K (x = 0) to ~240 K (x = 0.3). The room-temperature Mössbauer spectra consisted of three quadrupole doublets assigned to high-spin Fe^{3+} ions at the Fe1, Fe2, and Ga2 sites (isomer shift 0.3–0.5 mm s^{-1}), confirming the absence of mixed valence states. At 5 K, the magnetic sextets with hyperfine fields of 45–53 T indicate long-range ferrimagnetic ordering. The spectra recorded under 5 T showed asymmetric sextets and variations in the A_{23} intensity ratio, revealing site-dependent spin alignment and canting. These findings provide a microscopic understanding of substitution-induced modifications in magnetic ordering and spin dynamics in $Ga_{1-x}Al_xFeO_3$.

Keywords: Multiferroic, Ferrimagnetism, Ferromagnetic Resonance, Mössbauer Spectroscopy

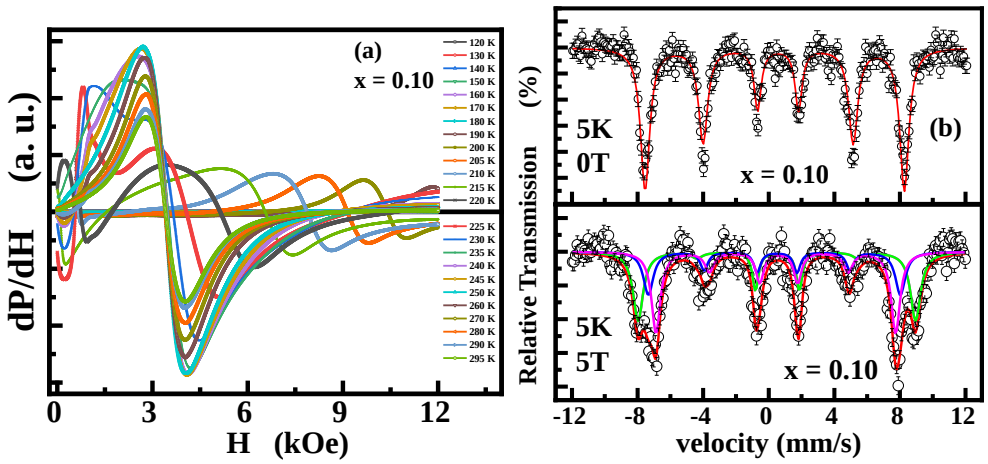


Fig. 1 (a.) FMR derivative spectra (dP/dH vs. H) of $Ga_{0.9}Al_{0.1}FeO_3$ samples measured at different temperatures. **(b.)** Mössbauer spectra of $Ga_{0.9}Al_{0.1}FeO_3$ at 5 K with and without an external magnetic field of 5 T.

References:

[1.] *Journal of Materials Chemistry C, 12*(2), 556-561 (2024). https://doi.org/10.1039/D3TC03368F

Abstract ID: 333

MAGNETIC AND OPTICAL STUDIES ON MAGNESIUM-DOPED LANTHANUM CHROMIUM OXIDE

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Abstract: The impacts of magnesium (Mg) substitution in the lanthanum chromite ($LaCrO_3$) perovskite structure are systematically examined in this study. Magnesium doping is introduced to partially replace chromium sites, aiming to tailor the structural, morphological, and compositional properties of $LaCrO_3$. The substitution is expected to influence the lattice parameters, induce possible oxygen vacancies, and modify the microstructure, which are critical for functional applications of perovskite oxides. To investigate these effects in detail, a comprehensive characterization approach is employed, combining X-ray diffraction (XRD) for phase identification, lattice distortion analysis, and crystallite size estimation, with scanning electron microscopy (SEM) for evaluating the surface morphology and grain structure of the synthesized samples. The results provide insight into the solubility limit of Mg in the $LaCrO_3$ lattice and reveal correlations between Mg content, phase purity, and microstructural evolution. Further, the magnetic and optical properties of the system is investigated.

Keywords: Perovskite, Magnetism, Optical properties

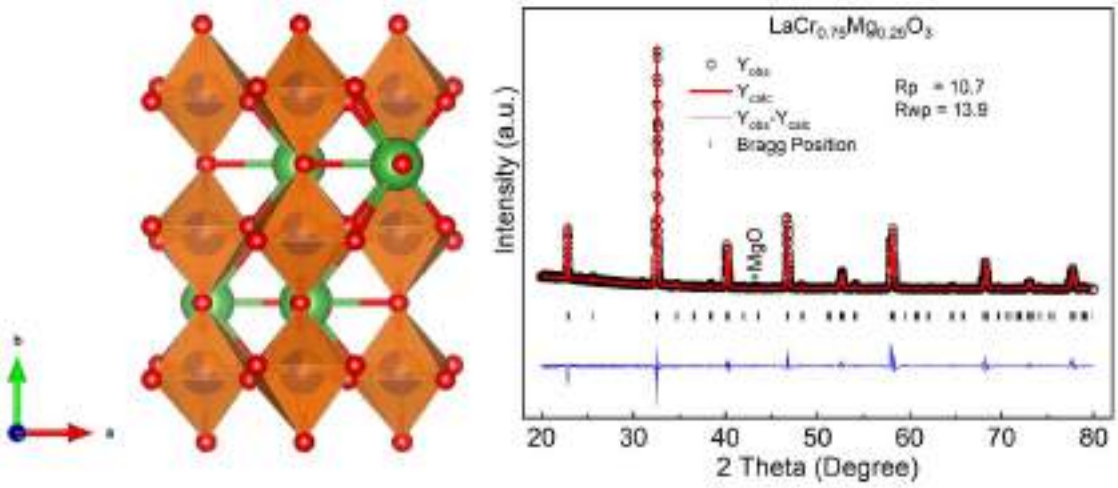


Fig. 1: Crystal structure and XRD pattern of Mg-doped LaCrO3 sample. The left panel illustrates the perovskite structure with Mg substitution, while the right panel shows the XRD pattern along with Rietveld refinement fit, indicating good phase purity and crystallinity.

Abstract ID: 334

THEORETICAL INVESTIGATION OF ELECTRONIC AND MAGNETIC PROPERTIES OF CrS_2 POLYMORPHS

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Abstract: In this research work, we have investigated the structural stability, electronic, and magnetic properties of CrS_2 polymorphs. CrS_2 It is one of the most promising Transition Metal Dichalcogenide (TMDC) materials for spintronics and magnetic device applications due to its layered structure. Here, we have studied the electronic band structure and the density of states of three phases, including 2H,1T, and 1T' phases, systematically, using Density Functional Theory (DFT) with the modular open-source package Quantum ESPRESSO, built on the plane-wave basis set. Further, we have performed spin-polarized calculations to observe magnetic ground states by comparing the total energies of all three polymorphs. Exchange parameter and magnetic transition temperatures have been evaluated using Monte Carlo simulation based on the Metropolis algorithm. Furthermore, we have investigated the effect of strain and electric field on electronic band structures and magnetic properties. Significant Magnetic anisotropy energy (MAE) has been calculated, and variation of MAE with strain has been observed. Hence, in this study we have investigated the electronic structure and magnetic properties of CrS_2 , which highlights their potential application for future spintronic devices.

Keywords: Spintronics, Layered magnetic material, Transition metal dichalcogenides, Strain modulation, MAE.

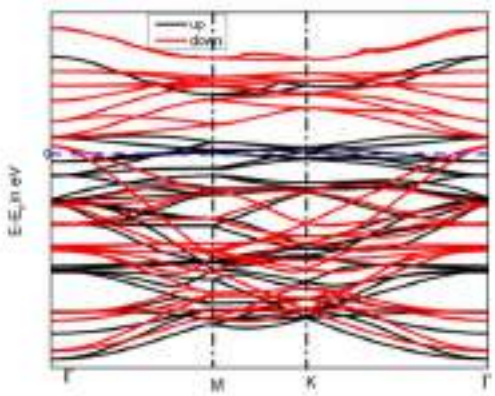


Fig. 1: Band Structure of 1T Ferromagnetic phase of CrS_2.

References:

[1] Chen, K., Deng, J., Yan, Y. et al. npj Comput Mater **7**, 79 (2021).
[2] N. Sethulakshmi, A. Mishra, P.M. Ajayan, Y. Kawazoe et al. Mater. Today. 27 (2019) 107–122.
[3] H. Shi, H. Pan, Y.W. Zhang, B.I. Yakobson, Phys. Rev. B - Condens. Matter Mater. Phys. 88 (2013) 205305.

Abstract ID: 335

THERMALLY INDUCED SPIN CURRENT IN PT/$Y_3FE_5O_{12}$ THIN FILMS FOR SPIN-BASED THERMOELECTRIC ENERGY CONVERSION

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Abstract: We investigated spin-based thermoelectric energy conversion through the longitudinal spin Seebeck effect (LSSE) in yttrium iron garnet ($Y_3Fe_5O_{12}$, YIG) thin films. An optimized combination of magnetic and heavy-metal layers was employed to enhance spin-to-charge current conversion efficiency. Polycrystalline YIG film of 120 nm thickness was deposited on Si(100) substrate by RF magnetron sputtering, followed by deposition of a Pt layer of 5 nm thickness on YIG/Si(100) using DC magnetron sputtering. Application of a temperature gradient across the Pt/YIG/Si(100) heterostructure generated a thermally excited pure spin current in YIG, which was injected into the adjacent Pt layer and converted into a transverse charge current via the inverse spin Hall effect (ISHE), enabling heat-to-electricity conversion through the spin degree of freedom. LSSE measurements were carried out using a custom-built in-house LSSE measurement setup that allowed precise control of temperature gradients and external magnetic fields. Clear V_{SSE}-H hysteresis loops were observed at various temperature gradients in Pt/YIG/Si(100) system. Moreover, the spin Seebeck voltage (V_{SSE}) increased linearly with the applied temperature difference (ΔT). Increasing the LSSE-induced voltage and integrating it with complementary spin-dependent effects enables the fabrication of high-performance spin-based thermoelectric energy conversion devices.

Keywords: Thin film, Spin Seebeck effect, Spin Current, Spintronics, Inverse spin Hall effect, Thermoelectric.

References:

[1] K. K. Kumawat *et al.*, Enhanced Longitudinal Spin Seebeck Effect in Au/$Y_3Fe_5O_{12}$, Journal of Alloys and Compounds 1001 (2024) 175187.
[2] K. Uchida *et al.*, Observation of longitudinal spin-Seebeck effect in magnetic insulators, Applied Physics Letters, 97 (2010) 172505.

Abstract ID: 336

MICROMAGNETIC SIMULATION OF SPIN HALL NANO-OSCILLATORS FOR TUNABLE HIGH-FREQUENCY OPERATION

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Abstract: Spin Hall Nano-Oscillators (SHNOs) are promising nanoscale sources of tunable microwave signals due to their strong spin orbit torque driven dynamics and nanoscale confinement effects [1]. In this work, we simulate nano-constriction SHNOs, considering both single-layer and synthetic antiferromagnet (SAF) coupled configurations. Current and magnetic-field distributions were first computed using COMSOL and then imported into MuMax3 for time-dependent micromagnetic simulations, followed by frequency and mode analysis in Python.

Nano-constriction geometries are known to efficiently generate and sustain propagating spin-wave modes rather than purely localized precession [2]. Consistent with this, the single-layer device in our study demonstrates controllable tuning characteristics with propagating spin-wave excitations extending beyond the constriction region. Magnetic-field variation further enables systematic modulation of the oscillation dynamics. The incorporation of SAF coupling modifies the effective magnetic interactions and dynamic response, leading to improved frequency and tunability compared to the single-layer design [3]. Overall, the results emphasize how device architecture and excitation conditions influence SHNO performance and dynamic behavior.

Keywords: Spin Hall Nano-Oscillators (SHNOs), Spin–Orbit Torque (SOT), MuMax3, Nano-constriction Geometry, Synthetic Antiferromagnet (SAF).

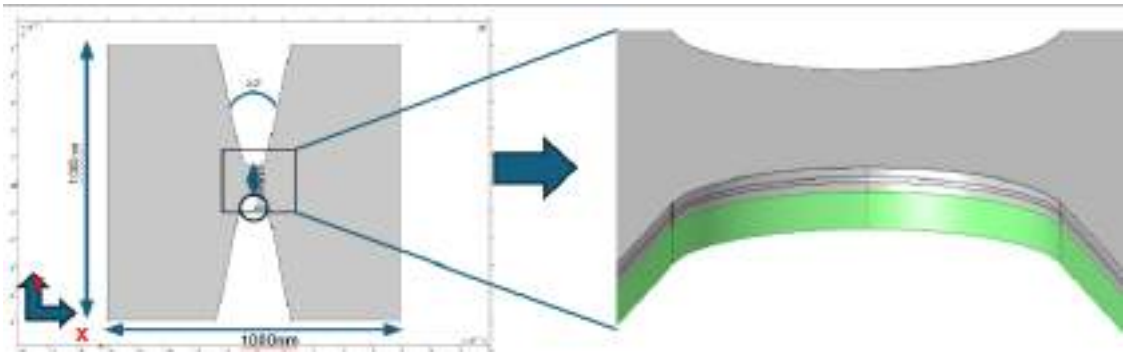


Fig. 1: High charge current density in the constriction region, resulting in high spin current.

References:

[1] Johansson, A. (2024). Theory of spin and orbital Edelstein effects. Journal of Physics Condensed Matter, 36(42), 423002.

[2] Takahashi, S., & Maekawa, S. (2008). Spin current, spin accumulation and spin Hall effect. Science and Technology of Advanced Materials, 9(1), 014105.

[3] Duine, R. A., Lee, K., Parkin, S. S. P., & Stiles, M. D. (2018). Synthetic antiferromagnetic spintronics. Nature Physics, 14(3), 217–219.

Abstract ID: 337

IMPACT OF PARTICLE SIZE ON STRUCTURAL AND MAGNETIC ORDERING OF $Nd_{0.65}Ca_{0.35}Mn_{0.7}Zn_{0.3}O_3$ MANGANITE

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Abstract: In this paper, we report the size dependent magnetic properties of $Nd_{0.65}Ca_{0.35}Mn_{0.7}Zn_{0.3}O_3$ manganite. Bulk (ZB3) and nano particles (ZN3) of hole-doped $Nd_{0.65}Ca_{0.35}Mn_{0.7}Zn_{0.3}O_3$ were prepared by sol gel method. These particles were characterized by XRD, TEM, SEM and EDAX. The XRD plots were refined using Rietveld fitting technique and indexed using an orthorhombic unit cell with Pbnm space symmetry. To investigate the effects of size reduction on the magnetic properties, dc magnetization measurements were carried out in temperature range $10K \leq T \leq 300K$.The low temperature ferromagnetic component enhances in nanoparticles (ZN3) as compared to its bulk counterpart, due to uncompensated surface spins. Temperature dependence of magnetization (M*T vs T) graph shows the disappearance of charge order in both the samples. Also, from the magnetization measurements, it is observed that the size reduction leads to an increase in the ferromagnetic transition temperature (Tc). Inverse susceptibility, $(1/\chi)$ variation with temperature along with the Curie Weiss (CW) fit is plotted and a deviation from the fit is observed for the nanosample at high temperature. Field dependent hysteresis measurements were carried out at different temperature and unsaturated hysteresis loop at high field can be attributed to the presence of residual antiferromagnetism in these samples.

Keywords: Magnetization, Perovskite, Manganite, Hysteresis, Nanoparticles.

Abstract ID: 339

STRUCTURAL AND MAGNETIC PROPERTIES OF Gd-RICH $Gd_{1+\delta}Sb$ SINGLE CRYSTAL

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Abstract: Rare-earth monopnictides exhibit magnetic properties that are highly sensitive to lattice defects and stoichiometry. Here, we investigate the effect of off-stoichiometry on the structural and magnetic behavior of a Gd-rich $Gd_{1+\delta}Sb$ single crystal grown by a high-temperature flux method. Single-crystal X-ray diffraction shows intense (200), (400), and (600) reflections, confirming a well-ordered rock-salt structure without detectable impurity phases, indicating that excess Gd is incorporated into the lattice rather than forming secondary phases. Temperature-dependent magnetization measured under an applied field of 500 Oe along the [100] direction reveals a clear antiferromagnetic transition at the Néel temperature ($T_N \approx 25.8$) K. Above (T_N) the sample exhibits paramagnetic behavior, while below this temperature the magnetic moment decreases due to long-range ordering of localized Gd moments. A bifurcation between zero-field-cooled and field-cooled curves near the transition suggests domain pinning associated with defect-induced magnetic centers. These results show that small deviations from stoichiometry significantly modify the physical and magnetic response of GdSb, highlighting defect engineering as a route to tune magnetic ordering in rare-earth monopnictides.

Keywords: Rare-earth monopnictides, Off-stoichiometry, Defect-induced magnetism, Magnetization measurements.

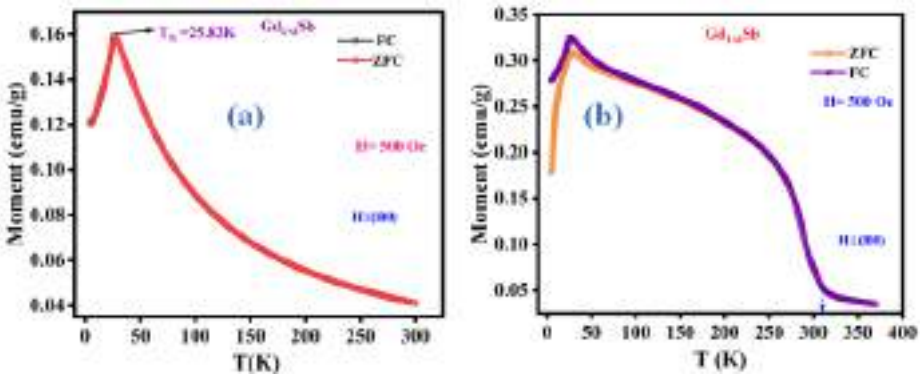


Fig. 1: Temperature-dependent magnetization of $Gd_{1+\delta}Sb$ at 500 Oe: (a) $H \parallel (100)$ and (b) $H \perp (100)$ shown ZFC–FC behavior.

References:

[1] J. J. Song, F. Tang, Y. W. Du, *J. Mater. Chem. C,* 2018, 6, 3026.

Abstract ID: 340

LONG TERM STABILITY OF AQUEOUS BASED MAGNETITE FERROFLUIDS FUNCTIONALIZED WITH ZWITTERIONIC AMINE-OXIDE SURFACTANT FOR MAGNETIC HYPERTHERMIA APPLICATION

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Abstract: In this study, Fe_3O_4-based ferrofluids were synthesized for use in magnetic fluid hyperthermia, leveraging their superparamagnetic properties, biocompatibility and under an alternating magnetic field (AMF) where have the ability to convert electromagnetic energy into localized heat [1]. Aqueous-based Fe_3O_4 ferrofluids were prepared via a coprecipitation approach and functionalized with zwitterionic amine oxide-derived surfactants, such as N,N-dimethyldodecylamine N-oxide (DDAO), to enhance their stability and dispersion in aqueous environments. A variety of analytical techniques were employed to investigate the structural, surface, morphological, colloidal stability, magnetic and thermal properties. XRD confirmed the inverse spinel property with an average crystallite size of about ~9 nm. FTIR spectra indicated that surfactants had been successfully attached to the nanoparticle surface. HRTEM images showed quasi-spherical nanoparticles and uniform size dispersion of about ~11 nm, confirming the presence of monocrystalline nature. XPS provided detailed insights into the chemical composition and oxidation states of the surface elements. The functionalization leads to strong stability with a negative zeta value and enhanced hydrophilic nature when compared to unmodified iron oxides. The superparamagnetic behavior was observed by magnetic measurements with a saturation magnetization of 53 emu/g values for DDAO-functionalized ferrofluids. The highest calculated SAR values were found at 0.5 mg/mL concentrations, highlighting the importance of surface modification in improving the heating potential for hyperthermia applications.

Keywords: Magnetic nanoparticles; Ferrofluids; Surfactant; Magnetic hyperthermia applications; Specific adsorption rate.

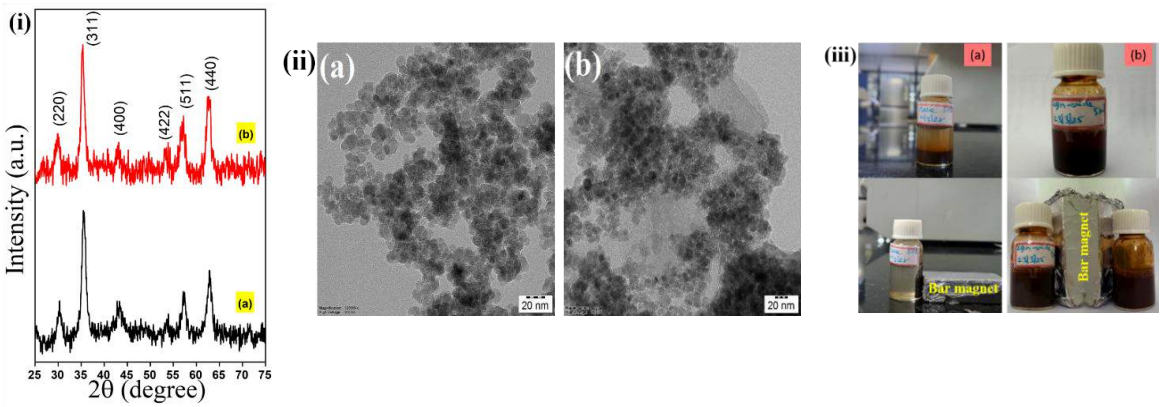


Fig. 1: (i), (ii) and (iii) represents the XRD, HRTEM and real time images under the response of magnet and its stablity properties of (a) bare and (b) DDAO-ferrofluids.

References:

[1] L. Souiade *et al.*, *Int. J. Mol. Sci.*, vol. 24, no. 21, p. 15933, Nov. 2023. 10.3390/ijms242115933

Abstract ID: 341

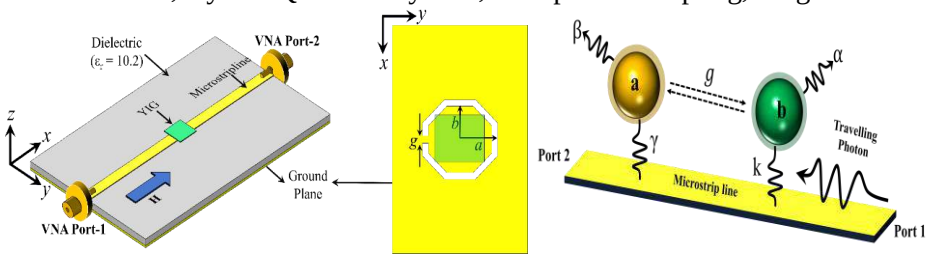
PURCELL EFFECT AND SATURATION MAGNETIZATION CONTROL IN THE LEVEL-ATTRACTION REGIME OF A PLANER PHOTON–MAGNON HYBRID SYSTEM

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Abstract: The Purcell effect is widely used to control spontaneous emission in cavity and nanophotonic systems, yet its realization in planar photon–magnon platforms under dissipative, non-Hermitian conditions remains largely unexplored. We investigate the Purcell effect in a planar photon–magnon hybrid quantum system consisting of a yttrium iron garnet (YIG) thin film coupled to an inverted octa-ring resonator (IORR)[1]. The system is engineered to operate in the level-attraction regime through dissipative photon–magnon coupling, and the magnon damping is systematically tuned to explore the resulting Purcell physics. Within this regime, we demonstrate controlled modification of cavity photon dissipation, identifying the emergence of the Purcell regime[2]. A quantum theoretical framework based on non-Hermitian coupled-mode theory and input–output formalism is employed to describe the dissipative dynamics of the hybrid system. We explicitly analyze the saturation magnetization (M_s) dependence for each damping condition, showing that M_s-controlled variations in coupling determine the onset and robustness of Purcell-enhanced photon decay. Full-wave electromagnetic simulations performed using CST Microwave Studio, with simultaneous tuning of magnon damping and saturation magnetization, reveal their combined influence on photon–magnon coupling, hybrid-mode formation, and dissipation dynamics. Also demonstrating experimentally accessible routes for magnetization- and dissipation-engineered photon–magnon interactions in chip-compatible quantum systems.

Keywords: Purcell effect, Hybrid Quantum System, Dissipative Coupling, Magnetization



(a) **(b)**

Fig. 1: The simulation setup is shown in **(a)** hybrid system composed of a YIG film (green) and a microstrip line (yellow) fabricated on an RO3010 substrate **(b)** Schematic diagram of the quantum coupled-mode model.

References:

[1] Zhao, Y., L. Wang, X. Han, Y. Tian, S. Yan, Q. Guo, Y. Zhai, and L. Bai, Control of magnon–photon coupling by a direct current in a Py/Pt-superconducting cavity hybrid system, Applied Physics Letters. 122 (2023). https://doi.org/10.1063/5.0153616.

[2] Verma, S., A. Maurya, R. Singh, and B. Bhoi, Control of Photon-Magnon Coupling in a Planar Hybrid Configuration, Journal of Superconductivity and Novel Magnetism. 37 (2024) 1163-1171. https://doi.org/10.1007/s10948-024-06721-w.

Abstract ID: 342

FORMATION AND EFFECT OF FERRIMAGNETIC PARTICULATE IN FERROELECTRIC-ANTIFERROMAGNETIC COMPOSITE SYSTEM

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Abstract: The mechanical strain transfer from the magnetostrictive ferromagnetic phase to ferroelectric phase through actual physical contact gives rise to magnetoelectric coupling in 0-3 composite materials. We observe no measurable magnetostriction in the unpoled state of the composite with ~6 vol% of the ferrimagnetic phase, whereas in the poled specimen the magnetosriction is observed indicating the aligned ferrolectric domains, acting as the bridge between the ferrimagnetic domains situated as islands in the ferroelectric matrix [1], Fig. 1. We also observe ~50% increase in saturation polarization at room temperature under a modest magnetic field of 1 T [2], Fig. 3. The plausible reason of the increase in the polarization is attributed to the decrease in size of the garnet particulates after application of magnetic field, negative magnetostriction and we also expect a decrease in the polarization with positive magnetostrictive garnet particulates; indicating that the phenomenon is not an outcome of the polarization relaxation. The formation of the garnet phase is not spurious, we have shown systematically that what can be the spontaneous precipitation in the matrix while preparing the ferromagnetic-ferroelectric magnetoelectric materials [3].

Keywords: Magnetoelectric, Ferroelectric, Ferromagnetic, 0-3 particulate composite, magnetostriction

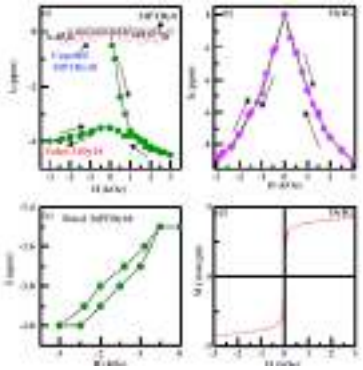


Figure 1

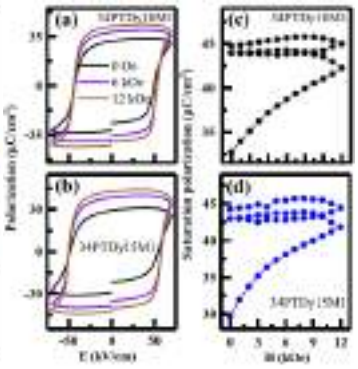


Figure 2

Fig. 1: Poling induced magnetostriction. **Fig. 2:** Magnetic field induced polarization enhancement.

References:

[1] S. Saha, R. P. Singh , Y. Liu, A. B. Swain, A. Kumar, V. Subramanian, A. Arockiarajan, G. Srinivasan, R. Ranjan, Phys. Rev B 103 (2021) L140106.

[2] S. Saha, R. P. Singh, A. Kumar, A. De, P. Pandey, B. Narayan, H. Basumatary, A. Senyshyn, R. Ranjan, Appl. Phys. Lett. 116 (2020) 142902.

[3] S. Saha, R. P. Singh, A. Rout, A. Mishra, A. Ali, H. Basumatary, R. Ranjan, J. Appl. Phys. 133 (2023) 064101.

Abstract ID: 343

DEVELOPMENT OF HIGH-TEMPERATURE SOFT MAGNETIC Fe_3Al-BASED ALLOYS WITH IMPROVED MAGNETIC STABILITY FOR INDUSTRIAL ELECTROMAGNETIC APPLICATIONS

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Abstract: Fe_3Al-based intermetallic alloys have attracted considerable attention due to their excellent soft magnetic behavior and high thermal stability for advanced magnetic applications[1, 2]. In this study, Fe_3Al, Fe_3NiAl, and Fe_3CoAl alloys were successfully synthesized using the Vaccum Melting technique, and phase analysis confirmed the formation of an ordered $D0_3$ crystal structure in all compositions. Magnetic characterization revealed intrinsic soft magnetic properties, with enhanced magnetic response resulting from Ni and Co substitution. Magnetization versus temperature (M-T) measurements of the $Fe_{75}Al_{25}$ alloy exhibited a Curie temperature (T_c) of approximately 914 K, indicating excellent thermal stability. Furthermore, Ni- and Co-substituted alloys showed a significant increase in Curie temperature, exceeding 1000 K, demonstrating improved magnetic exchange interactions and high-temperature magnetic performance. To further evaluate magnetic stability, isothermal magnetization measurements were carried out at different temperatures of 300, 400, 600, 800, and 1000 K. The results confirm enhanced magnetic stability and retention of soft magnetic characteristics over a wide temperature range. These findings demonstrate that controlled elemental substitution, combined with thermal magnetic analysis, significantly enhances the magnetic behaviour and stability of Fe_3Al-based alloys, making them promising candidates for high-temperature soft magnetic and industrial electromagnetic applications. Furthermore, the present work highlights the potential of conventional melting techniques as a viable precursor route for future 3D metal printing and advanced manufacturing applications [3].

Keywords: Fe_3Al-based alloys, $D0_3$ ordered structure, Soft magnetic materials, Curie temperature (T_c) and Isothermal magnetization.

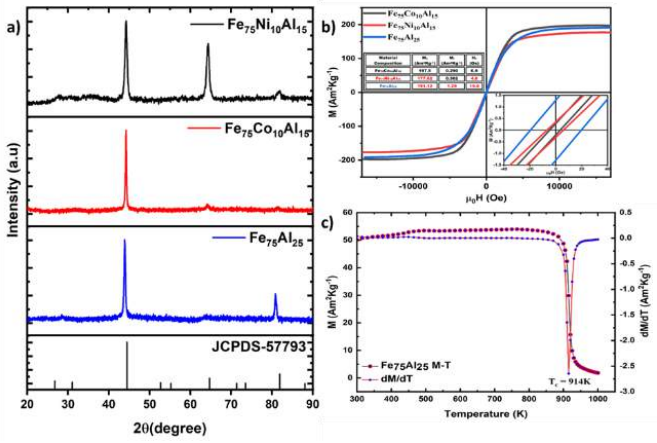


Fig. 1: a) X-ray Diffraction of Soft Magnetic Materials, b) M vs H measurement of the Soft Magnetic Alloys, and c) M vs T data of $Fe_{75}Al_{25}$ measured at 500 Oe.

References:

[1] Ravisankar, N.K., Koppolu, U.M.K., M, M.R. et al. J Supercond Nov Magn 37, 1815–1820 (2024).
[2] Ravichandran, S., Ravisankar, N.K., Koppolu, U.M.K., et al., *Mater Sci Eng B* **313**, 117938 (2025).
[3] Bibi, A., Khan, F., Kallaste, A. et al Electr Eng 108, 128 (2026).

Abstract ID: 344

ESTIMATING THE PERFORMANCE OF MAGNETIC HYPERTHERMIA THROUGH PHYSICS INFORMED NEURAL NETWORK PREDICTIONS

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Abstract: In this study, we present the development of a physics-informed neural network (PINN) model for predicting the performance of magnetic hyperthermia (MH) in cancer treatment. The effective cancer cell destruction requires heating to 42 – 45 °C.The model incorporates key input parameters, including nanoparticle size**,** saturation magnetization**,** magnetic field intensity**,** frequency**,** specific heat of fluid**,** nanoparticle concentration, and time, to predict the temperature evolution. However, in this work, the performance estimation is carried out by analysing the influence of parameters such as diameter**,** frequency**,** field strength**,** concentration**,** anisotropy constant**,** susceptibility, and relaxation times (Néel and Brownian) on the hyperthermia response. Through this parametric analysis, we investigate the optimal conditions for achieving effective hyperthermia performance. The PINN model is trained on a dataset of 3690 data points and the model achieves a high predictive accuracy with an R^2 value of 0.98 against the test data, confirming its reliability in estimating hyperthermia performance. This work enables the identification of optimal physical and magnetic parameters to enhance the effectiveness of magnetic nanoparticle-based cancer therapy.

Keywords: Magnetic hyperthermia, PINN, magnetic nanoparticles, physicochemical properties.

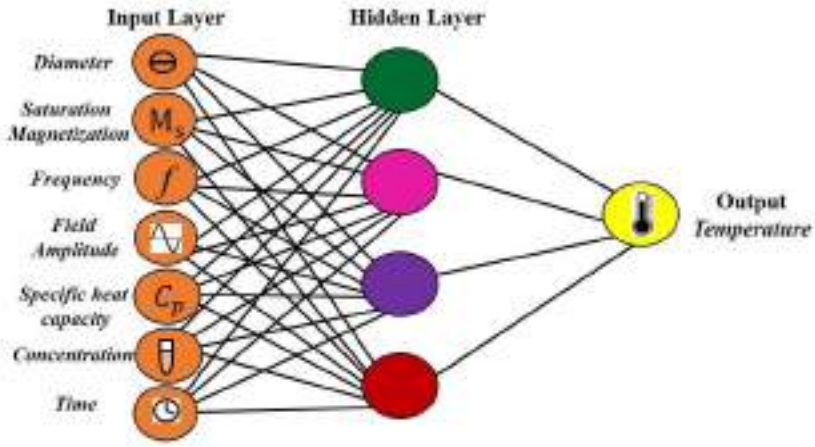


Fig. 1: Schematic of Physics informed neural network.

References:

[1] A R Menon, H Y Patil, A Mahajan, N K Sahu, IEEE Trans. Magn., 62 (2026).
[2] R.E. Rosensweig, J. Magn. Magn. Mater., 252 (2002) 370–374.

Abstract ID: 345

A MICROMAGNETIC STUDY ON MATERIAL DEPENDENT STABILIZATION OF INTERFICIAL DMI INDUCED SKYRMIONS

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Abstract: Magnetic skyrmions are nanoscale, topologically protected[1] spin textures stabilized by the interplay of exchange interaction, perpendicular magnetic anisotropy (PMA)[2], dipolar interaction, and interfacial Dzyaloshinskii–Moriya interaction (DMI)[3, 4]. Heusler alloys are also one of the important class of alloys focusing major application in spintronics as they possesed high curie tempertature and high spin polarization. In this work, a systematic micromagnetic investigation of skyrmion formation in Co_2FeGa Heusler alloy & Fe and CoNi based ultrathin heterostructures interfaced with different heavy metals and MgO is performed using MuMax3 simulations and experimentally. It is shown that skyrmion stability is governed by the strength of interfacial DMI and the effective saturation magnetization.

Keywords: Magnetic skyrmions, Interfacial DMI, Heusler alloy, Heavy metals

References:

[1] Hu, H., et al., High-topological-number skyrmions and phase transition in two- dimensional frustrated $ J_1 $-$ J_2 $ magnets. arXiv preprint arXiv:2401.05719, 2024.
[2] Dieny, B. and M. Chshiev, Perpendicular magnetic anisotropy at transition metal/oxide interfaces and applications. Reviews of Modern Physics, 2017. 89(2): p. 025008.
[3] Yang, H., J. Liang, and Q. Cui, First-principles calculations for Dzyaloshinskii–Moriya interaction. Nature Reviews Physics, 2023. 5(1): p. 43–61.
[4] Kuepferling, M., et al., Measuring interfacial Dzyaloshinskii-Moriya interaction in ultrathin magnetic films. Reviews of Modern Physics, 2023. 95(1): p. 015003.

Abstract ID: 346

DEVELOPMENT OF DOUBLE PEROVSKITE Gd_2NiMnO_6 AND Eu_2NiMnO_6 FOR MAGNETOCALORIC APPLICATION

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Abstract: Double perovskites are becoming an important research topic due to their intriguing magnetic properties coupled with electric fields. As the focus of invension of new energy materials which as renewable in nature has taken a speed, the rare earth manganites possess most of the qualities to become a new energy material for cooling purpose. The magnetocaloric effect exhibited by these materials finds application in many energy devices such as refrigerator, cooler etc. The double perovskite structure of rare earth manganites helps in attaining the goal of becoming successful magnetic refrigerant. In this work, Eu_2NiMnO_6 and Gd_2NiMnO_6 was synthesized using solid state reaction method. The Eu_2NiMnO_6 and Gd_2NiMnO_6 were studied for their structural, magnetic and magnetocaloric properties. The PXRD analysis confirms the monoclinic structure and P21/n(14) space group of Eu_2NiMnO_6 and Gd_2NiMnO_6. The space group, bond angles, lattice parameters were derived from the data obtained after Rietvald refinement of the XRD diffraction pattern. The temperature dependence and field dependence magnetic properties were evaluated using SQUID-VSM. The exhibition of magnetocaloric properties were suggested by the presence of second order transition in the temperature dependent magnetic measurement. The magnetic entropy with respect to the Magnetocaloric effect of Eu_2NiMnO_6 and Gd_2NiMnO_6 was derived and studied in detail.

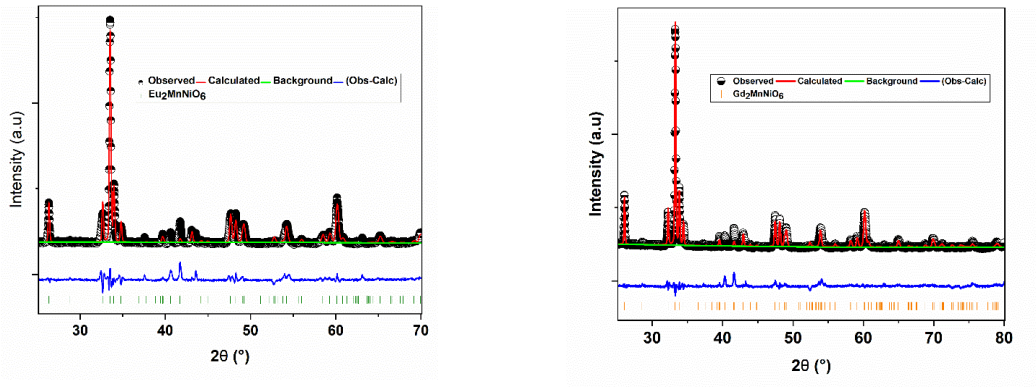


Fig. 1: Powder XRD Rietveld Refinement of Eu_2NiMno_6 and Gd_2NiMnO_6

References:

[1] Leng, K., Tang, Q., Wei, Y., Yang, L., Xie, Y., Wu, Z., Zhu, X.: AIP Adv. 10, (2020). https://doi.org/10.1063/5.0031196

[2] Afroze, S., Karim, A.H., Cheok, Q., Eriksson, S., Azad, A.K.: Front. Energy. 13, 770–797 (2019). https://doi.org/10.1007/s11708-019-0651-x

Abstract ID: 347

DEMONSTRATION OF FIELD-FREE SWITCHING VIA ORBITAL HALL EFFECT IN NiFe/Cr BILAYER

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Abstract: We demonstrate deterministic field-free magnetization switching in an in-plane magnetized NiFe/Cr bilayer driven solely by orbital Hall torque (OHT). In this system, orbital currents generated via the orbital Hall effect in Cr, a 3d transition metal, are converted into an interfacial orbital torque acting on the NiFe layer, enabling efficient magnetization reversal without the use of external magnetic fields or heavy-metal spin Hall layers. The efficiency of the orbital torque was systematically investigated as a function of Cr thickness using room-temperature transport measurements. In-plane magnetic anisotropy was confirmed by M-H hysteresis loops, while planar Hall effect measurements were employed to track magnetization orientation. Quantitative evaluation of the torque was performed using second harmonic Hall measurements, revealing a robust and consistent OHT contribution across the studied thickness range. Field-free switching was electrically detected using the odd planar Hall voltage (O-PHV), a DC readout technique that provides unambiguous identification of magnetic states through its odd symmetry under magnetic field reversal. A clear O-PHV signal of was observed at a switching current of 30 mA. These results constitute, to the best of our knowledge, the first experimental demonstration of field-free switching in an in-plane magnetic system driven exclusively by orbital torque, highlighting the potential of orbitronic mechanisms for low-power
and scalable spintronic devices.

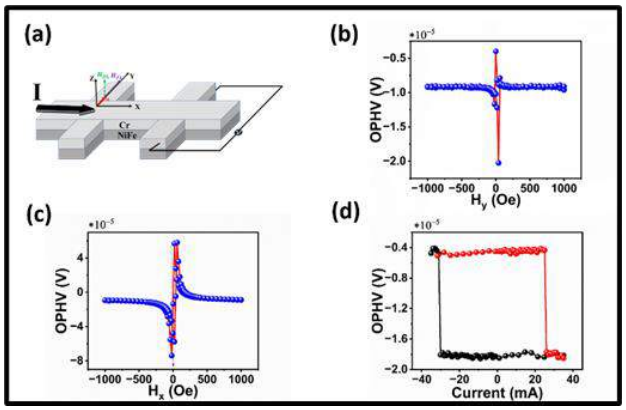


Fig. 4: Magnetiz*ati*on switching.

Abstract ID: 348

INVESTIGATIONS ON ANNEALING INDUCED MAGNETIC PROPERTIES OF $Co_{35}Cr_5Fe_{10}Ni_{30}Al_{20}$ HIGH ENTROPY ALLOYS THROUGH PHOTOEMISSION SPECTROSCOPY AND X-RAY MAGNETIC CIRCULAR DICHROISM

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Abstract: It is now well known that the magnetic properties of High Entropy Alloys (HEAs) are significantly affected by the annealing. $Co_{35}Cr_5Fe_{10}Ni_{30}Al_{20}$ HEA was synthesized through the mechanical alloying technique and the synthesized HEA, exhibited mixture of fcc and bcc phase [1]. The value of M_s and H_c for the synthesized HEA was found to be 50 emu/g and 14 Oe respectively. However, for $Co_{35}Cr_5Fe_{10}Ni_{30}Al_{20}$ HEA annealed at 700°C, the volume phase fraction of bcc phase increased and the fcc phase decreased. Along with the increase in bcc phase the value of Ms increased by more than 100 %. We investigated element specific magnetization through X ray magnetic circular dichroism (XMCD) for the as synthesized and annealed sample. We found that after annealing the magnetic moment corresponding to Fe and Ni enhanced significantly. The detail reason behind the change in magnetic properties of $Co_{35}Cr_5Fe_{10}Ni_{30}Al_{20}$ HEA after annealing and element specific magnetization is discussed in this study.

Keywords: High Entropy Alloys; Magnetic Properties; X-Ray Magnetic Circular Dichroism; Annealing.

References:

[1] P. Kumari, S. Mohapatra, R.J. Choudhary, S.K. Nath, S.D. Singh, R.R. Shahi, J. Appl. Phys., 2025, 139, 015103.

Abstract ID: 349

DEVELOPMENT OF MAGNETIC–CONDUCTIVE PLA COMPOSITES REINFORCED WITH CARBONYL IRON AND GRAPHENE NANOPLATELETS FOR FUSED FILAMENT FABRICATION

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Abstract: The development of multifunctional polymer composites which provide magnetic, electrical, and structural performance is essential for future smart and additive manufacturing systems. In this work, a hybrid magnetic and conductive composite was developed and optimized from polylactic acid, carbonyl iron powder, and graphene nanoplatelets for fused filament fabrication (FFF). Composite formulations were framed using a structured design of experiments approach. Iron content, ranging from 20 to 40 wt%, and graphene content, from 1 to 5 wt%, were systematically varied. Melt compounding took place through twin-screw extrusion. This was followed by filament fabrication and FFF printing. The SEM analysis confirmed a uniform distribution of hybrid fillers at optimized compositions. Magnetic tests using vibrating sample magnetometry showed a steady rise in saturation magnetization as iron content increased. A maximum saturation magnetization (M_s) of 75 emu/g was observed at 40 wt% iron content. The electrical conductivity test revealed the percolation threshold between 2-3wt% for the graphene. The tensile test confirmed that 3wt% of graphene into PLA, can support for the maxiumum strength up to 58 Mpa. Statistical analysis has been explored that the content of graphene is a significant factor affects conductivity. Conversely, iron content is an influencing factor that affects magnetic performance. Furthermore, multi-objective optimization results indicated that a combination of 30 wt% iron and 3 wt% graphene content would provide a good trade-off for magnetic saturation, conductivity, and tensile strength with good printability. This paper demonstrates a way to produce multifunctional magnetic and conductive PLA composites via conventional processing routes for FFF processes.

Keywords: 3D Printing, PLA, Magnetic, Conductivity, Graphene.

Abstract ID: 350

TOPOLOGICAL FEATURES IN FERROMAGNETIC CHROMIUM TELLURIDE

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Abstract: Magnetic refrigeration has recently emerged as a promising alternative to conventional refrigeration due to its higher efficiency, lower energy consumption, and reduced noise. Materials exhibiting large magnetocaloric effect (MCE) and favorable thermoelectric performance are of significant interest for all-solid-state refrigeration technology. CrTe-based ferromagnets have been reported as promising candidates because of their near-room temperature Tc. Motivated by these characteristics, the present work focuses on the lattice dynamical properties of ferromagnetic CrTe. In the absence of applied pressure, CrTe crystallizes in hexagonal Ni-As type structure (space group P63/mmc) with a lattice parameters a = b = 3.99 Å and c = 6.22 Å. Using ab initio phonon calculations combined with detailed symmetry analysis, the topological phonon features of hexagonal CrTe are systematically investigated. The phonon spectrum reveals multiple symmetry-enforced band degeneracies ,including a nodal surface at ($k_z = \pi$) formed by doubly degenerate phonon modes, a quadratic Dirac point at the high-symmetry point A arising from non symmorphic (S_{6z}) symmetry and twofold rotation, and symmetry-protected nodal lines along the M-G-K path stabilized by screw-rotation symmetry. These results underscore the cruciality of crystal symmetry in governing topological phonon excitations and establish CrTe as a promising platform for exploring symmetry-driven phonon topology in magnetic materials.

Keywords: CrTe, Topological materials, Density Functional Theory, Phonons.

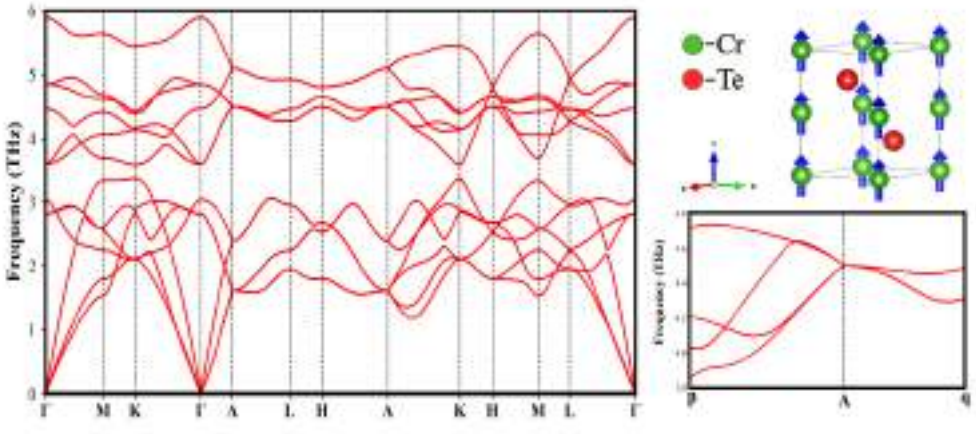


Fig. 1: Crystal Structure of CrTe, Full Phonon Dispersion and QDP at A point.

References:

[1] Borghesi, Costanza, Giacomo Giorgi, Daniele Varsano, and Riccardo Rurali, *Advanced Electronic Materials* (2025): e00477.

Abstract ID: 351

CITRATE FUNCTIONALIZED COBALT-DOPED IRON OXIDE NANOPARTICLES FOR RHODAMINE DYE AND LEAD ION SEQUESTRATION

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Abstract: There is an immense interest in magnetic nanoparticles (MNPs) for the sequestration of toxic pollutants in water due to their exceptional magnetic properties and high surface-to-volume ratio [1, 2]. We describe here the functionalization of cobalt-doped iron oxide MNPs with citrate moieties for the removal of rhodamine B dye and lead ions from aqueous solutions. The MNPs are prepared using a co-precipitation technique, where, the hydrodynamic diameter, and zeta potential of the uncoated nanoparticles are found to be ~ 21 nm, and ~ 45 ± 3.1 mV, respectively. The hydrodynamic diameters are found to increase to ~ 51, ~ 59, and ~ 68 nm for the MNPs functionalized with ~ 20, 40, and 60 mg/mL of citrate, respectively, whereas the corresponding zeta potentials are found to be ~ -27.95 ± 3.5 mV, ~ -32.5 ± 3.6 mV, and ~ -33.9 ± 3.5 mV, respectively. Fourier transform infrared (FTIR) spectra of the surface-functionalized MNPs further confirm the chemisorption of the citrate moieties (Fig. 1a). The coated and uncoated MNPs are treated with aqueous solutions of rhodamine B dye and lead nitrate. The sequestration of the dye and lead ions is determined spectrophotometrically, where, the citrate functionalized nanoparticles are found to exhibit the dye and lead ion removal efficiencies of ~ 93.7 ± 2.6 % and ~ 90 ± 2.4 %, respectively. The experimental findings show the efficacy of the citrate-functionalized cobalt-doped iron oxide MNPs for the sequestration of dye pollutants and lead ions from the contaminated water.

Keywords: Rhodamine B, Lead removal, Dye removal, Magnetic nanoparticles

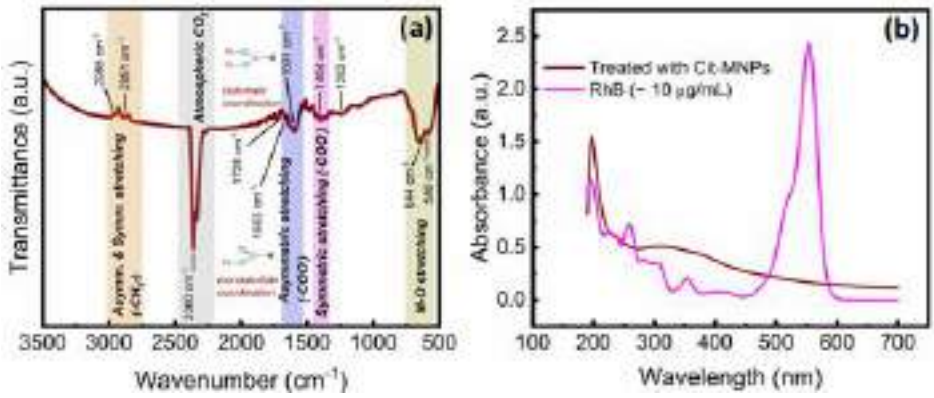


Fig. 1: (a) FTIR spectra of the citrate-functionalized MNPs, where, the major absorption bands are indexed. (b) Absorbance as a function of wavelength for the ~ 10 µg/mL rhodamine B dye solution and the supernatant after treatment with the citrate-functionalized MNPs.

References:

[1] S.M. Ibrahim, A.A. Badawy, H.A. Essawy, J. Nanostrc. Chem. *9* (2019) 281-298.
[2] Qurrat ul Ain, S. Khurshid, Z. Gul, J. Khatoon, M.R. Shah, I. Hamid, I.A.T Khan, F. Aslam, RSC Adv. 10 (2020) 1021-1041.

Abstract ID: 352

SYNTHESIS AND PIEZO-PHOTOCATALYTIC ACTIVITY OF MOLYBDENUM OXIDE DECORATED $BiFeO_3$ NANOPARTICLES

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Abstract: Removal of antibiotics and dyes plays an important role in water treatment because negatively impact both the environment and human health. Dyes are widely used in industries to add colour to products such as textiles, paper, and leather, and are also found in food [2]. The antibiotics for treating bacteria infections, it is difficulty to completely absorb human being and live stocks. The antibiotics are directly entered to aquatic environment like surface water, ground water, drinking water through human urine [1]. In this process, light activates a semiconductor catalyst that promotes the breakdown of pollutants present in water. The piezoelectric field enhancing the rate of excited charge carriers. During heterogeneous photocatalysis, reactive species such as hydroxyl radicals (•OH), holes (h^+), superoxide ions (O_2•$^-$), and peroxide radicals (HO_2•) participate in oxidation reactions that often lead to the complete mineralization of organic contaminants(dyes) and removal of antibiotics [1]. Bismuth ferrite ($BiFeO_3$), a representative single-phase multiferroic material, offers promising applications in piezo-photocatalytic degradation [1]. This perovskite compound possesses a rhombohedral *R3c* crystal structure and exhibits strong potential as a visible-light photocatalyst, though its performance is limited by a low surface area and rapid charge recombination [3]. The hydrothermal method was employed to synthesize of $BiFeO_3$ nanoparticles decorated with molybdenum oxide to improve piezo-photocatalytic efficiency [2]. The crystal structure, morphology, UV–visible spectroscopy and performance of the dye degradation and removal of antibiotics of BFO samples will be presented in conference.

Keywords: $BiFeO_3$, multiferroic, molybdenum oxide, catalyst, antibiotics

Reference:

[1] Wang, Y., Yang, M., Cui, K., Zhang, L., Wang, X., Ge, S., Cheng, Z. (2024).*ACS Sustainable Chemistry & Engineering*, *12*(6), 2300-2312.

[2] Shi, L., Jia, T., Sun, C., Fu, F., Huang, J., Zhang, Q., Lee, J. H. (2025). *Journal of Alloys and Compounds*, *1038*, 182714.

[3] Varshney, A., Chauhan, S., Kumar, M., Raymond Herrera, O., Sharma, S. (2026) ACS Applied Nano Materials.

Abstract ID: 353

FIELD-INDUCED METAMAGNETIC TRANSITIONS IN Nd SUBSTITUTED La(CoMn)O_3 PEROVSKITES

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Abstract: Precise control of rare-earth (R) metals substitution (x) on the transition metal based perovskites ($A_{1-x}R_xBO_3$) leads to various unique phenomena in magnetic and magnetoelectric properties which plays a key tole on in developing the novel spintronic devices [1,2]. Such control of composition can be achieved through various synthesize techniques involving sol-gel method which has many advantages in site-specific substitution and producing a thermodynamically stable compound. Here in the present work we report some of the interesting physical properties of orthorhombic polycrystalline Nd- and Mn substituted $LaCoO_3$ realizing the following specific composition: $(La_{0.5}Nd_{0.5})Co_{0.5}Mn_{0.5}O_3$ (LNCMO) which exhibits different magnetic structure in comparison to pristine $LaCoO_3$ perovskite. Specifically, the parent $LaCoO_3$ (monoclinic, I2/a), Nd substitution reduces lattice distortion (Orthorhombic, Pbnm) leading to the low temperature re-entrant spin-glass-like behavior as evident from the ac-susceptibility and wait-time-dependent magnetization M(t) measurements. Such cosubstitution also induces a field-driven metamagnetic transition (H_T) and a pseudo-first-order spin-state transition (H*, Co: S = 0→2). The modified Arrott plot analysis in this Nd driven system gives critical exponents $\beta = 0.67$, $\gamma = 1.44$, and $\delta = 3.13$. A field–temperature (H–T) phase diagram was constructed on the basis of several magnetic measurements and their results which will be discussed in the light of pure spin-state transitions of Co in LNCMO.

Keywords: Jahn-Teller Distortion, Spin-State Transition, Spin-glass state, Critical exponents

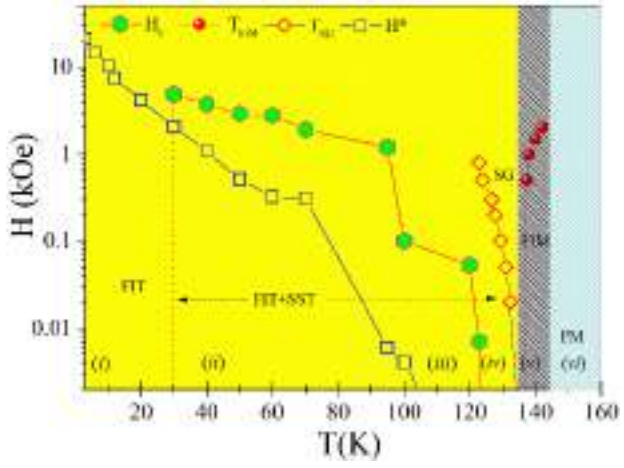


Fig. 1: Magnetic field (H) and temperature (T) phase diagram obtinaed from various magnetic measurements of bulk polycrystals of perovskite $La_{0.5}Nd_{0.5}Co_{0.5}Mn_{0.5}O_3$. One can clear notice the demarcation between different regimes of Field induiced transition (FIT: H_T and H*) and structural transition (SST) mapped on H-T phase diagram along with ferrimagnetic (T_{FiM}) and spin-glass (T_{SG}).

References:

[1] M. B. Salamon, M. Jaime, Rev. Mod. Phys.,73, 583(2001).
[2] P. Tiwari, A. D. Singha and S. Thota et al., J. Phys.: Condens. Matter, 35 375402,(2023).

Abstract ID: 354

Hf-BASED HALF-HEUSLER ALLOYS FOR SPINTRONIC AND THERMOELECTRIC APPLICATIONS: A COMPUTATIONAL APPROACH

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Abstract: Half-Heusler alloys have attracted significant interest due to their tunable electronic structures and multifunctional potential in spintronic and thermoelectric applications, as widely reported in recent theoretical studies [1-3]. Motivated by these developments, the present work aims to investigate whether the HfFeSn and HfFeGe half-Heusler alloys exhibit half-metallic ferromagnetism and favorable thermoelectric performance suitable for device applications. Using spin-polarized density functional theory within the generalized gradient approximation, the structural stability, electronic band structure, density of states, magnetic moments, and transport coefficients were systematically analyzed. The optimized lattice parameters and negative formation energies confirm the thermodynamic stability of both compounds in the cubic $C1_b$ structure. The electronic structure calculations reveal that HfFeSn displays half-metallic behavior, characterized by a metallic majority spin channel and a semiconducting minority spin channel, resulting in nearly complete spin polarization at the Fermi level, while HfFeGe shows modified electronic features due to Sn-Ge substitution. The total magnetic moments follow the Slater–Pauling rule and are mainly due to Fe 3d states, indicating robust ferromagnetic ordering. Furthermore, Boltzmann transport calculations predict promising Seebeck coefficients and power factors at elevated temperatures. Overall, these findings suggest that HfFeSn is a strong candidate for spintronic applications, while HfFeGe demonstrates multifunctional potential, highlighting the role of compositional tuning in optimizing Hf-based half-Heusler alloys [1-3].

Keywords: DFT, Stability, Magnetic response, Thermoelectric properties

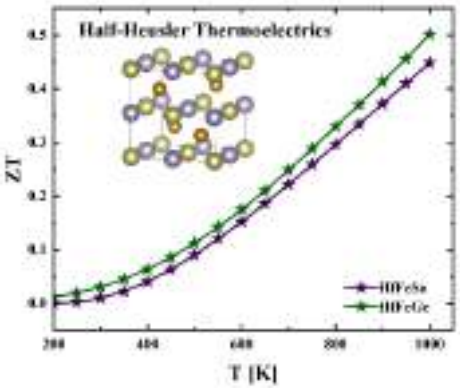


Fig. 1: Temperature-dependent thermoelectric figure of merit (ZT) of HfFeSn and HfFeGe half-Heusler alloys.

References:

[1] M. K. Bamgbose, F.Ayedun, G.T. Solola, A. A. Musari, S. Kenmoe, et al., *Crystals*. 13(1):37, 2022.
[2] Klinton Brito, JB Sudharsan, M Srinivasan, et al., *Computational and Theoretical Chemistry*. 1246:115124, 2025.
[3] Kulwinder Kaur, Ranjan Kumar, DP Rai, *Journal of Alloys and Compounds*. 763:1018–1023, 2018.

Abstract ID: 355

PREPARATION OF HIGH PURE PRASEODYMIUM (Pr) METAL FROM PRASEODYMIUM OXIDE: A TWO-STEP CHLORINATION AND METALLOTHERMIC APPROACH FOR NdFeB MAGNETS

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Abstract: Praseodymium (Pr) is a critical rare-earth metal with extensive applications in green and advanced technologies. This study focuses on the production of high-purity Pr metal via a metallothermic reduction route. Initially, praseodymium oxide (Pr_6O_{11}) was converted into praseodymium chloride ($PrCl_3$) using ammonium chloride (NH_4Cl) as the chlorinating agent. The synthesized $PrCl_3$ was subsequently reduced to metallic Pr using calcium as the reductant. To prevent oxidation and contamination, all metallothermic reduction experiments were carried out in a crucible reduction setup under a controlled argon atmosphere. The chlorination parameters were systematically optimized to obtain phase- pure $PrCl_3$ free from secondary impurities. Detailed investigations were conducted to establish the optimum reduction conditions for achieving maximum metal yield and purity. The reduced Pr metal was characterized using X-ray diffraction (XRD), Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), and Energy-dispersive X-ray fluorescence spectrometry (EDXRF) to confirm phase purity, identification, and elemental composition. The process successfully yielded Pr metal with a purity of approximately 99% prior to refining, demonstrating its suitability for NdFeB magnet preparation.

Keywords: Pr metal, Praseodymium oxide (Pr_6O_{11}), Metallothermic reduction, NdFeB magnets, XRD.

References:

[1] Gupta, C.K., Krishnamurthy, N., 1992. Extractive metallurgy of rare earths. Int. Mater.Rev. 37, 197-248.

[2] Campbell, Thomas T. Preparation and Metallic Reduction of Rare-earth Halides and Oxides. Vol. 5880. US Department of the Interior, Bureau of Mines, 1961.

Abstract ID: 356

MAGNETIC $CoAl_2O_4$ NANOPARTICLES AS CATALYSTS FOR EFFICIENT AND STABLE WATER SPLITTING

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Abstract: Nanoparticles with magnetism, like metal oxide or spinel ferrite nanoparticles offer new ways to manipulate magnetism and spin effects when electrocatalytically or photoelectrochemically used in splitting water molecules, through expanding compositional and morphological variations [1]. Cost-effective and durable electrocatalysts are needed for the large-scale production of hydrogen through electrochemical water splitting. In this study, we explored the suitability of cobalt aluminate nanoparticles with a spinel structure ($CoAl_2O_4$) as bifunctional catalysts (HER & OER) for producing hydrogen. $CoAl_2O_4$ is structurally robust and has tunable magnetic/electronic properties, providing a potentially better performing catalytic material when subjected to alkaline conditions. $CoAl_2O_4$ possesses a stable cubic spinel crystal structure that allows for cation substitution and defect engineering. Designing nanoparticles with nanoscale dimensions results in an increased surface area and exposes many active sites for reacting species. The spin-polarised nature of $CoAl_2O_4$ also introduces a new mechanism by which triplet oxygen forms and reduces the O–O bond coupling barrier, thus greatly enhancing the kinetics of the reaction [2]. In addition, the use of these materials will provide structural stability and the ability to magnetically retrieve them after they have been utilised, benefiting large-scale hydrogen generation systems. The results from the overall water splitting performance show that OER has a low Tafel slope of 49 mV/dec and a high kinetic rate, and HER has a low overpotential (97 mV) that aligns near the benchmark of a commercial electrode (RuO_2, IrO_2).

Keywords: $CoAl_2O_4$, Oxygen Evolution Reaction, Water Splitting, Electrocatalysis, green hydrogen.

References:

[1] P. Sundararajaperumal, P. Velusamy, M. Mahendran, P. Sivaprakash, Influence of Nd3+ ions modified CoAl2O4 nanomaterials for high efficiency dye degradation application, Ceramics International 50 (2024) 34173–34183. https://doi.org/10.1016/j.ceramint.2024.06.236.

[2] P. Sundararajaperumal, M. Mahendran, P. Velusamy, I. Kim, Incorporation of W6+ metal ion in CoAl2O4 for enhanced green hydrogen production: A synergetic effect and phase contributions, Surfaces and Interfaces 65 (2025) 106410. https://doi.org/10.1016/j.surfin.2025.106410.

Abstract ID: 357

OPTIMIZATION OF IN-PLANE AND PERPENDICULAR MAGNETIC ANISOTROPY OF CoFeB LAYERS FOR LINEAR SENSING APPLICATIONS

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Abstract: TMR sensors are highly sensitive, fast and low power consumption magnetic sensor widely used across automotive, industrial, consumer, and scientific applications. Conventional TMR sensor (in-plane sensitive) is suitable candidate for these applications. However, particular applications such as high range current sensor, camera module, or miniaturized motor controls desires high sensitive z-axis TMR sensor. Though techniques likes flux guide and mechanical alignment are used for z-axis sensor using in-plane TMR sensor, the sensor becomes bulky and costly. To simplify this, TMR sensor with top and bottom cross sensing configuration i.e. one FM layer with PMA and other with in-plane need to be fabricated [1,2]. In this work, PMA characteristics of CoFeB at bottom of MgO systems requires precise thickness optimization so that interfacial integrity will be maintained. These films were deposited using magnetron sputtering conditions with base vacuum $<8 \times 10^{-9}$ torr and deposition pressure at 3.5×10^{-3} Torr. Further stacks were annealed at 280 °C and characterised using the Vibrating sample magnetometer (VSM) to study their magnetic behaviour. For bottom CoFeB, a stack of Ta (5 nm) / Ru (5 nm) / Ta (4 nm) / CoFeB (t_1) / MgO (3 nm) / Ta (2 nm) was deposited with *"t_1"* varied from 1.0 nm to 1.5 nm. The PMA was observed for t_1= 1.4 nm to 1.5 nm with coercivity ~ 19 G. For top CoFeB a stack of Ta (5 nm) / Ru (5 nm) / Ta (4 nm) / MgO (3 nm) /CoFeB (1.5 nm)/ Ta (0.3 nm)/CoFeB (t_2 nm) /Ta (2 nm) with t_2 varied from 1.2 nm to 1.9 nm was deposited. For t_2 =1.7 nm, the the VSM data showed linear transition suggesting low anisotropy. Integration of both top and bottom CoFeB with above mentioned characteristics in MTJ structure will result perpendicular linear MR curve. Future work will focus on fabrication of perpendicular TMR sensors.

Keywords: PMA, VSM, Z-axis sensor.

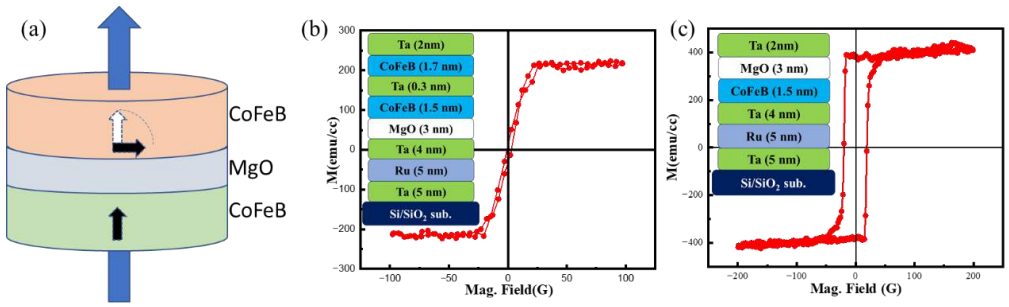


Fig. 1: (a) Schmeatic magnetization direction of z-axis linear sensor (b) Magnetization curve of top CoFeB (b) Magnetization curve of bottom CoFeB..

References:

[1] Sato H, Enobio EC, Yamanouchi M, Ikeda S, Fukami S, Kanai S, Matsukura F, Ohno H. Properties of magnetic tunnel junctions with a MgO/CoFeB/Ta/CoFeB/MgO recording structure down to junction diameter of 11 nm. Applied Physics Letters. 11 (2014) 105(6).

[2] S. van Dijkena and J. M. D. Coey Magnetoresistance sensor with an out-of-plane magnetized sensing layer. Applied Physics Letters 87, (2005) 022504

Abstract ID: 358

PRESSURE-INDUCED SITE-SELECTIVE MOTT TRANSITION IN α-$LiFe_5O_8$

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Abstract: The Mott insulator-to-metal transition (IMT) driven by electron correlations has been among the main research topics in materials science over past decades [1-2]. The complex interplay between electronic and lattice degrees of freedom leads to various transition scenarios. Of particular interest may be the case of a transition involving the formation of complex phases comprising regions, which differ significantly in their physical properties, within the same material. The results presented here advance the understanding of the IMT phenomenon offering the documentation of a "pure" site selective mechanism, not complicated by any structural and spin transformation. Combining XRD, resistivity, Mössbauer and Raman spectroscopy measurements we provide evidence for a pressure-induced MT in α-$LiFe_5O_8$, characterized by site-selective delocalization of electrons, leading to the formation, above ~65 GPa, of a site-selective Mott phase consisting of metallic and insulating sublattices [3]. We note that the electron delocalization in the partially disordered octahedral sublattice cannot be understood purely in terms of a Mott transition, the "Anderson-Mott transition" picture seems more adequate [3].

Keywords: Mott transition, high-pressure, magnetic measuremnets, Mössbauer spectroscopy.

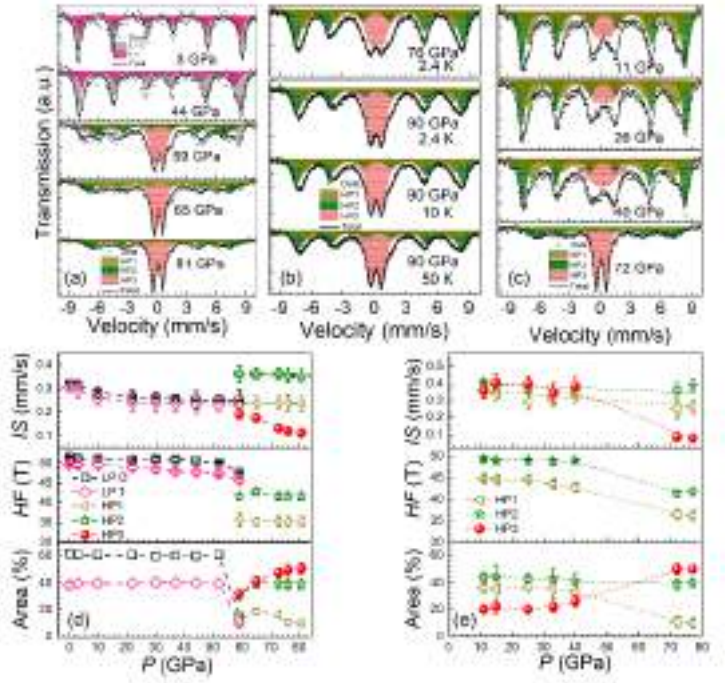


Fig. 1: (a-c) Mössbauer spectra as a funtion of pressure and temperature and (d-e) Mössbauer parameters as a function of pressure during compression and decompression cycle.

References:

[1] E. Greenberg, I. Leonov, S. Layek et al., Phys. Rev. X 8, (2018) 031059.

[2] S. Layek, et al., J. Am. Chem. Soc. 144, (2022) 10259.

[3] S. Layek, et al., Commun. Mater. 5, (2024) 155.

Abstract ID: 359

FROM MAGNETISM TO MARKETS: THE ROLE OF MAGNETIC STORAGE TECHNOLOGIES IN MODERN FINANCIAL INFRASTRUCTURE

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Abstract: The growth of digital finance has rapidly changed global financial systems. While research on financial technology normally focuses on software innovation and regulatory rules, the physical technological infrastructure that supports these systems gets less attention. One important but normally overlooked part of digital financial infrastructure, is magnetic storage technology. Many devices like hard disk drives and magnetically encoded storage systems have allowed for reliable storage, processing, and retrieval of large amounts of financial data. This paper explores the technological and economic importance of magnetic storage technologies in modern financial infrastructure. It also examines how magnetism-based data storage systems help the functioning and cost efficiency of digital financial ecosystems .This paper relies mainly on secondary data from industry reports, technology studies, and financial infrastructure analyses The study ultimately seeks contributes to interdisciplinary discussions on how magnetic materials and storage systems form a critical technological foundation of the digital economy. Recognizing the role of magnetism in these infrastructures is essential for understanding the resilience, scalability, and long-term sustainability of contemporary financial networks.

Keywords: Magnetic Storage Technologies, FinTech, Financial Infrastructure, Digital Economy, Data Storage Systems, Information Infrastructure

Abstract ID: 360

SYMMETRY-PROTECTED ELECTRONIC AND PHONONIC TOPOLOGY IN FERROMAGNETIC $SrRuO_3$

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Abstract: Topological phases in crystalline solids provide a powerful framework for understanding symmetry-protected excitations in both electronic and vibrational spectra. In this work, we present a systematic first-principles investigation of the electronic and phononic topology of perovskite $SrRuO_3$. The analysis combines density functional theory (DFT), density functional perturbation theory (DFPT), and group-theoretical symmetry methods to elucidate the role of crystalline symmetries in governing band degeneracies and lattice dynamics. The optimized crystal structure and corresponding Brillouin zone establish the symmetry environment of the system. The calculated electronic band structure reveals symmetry-enforced crossings near the Fermi level that form Dirac nodal-line (DNL) features along high-symmetry directions. Detailed momentum-space analysis, supported by irreducible representation assignments and compatibility relations, confirms the nontrivial band connectivity and symmetry protection of these degeneracies. Phonon dispersion calculations demonstrate the dynamical stability of $SrRuO_3$, with no imaginary modes across the Brillouin zone. Notably, the phonon spectrum exhibits hourglass-like branches and nodal-line features originating from mirror and nonsymmorphic symmetry constraints. Three-dimensional phonon band mapping and surface spectral analysis reveal symmetry-protected phononic surface states and arc-like features, establishing the bosonic topological character of the vibrational modes. The coexistence of electronic Dirac nodal lines and topological phonon states identifies $SrRuO_3$ as a promising platform for exploring coupled fermionic and bosonic excitations in oxide perovskites, with potential implications for spintronic and phononic applications.

Keywords: Topological materials, Dirac nodal lines, Phonon topology, Density functional theory.

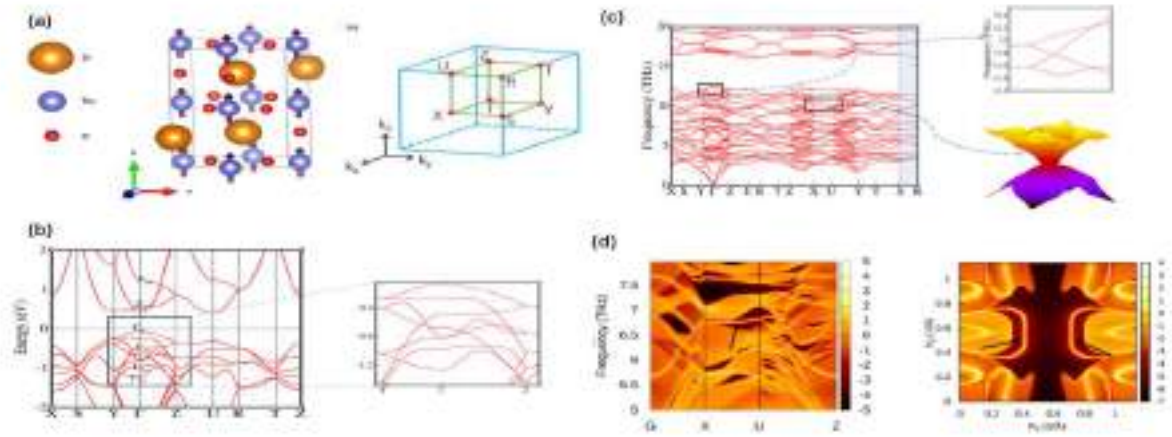


Fig. 1 : (a) Crystal structure and Brillouin zone (b) electronic band structure (c) full phonon dispersion featuring hourglass-like bands and (d) phononic surface states and Fermi arc.

References:

[1] M. Longo, J. M., P. M. Raccah, and J. B. Goodenough. Journal of Applied Physics 39.2 (1968): 1327-1328.

Abstract ID: 364

ENGINEERING AND ENHANCEMENT OF MAGNETIC ANISOTROPY IN ZIGZAG-STRUCTURED Co/Ag MULTILAYERS

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Abstract: The artificial tailoring of magnetic anisotropy by manipulating surface and interface morphology is attracting widespread interest from the application point of view in spintronic and magnetic memory devices. Magnetic anisotropy in nanostructured thin films is governed by the interplay between morphology-driven and interface-induced effects. In zigzag-structured Co thin films, anisotropy originating from columnar growth competes with shape anisotropy arising from high-density interface layers formed at zig–zag junctions, leading to a thickness-dependent crossover in easy-axis orientation. [1]. In the present work, zigzag-structured Co films consisting of seven bilayers, with each zig or zag layer having a thickness of 5 nm, are investigated. For this configuration, magneto-optical Kerr effect (MOKE) measurements reveal the absence of a net in-plane magnetic anisotropy, indicating a near-complete compensation between the competing anisotropy contributions. To intentionally disrupt the formation of the high-density interface layer and induce magnetic anisotropy, a non-magnetic Ag spacer layer of 2 nm thickness is introduced at each zig–zag junction, forming zigzag-structured Co/Ag multilayers with seven repeating units. Grazing-incidence small-angle X-ray scattering (GISAXS) measurements confirm the preservation of the zigzag morphology and reveal distinct Bragg peaks, indicating well-defined multilayer periodicity. MOKE studies of the Co/Ag zigzag structures show the emergence of a clear in-plane magnetic anisotropy, demonstrating that interface engineering via Ag insertion effectively alters the balance between competing anisotropy components. Temperature-dependent GISAXS measurements further indicate progressive interfacial diffusion upon annealing, suggesting the potential for further tuning of magnetic anisotropy through controlled thermal treatment.

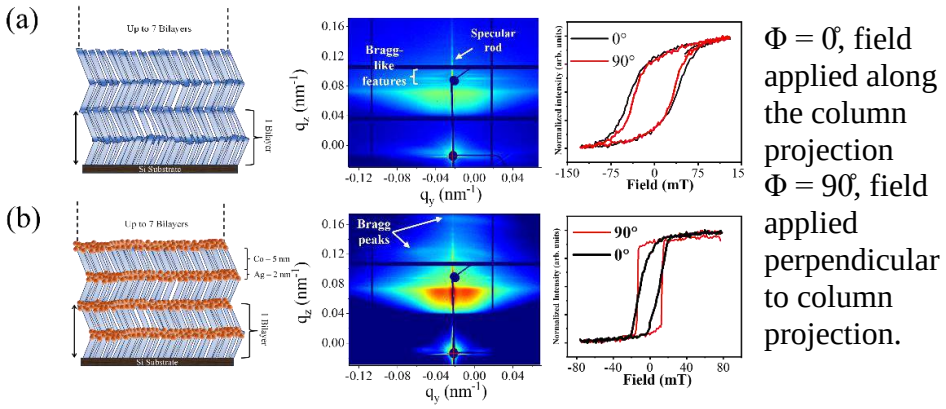


Fig. 1: Schematic multilayer structure, GISAXS patterns, and MOKE hysteresis loops measured at 0° and 90° for (a) Co zig-zag films and (b) (Co/Ag) bilayers.

References:

[1] S. Singh, et al, Tailoring Magnetic Properties of Zigzag Structured Thin Films via Interface Engineering and Columnar Nano-structuring, (2025), arXiv:2506.19577.

Abstract ID: 365

MAGNETIC FIELD ENGINEERED MULTIFERROIC ORTHOFERRITES FOR ADVANCED ENERGY STORAGE APPLICATIONS

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Abstract: The convergence of magnetism and electrochemistry in multiferroic oxides offers a transformative pathway toward next-generation multifunctional devices. In this invited talk, I will present our recent advances on rare-earth and Pb-based orthoferrites, focusing on $Pb(Fe_{0.67}W_{0.33})O_3$ (PFWO), $LaFeO_3$ (LFO), and $NdFeO_3$ (NFO) as magnetic-field-responsive energy materials. PFWO crystallizes in a *pseudo-cubic* perovskite structure (*Pm-3m*), confirmed by XRD, Rietveld refinement, and Raman spectroscopy. Magnetic studies reveal a paramagnetic-antiferromagnetic transition near 344 K with weak ferromagnetism below 7 K, accompanied by a measurable magnetocaloric response under 1-6 T fields. Remarkably, electrochemical measurements demonstrate an 80-110% enhancement in specific capacitance under a low magnetic field (30 mT), associated with reduced charge transfer resistance and magnetically modulated charge transport. Density functional theory (DFT) calculations corroborate that structural disorder induces electronic modifications that enhance charge storage. In contrast, nanolayered LFO exhibits a significant decrease in specific capacitance under the same magnetic field, revealing an unrevealed mechanism in layered orthoferrites. The performance drop is attributed to oxygen vacancies, Nernst layer formation, solvated ion diffusion, and magnetoresistance effects. Nevertheless, optimized symmetric supercapacitor devices demonstrate stable cycling (92.3% retention after 10,000 cycles) and practical LED powering capability, highlighting magnetic-field-tunable energy storage behavior. Furthermore, sol-gel synthesized NFO nanoparticles exhibit orthorhombic phase purity with promising pseudocapacitive performance (94.2 F g^{-1} at 1 A g^{-1}) and good energy-power characteristics. Collectively, these findings establish magnetic-field engineering as a powerful strategy to tailor electrochemical performance in multiferroic orthoferrites. The integration of CV, GCD, and EIS supercapacitor functionalities positions these materials as viable candidates for smart energy systems, spintronic devices, and room-temperature magnetic refrigeration technologies.

Keywords: Nanoparticles, Magnetism, Structure, Supercapacitor and Density functional theory (DFT) calculations.

Abstract ID: 366

MAGNETIC FIELD-ASSISTED ELECTROCHEMICAL PERFORMANCE OF $NdFeO_3$ NANO FLAKES

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Abstract: Perovskite-type rare-earth orthoferrites have attracted considerable attention due to their unique structural, electrical, and electrochemical properties. In this work, $NdFeO_3$ nanoflakes were synthesized using a simple auto-combustion method and systematically investigated for their structural, vibrational, dielectric, and electrochemical properties. Powder X-ray diffraction analysis followed by Rietveld refinement confirms that the synthesized $NdFeO_3$ crystallizes in a distorted *orthorhombic* perovskite structure with the *Pnma* space group and an average crystallite size of approximately 84 nm. Raman spectroscopy further validates the *orthorhombic* symmetry through the identification of characteristic phonon modes. X-ray photoelectron spectroscopy reveals the presence of Nd^{3+} and mixed Fe^{3+}/Fe^{4+} oxidation states along with significant oxygen vacancies, which contribute to enhanced electronic conductivity and surface reactivity. Dielectric studies demonstrate strong frequency-dependent behavior governed by space-charge polarization and grain boundary effects, while AC conductivity follows Jonscher's power law, indicating a small polaron hopping conduction mechanism. Electrochemical performance of the $NdFeO_3$ electrode was evaluated in 1 M KOH electrolyte using cyclic voltammetry and galvanostatic charge-discharge techniques. The electrode exhibits battery-type Faradaic behavior with a high specific capacitance of 335 F g^{-1} at 10 mV s^{-1}, which significantly increases to 465 F g^{-1} under the influence of a small external magnetic field. The enhanced performance is attributed to magnetohydrodynamic effects that improve ion transport and charge transfer kinetics at the electrode and electrolyte interface. These findings highlight the potential of $NdFeO_3$ perovskite nanoflakes as promising electrode materials for advanced electrochemical energy storage.

Keywords: Perovskite, Auto-combustion method, Dielectrics, Supercapacitors.

Abstract ID: 368

LOW-TEMPERATURE MAGNETIC TRANSITION AND MAGNETOCALORIC PERFORMANCE IN SOL–GEL DERIVED $GdNdCrMnO_6$

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Abstract: Rare-earth-based double perovskite oxides have attracted significant attention due to their promising magnetic and magnetocaloric properties for low-temperature magnetic refrigeration. In the present work, the structural, magnetic, and magnetocaloric properties of the double perovskite oxide $GdNdCrMnO_6$ were systematically investigated. The compound was successfully synthesized using the sol–gel method to achieve high phase purity and homogeneity. Structural characterization through X-ray diffraction (XRD) confirmed the formation of a single-phase double perovskite structure with an orthorhombic crystal symmetry belonging to the *Pbnm* space group, indicating good crystallinity. The magnetic properties were examined through temperature-dependent magnetization (M–T) measurements under an applied magnetic field of 100 Oe. The results revealed a clear magnetic phase transition around 56 K, which is attributed to ferromagnetic ordering arising from superexchange interactions between Cr^{3+}–O–Mn^{3+} ions at the B-site of the perovskite lattice. The transition temperature was further verified using the derivative curve (dM/dT). Moreover, a clear bifurcation between zero-field-cooled (ZFC) and field-cooled (FC) magnetization curves below the transition temperature suggests the presence of magnetic irreversibility caused by domain wall pinning and magnetic anisotropy. The magnetocaloric effect was evaluated from isothermal magnetization curves using the Maxwell thermodynamic relation. A significant magnetic entropy change ($-\Delta S_M$) peak was observed in the cryogenic temperature region, with a maximum value of 9.82 J kg^{-1} K^{-1} under a magnetic field variation of 0–7 T. These results indicate that $GdNdCrMnO_6$ is a promising candidate for cryogenic magnetic refrigeration applications.

Keywords: Double perovskite oxide, Magnetocaloric effect, Rare-earth oxides, Magnetic refrigeration.

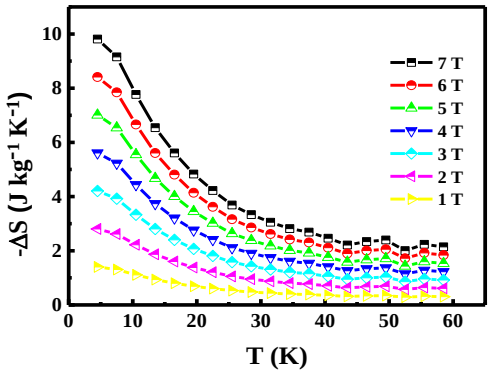


Fig. 1: Magnetic entropy change ($-\Delta S_M$) vs. T under 1–7 T fields for $GdNdCrMnO_6$ compound.

References:

[1] I. B. Sever, A. O. Ayaş, A. Kandemir, and A. Ekicibil, *J. Sol-Gel Sci. Technol.*, 114 (2025) 235–249.

Abstract ID: 369

NEGATIVE MAGNETIZATION AND CLUSTER-GLASS BEHAVIOR IN SOL-GEL SYNTHESIZED MCC SPINEL

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Abstract: $MnCr_{1.2}Co_{0.8}O_4$ (MCC) was synthesized by the sol–gel method to investigate its structural, electronic, and magnetic properties. X-ray diffraction confirms that the sample crystallizes in a single-phase cubic spinel structure with the $Fd\bar{3}m$space group. X-ray photoelectron spectroscopy reveals the presence of mixed oxidation states, indicating a complex electronic environment in the compound. Magnetization measurements performed under zero-field-cooled (ZFC) and field-cooled (FC) conditions establish the ferrimagnetic nature of the sample, with a ferrimagnetic transition temperature around 110 K. Interestingly, the system exhibits negative magnetization below 96 K, suggesting the presence of competing magnetic interactions. In addition to negative magnetization, the sample shows cluster-glass-like behavior arising from magnetic frustration and local spin disorder. To understand this unusual magnetic ground state, the experimental results were further analyzed using molecular field theory. The estimated exchange coupling constants, J_{AA}, J_{AB}, and J_{BB}, are 7.75, 10.25, and 14.05 K, respectively, indicating strong competition among the magnetic sublattices and supporting the system's frustrated nature. The cluster-glass-like state is further confirmed by ZFC and FC magnetic relaxation measurements. Moreover, memory measurements under positive temperature cycling exhibit distinct relaxation behavior, providing evidence for a hierarchical energy landscape associated with glassy magnetic dynamics. These results establish MCC as a frustrated ferrimagnetic spinel showing coexistence of negative magnetization and cluster-glass-like behavior [1].

Keywords: negative magnetization, ferrimagnetism, cluster glass, magnetic frustration, molecular field theory, memory effect, relaxation dynamics.

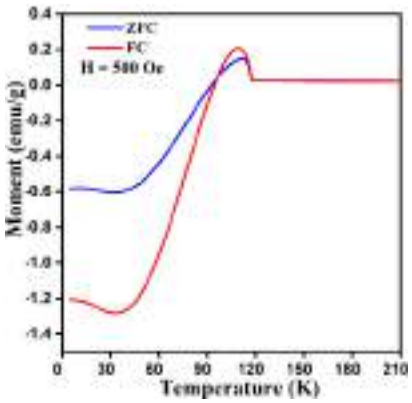


Fig. 1: Temperature-dependent ZFC and FC magnetization curves of the MCC sample measured under an applied magnetic field of 500 Oe.

References:

[1] *Yadav D K and Ravi S 2025 Tuning frustrated magnetism in $Mn_{1-x}Mg_xCr_2O_4$ via A-site Mg substitution J. Appl. Phys.* ***59*** *025301.*

Abstract ID: 370

GENERATION AND DETECTION OF PURE SPIN CURRENT AT MAGNET/NONMAGNET INTERFACES

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Abstract: Spin-to-charge current conversion has opened up Pandora's box to the scientific community by providing an energy-efficient solution to record, store, and process data. This is the essence of spintronics, where magnetism complements electronics. The pure charge current can modulate not only static or quasistatic magnetic states of nanoscale magnetic materials, but also ultrafast demagnetization and spin-wave dynamics that occur at femtosecond and nanosecond time scales. To detect the modulation of demagnetization time, precessional frequency, Gilbert damping, etc., within a magnetic layer in the presence of adjacent nonmagnets with high spin-orbit coupling, can be probed only via all-optical methods. State-of-the-art time-resolved magneto-optical Kerr effect magnetometry is used to study spin-torque-driven ultrafast carrier dynamics in substrate/magnet (e.g., CoFeB, CoGd, etc.)/nonmagnet (e.g., W and graphene, etc.) heterostructures[1,2]. Qualitative and quantitative demonstrations of the spin Hall and spin pumping effects are presented, which are considered key mechanisms governing the performance of modern spintronic devices.

Keywords: Spin current, spin Hall effect, spin pumping effect, ultrafast demagnetization, spin precession, damping.

References:

[1] S. Mondal, S. Choudhury, N. Jha, A. Ganguly, J Sinha, A. Barman, Physical Review B 96 (2017), 054414.
[2] S. Mondal, Y. Lin, D. Polley, C. Su, A. Zettl, S. Salahuddin, J. Bokor, ACS Nano 16 (2022) 9620–9630.

Abstract ID: 372

DISORDER MEDIATED FULLY COMPENSATED FERRIMAGNETIC SPIN-GAPLESS SEMICONDUCTING BEHAVIOUR IN Cr_3Al HEUSLER ALLOY

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Abstract: Spin-gapless semiconductors (SGSs) that host fully compensated ferrimagnetism (FCF) are highly sought for energy-efficient and stray-field-free spintronics, yet their realization in chemically disordered systems has remained elusive. Here, we demonstrate that the binary Heusler alloy Cr_3Al—despite adopting a fully A2-disordered structure—exhibits a rare coexistence of SGS transport and an FCF ground state. Single-crystalline and polycrystalline Cr_3Al samples were synthesized, and structural analyses using single-crystal XRD, synchrotron powder XRD, and neutron diffraction reveal complete Cr/Al site mixing. Magnetization, X-ray magnetic circular dichroism (XMCD), and temperature-dependent neutron diffraction establish a compensated ferrimagnetic state with a vanishing ordered moment of ~0.1(1) μ_B /f.u and a high Curie temperature of 773 ± 2 K. Electrical and thermal transport measurements uncover SGS characteristics, including weak temperature-dependent conductivity, low Seebeck coefficients, and electron-hole compensated transport. Hall measurements show unusual temperature-dependent carrier concentrations consistent with disorder-modified electronic states. First-principles calculations reproduce the experimentally observed negligibly small magnetization (0.0072 μB /f.u) and reveal a vanishing spin-up band gap—supporting SGS behavior driven by chemical disorder. Our results identify Cr_3Al as the first experimentally verified A2-disordered Heusler alloy exhibiting FCF-characteristics and SGS transport, positioning it as a disorder-tolerant platform for next-generation, high-temperature spintronic devices.

Keywords: Spintronics, Spin gapless semiconductor, Heusler alloy, Fully compensated ferrimagnet.

References:

[1] G. Y. Gao and K.-L. Yao, "Antiferromagnetic half-metals, gapless half-metals, and spin gapless semiconductors: The DO3-type Heusler alloys," Applied Physics Letters, vol. 103, no. 23, p. 232409, 12 2013.
[2] M. E. Jamer, Y. J. Wang, G. M. Stephen, I. J. McDonald, A. J. Grutter, G. E. Sterbinsky, D. A. Arena, J. A. Borchers, B. J. Kirby, L. H. Lewis, B. Barbiellini, A. Bansil, and D. Heiman, "Compensated ferrimagnetism in the zero-moment heusler alloy Mn3Al," Phys. Rev. Appl., vol. 7, p. 064036, Jun 2017.

Abstract ID: 373

MAGNETIC AND MAGNETOCALORIC PROPERTIES OF POLYCRYSTALLINE $Pr_{0.3}Gd_{0.3}Ca_{0.4}MnO_3$ COMPOUND

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Abstract: We report a comprehensive study of the magnetic and magnetocaloric properties of polycrystalline $Pr_{0.3}Gd_{0.3}Ca_{0.4}MnO_3$, a rare-earth mixed manganite synthesized via the sol–gel method. Temperature-dependent magnetization data reveal an antiferromagnetic (AFM) transition near T ~ 100 K, followed by the emergence of a ferrimagnetic-like state below T ~ 50 K, without any apparent charge ordering up to 300 K. Isothermal magnetization and Arrott plot analyses confirm a second-order-like magnetic phase transition. The magnetic entropy change ($-\Delta S$), derived from isothermal M–H curves, shows a broad peak around 100 K corresponding to the AFM transition, and a sharp increase below 50 K, reaching a maximum of approximately 5.9 J kg^{-1} K^{-1} at T=7.5 K for ΔH = 0-70 kOe. A power-law analysis reveals that the exponent n in the relation $\Delta S_M \alpha H^n$ remains nearly constant (n~1.8) over a wide temperature and field range, indicating field- and temperature-independent magnetocaloric behavior. This behavior enabled the successful construction of a universal master curve of $-\Delta S$ without rescaling the temperature axis. The collapse of entropy curves under high magnetic fields further supports the presence of inverse magnetocaloric-like universal scaling, despite the system exhibiting conventional MCE features. These findings highlight the role of rare-earth site disorder in stabilizing complex spin states and enhancing low-temperature magnetocaloric performance.

Keywords: Perovskite, Exchange Bias, Spin Glass, Disorder.

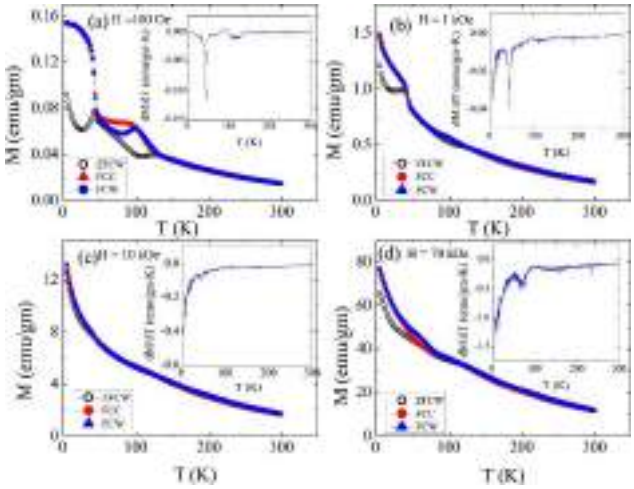


Fig. 1: Temperature-dependent magnetization curves of $Pr_{0.3}Gd_{0.3}Ca_{0.4}MnO_3$ compound measured under different magnetic fields: (a) 100 Oe, (b) 1 kOe, (c) 10 kOe, and (d) 70 kOe using ZFCW, FCC, and FCW protocols. The insets show the corresponding temperature derivatives of magnetization (dM/dT) (FCW data), highlighting transition temperatures.

Abstract ID: 374

TEMPERATURE-INDUCED SPIN-REORIENTATION TRANSITION (SRT) IN FeCoB/Pt MULTILAYERS WITH PERPENDICULAR MAGNETIC ANISOTROPY

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Abstract: Magnetic anisotropy plays a crucial role in determining the preferred orientation of magnetization in thin films and multilayers, thereby controlling the stability of magnetic states [1]. Perpendicular magnetic anisotropy (PMA) at heavy-metal/ferromagnet interfaces arises from strong spin–orbit coupling in the heavy metal and orbital hybridization at the interface. Therefore, the study of interfaces and their correlation with magnetic properties, such as PMA, in-plane anisotropy, and SRT, is crucial. FeCoB/Pt systems are particularly noteworthy, as Pt provides a strong spin Hall effect and generates Dzyaloshinskii–Moriya interaction (DMI), making it promising for fast, low-current switching in memory applications [2]. The multilayers (MLs), [FeCoB (0.8 nm)/Pt (1.5 nm)]$_{10}$, were deposited on Si(001)/Pt (5 nm) substrates using magnetron sputtering. A Pt buffer layer (5 nm) was introduced to prevent Si diffusion from the substrate. Multilayer's structural parameters were determined by X-ray reflectivity (XRR), while X-ray diffraction (XRD) and magneto-optical Kerr effect (MOKE) measurements were used for structural and magnetic properties. These multilayers exhibit PMA through interfacial hybridization with Pt d-states and interface-related structural modifications. However, this PMA weakens progressively with increasing annealing temperature, around 450 °C, a spin-reorientation transition (SRT) occurs, where the magnetization switches from a perpendicular to an in-plane orientation. This transition occurs because interfacial anisotropy, which typically scales with a power of the magnetization, decreases more rapidly with increasing temperature, resulting in a reduction in effective anisotropy (K_{eff}). When the demagnetizing energy eventually exceeds K_{eff}, the system undergoes the perpendicular-to-in-plane reorientation.

Keywords: FeCoB/Pt, Perpendicular Magnetic Anisotropy, Spin-reorientation transition, XRR

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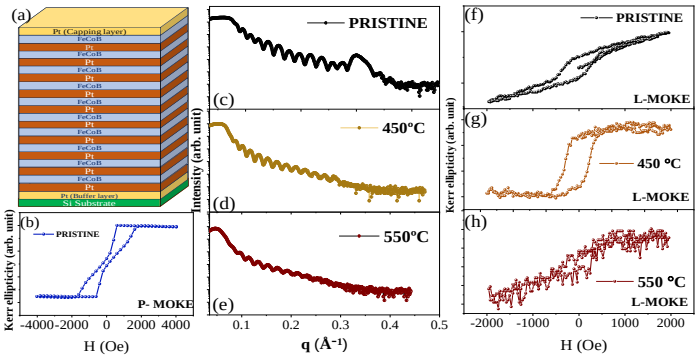


Figure 1:(a) [FeCoB/Pt]$_{10}$ Multilayer structure. Fig.(b) Polar MOKE -exhibiting PMA. (c), (d) and (e) XRR, Pristine, 450°C and 550°C respectively. (f), (g) and (h) Longitudinal MOKE, Pristine, 450°C and 550°C respectively.

References:

[1] Md. Shahid Jamal, Pooja Gupta, Ilya Sergeev, Olaf Leupold, et al., *Phys. Rev. B* 107, 075416 (2023).
[2] S. Tacchi, R. E. Troncoso, M. Ahlberg, G. Gubbiotti, et al., *Phys. Rev. Lett.* 118, 147201 (2017).

Abstract ID: 375

THERMODYNAMIC SIMULATIONS FOR PYROMETALLURGICAL SMELTING OF OXIDIZED SCRAP NDFEB PERMANENT MAGNETS

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Abstract: The demand of rare earth elements (REEs) especially Neodymium, which is strategically important but finite in availability, is continuously increasing along with diverse potential applications of neodymium–iron–boron (NdFeB) permanent magnets in electric vehicles, green energy systems, and modern electronic devices leading to growing volume of end-of-life and manufacturing scrap [1]. Therefore, development of effective recycling strategies and material recovery processes specific to the nature and type of complex magnet scrap consiting of $Nd_2Fe_{14}B$ is significantly important towards sustainability. The present study details a simulation study of the pyrometallurgical smelting of NdFeB magnets. The smelting investigations has resulted in concentrating the Nd in slag phase as Nd_2O_3, by separating the easily reducible Fe as metallic phase rich if Fe-Fe_3C. The magnet scraps are oxidized to make them amenable for smelting. The smelting is performed using induction melting furnace at the temperature of 1600 °C in an inert atmosphere. The experimental investigations of using coke for reduction and $MgCO_3$ as flux for the smelting is reported elsewhere [2]. The simulations are performed using FactSAGE 8.4 thermodynamic software with the Fact-PS and FT-oxid databases. Limitations of FT-oxid database to consider Nd_2O_3 in slag or any other solution is handled by considering it as pure oxide. The simulations are able to predict the requirement of flux and coke through mass balance calculations. The simulation has resulted in estimation of heat requirements through heat balance calculations.

Keywords: NdFeB magnets, basicity, FactSAGE, thermodynamic simulation, pyrometallurgical recycling.

References:

[1] A. Kumari, S. K. Sahu, Sep. Purif. Technol. 317 (2023) 123527

[2] S. Priyadarshini , A. Pathak, C. Srishilan, J. Alloys Compd. 1024 (2025) 180148.

Abstract ID: 376

NEW COATING PERSPECTIVES FOR NdFeB MAGNETS IN EXTREME AND CRITICAL APPLICATIONS

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Abstract: Neodymium iron boron (NdFeB) remains the most powerful permanent magnet available; despite continuous research since its discovery in the 1980s, no alternative currently matches its energy density. However, NdFeB magnets are inherently susceptible to corrosion and surface degradation because of electrochemical heterogeneity [1]. Demand for NdFeB magnets is increasing as their use expands into critical environments beyond traditional applications such as biomedical devices, marine, and aerospace systems. This expansion necessitates the development of environment-specific corrosion-protection coatings. Specifically for marine applications, resin-based nanocomposite coatings reinforced with nanoparticles such as CeO_2, graphene, and carbon nanotubes markedly enhance barrier properties and mechanical durability [2]. Along these lines, significant efforts have been made to deposit filler-reinforced modified epoxy coatings (TiO_2 as the primary filler) on NdFeB magnets via electrostatic spray technique. The coated samples were systematically evaluated for their mechanical, morphological, structural studies using multiple characterization techniques. SEM cross-sectional morphologies of coated samples revealed dense and uniform-thickness (Fig.1a). The anti-corrosion properties were assessed using neutral salt spray (NSS) testing and electrochemical impedance spectroscopy (EIS). With the NSS testing, the coated samples exhibited no visible corrosion even after 712 hours of continuous salt-fog exposure, while analysis of the nyquist plot (Fig.1b) revealed a high polarization resistance, $R_P \approx 6\times10^8$ $\Omega.cm^2$, indicating a robust barrier performance. These findings demonstrate that these coatings can deliver substantial corrosion protection for NdFeB magnets in extreme and harsh environments.

Keywords: NdFeB magnet; Corrosion protection; filler-reinforced epoxy; neutral salt spray test; electrochemical impedance spectroscopy.

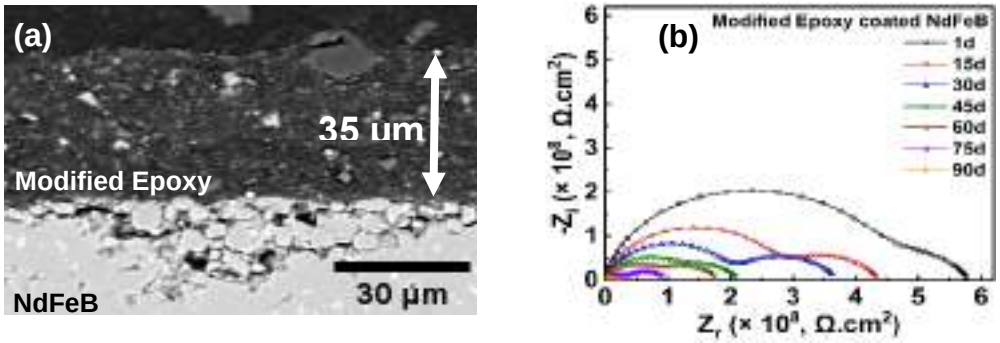


Fig. 1: (a) SEM cross-sectional micrograph and (b) Nyquist plots obtained over multi-day immersion test for modified epoxy coated NdFeB.

References:

[1] G.W. Warren, G. Gao, Q. Li, J. Appl. Phys. 70 (1991) 6609–6611.

[2] P. Zhang, M. Zhu, W. Li, G. Xu, X. Huang, X. Yi, J. Chen, Y. Wu, J. Rare Earths 36 (2018) 544–551.

Abstract ID: 377

INFLUENCE OF COPPER OXIDE MATRIX ON THE STRUCTURAL AND MAGNETIC PROPERTIES OF CERIUM OXIDE FOR SPINTRONIC APPLICATIONS

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Abstract: The continuous scaling of electronic devices demands materials that are compatible with modern semiconductor fabrication processes, particularly Complementary-Metal-Oxide-Semiconductor (CMOS) technology. Oxide nanomaterials that exhibit multifunctional properties such as ferromagnetism and ferroelectricity at room temperature are highly desirable for Next-Generation electronic, spintronic, and memory devices. Among them, cerium oxide (CeO_2) base materials have attracted significant attention due to their CMOS compatibility, high dielectric constant, chemical stability, and wide band gap. In this work, structural, optical, ferroelectric, and magnetic properties of CuO/CeO_2 composites were investigated with particular emphasis on room-temperature ferromagnetism (RTFM). The presence of CuO in the CeO_2 lattice induces oxygen vacancies, mixed valence states (Ce^{3+}/Ce^{4+}), and interfacial exchange interactions, which play a crucial role in generating ferromagnetic ordering. The X-ray diffraction of the CuO/CeO_2 composites exhibits the double-phase cubic fluoride and monoclinic structure. The optical analysis shows an increase in band gap energy up to 3.28 eV. The magnetic properties analysed by Vibrating Sample Magnetometer (VSM) at room temperature exhibits week ferromagnetism, attributed to the presence of oxygen-related defects in the composites. The presence of the defects was confirmed by the Raman spectra and Photoluminescence spectra. The emergence of ferromagnetism in such oxide composites is highly important for spin-based electronic devices, where the control of electron spin in addition to charge can enable low-power and high-speed information processing. Furthermore, enhanced ferroelectric polarization in the composite system provides the possibility of coupling electric and magnetic functionalities, making the material promising for multifunctional memory devices.

Keywords: Solid-state route, Composites, CMOS, Ferroelectric, Ferromagnetic.

Abstract ID: 378

QUANTUM GRIFFITHS-LIKE ANOMALIES AND NON-UNIVERSAL CRITICAL PHENOMENA IN THE DOUBLE PEROVSKITE Er_2NiMnO_6

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Abstract: This study presents a comprehensive investigation of the magnetic, magnetocaloric, and critical properties of the ordered double perovskite Er_2NiMnO_6 (ENMO). Detailed analysis of magnetization, heat capacity, and magnetocaloric effect (MCE) data reveals the presence of a robust Griffiths phase (GP) above the ferromagnetic (FM) Curie temperature $T_C \approx 76$ K. The GP, characterized by FM clusters embedded in a paramagnetic matrix, is confirmed by the downward curvature in inverse susceptibility and is quantitatively supported by the Bray model and Yang-Lee zeros theory. A systematic analysis of critical behavior near the FM-paramagnetic phase transition yields unconventional critical exponents [β = 1.081(8), γ = 0.765(6), δ = 1.731(7)], which deviate significantly from all standard universality classes yet satisfy the magnetic scaling equation of state. These anomalous exponents are attributed to the quantum GP formation above TC. The material also exhibits a substantial low-temperature magnetocaloric effect, with a maximum magnetic entropy change of $-\Delta S_{max} \approx 15$ J/kg K and an adiabatic temperature change of $\Delta T_{ad} \approx 15$ K for a field change of 70 kOe, consistent with heat capacity analysis. Furthermore, ENMO maintains robust insulating behavior across the measured temperature range, well-described by polaron hopping mechanisms. The findings challenge conventional models of magnetic phase transitions in disordered systems, highlighting the critical role of clustered-phase dynamics and emphasizing the need for new theoretical frameworks to describe such unconventional critical phenomena in complex oxides.

Keywords: Anti-site disorder, Magnetocaloric effect, Quantum Griffiths phase, Unconventional critical exponents, Bray model, Yang-Lee zeros theory.

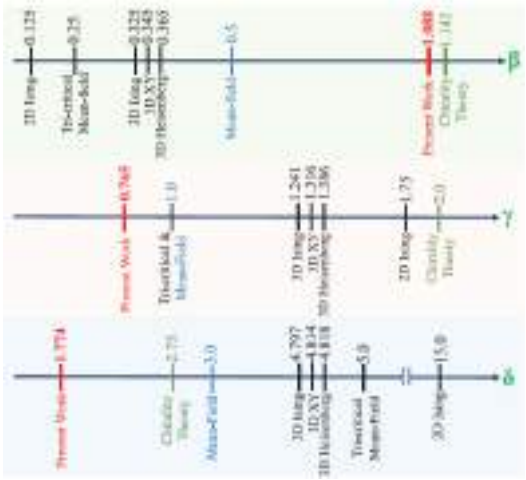


Fig. 1: Comparison of critical exponents (β, γ, and δ) for ENMO system (present work) and those for the other known theoretically predicted universality classes of magnetism.

References:

[1] Dipak Mazumdar, and I. Das, PHYSICAL REVIEW B **112**, 214432 (2025).

Abstract ID: 379

ANOMALOUS MAGNETO-TRANSPORT PROPERTIES IN RARE EARTH BASED FERRIMAGNET $TbFe_{11}Ti$

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Abstract: Exploring novel topological materials exhibiting remarkable physical properties has become a pivotal area of modern scientific research. One of the most significant advancements in the past decade has been the discovery of exotic electronic transport phenomena driven by band topology. In this study, we systematically investigate the electronic transport and magnetic properties of the tetragonal ferrimagnetic compound $TbFe_{11}Ti$. Our temperature-dependent neutron diffraction analysis reveals a spin-reorientation transition from an easy-axis to an easy-plane magnetization configuration. For transport measurements, single-crystalline grains with the desired crystallographic orientation were identified using the Electron Backscatter Diffraction (EBSD) technique. Subsequently, site-specific devices with two distinct orientations were fabricated using the Focused Ion Beam (FIB) technique. These devices were then mounted onto gold electrodes, patterned on a Si/SiO_2 substrate via electron beam lithography. Remarkably, we observe a pronounced anomalous Hall conductivity (AHC) when the system exhibits easy-axis magnetization. However, as the sample transitions to an easy-plane magnetization configuration, the AHC diminishes significantly. This pronounced variation highlights the strong correlation between the magnetization state and the electronic transport characteristics of the compound. The underlying origin of this intriguing Hall conductivity behaviour could be attributed to the modification of the Fermi surface associated with the spin-reorientation transition. The complex interplay between the 4f and 3d electrons in $TbFe_{11}Ti$ introduces additional degrees of freedom, enabling the manipulation of magnetic structures through alterations in magnetic anisotropy across different sublattices. This interplay between magnetic structure and electronic transport underscores the material's potential for future spintronic applications.

Keywords: Rare Earth Magnets, Spin Reorientation Transition, Anomalous Hall Effect, Neutron Diffraction.

Abstract ID: 380

INFLUENCE OF B-SITE CATION ORDERING ON THE MAGNETIC AND TRANSPORT PROPERTIES OF $LaSrMnRuO_6$ DOUBLE PEROVSKITE THIN FILMS

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Abstract: Bulk $LaSrMnRuO_6$ (LSMRO) has an orthorhombic Pnma structure and Mn/Ru disorder at the B-site [1]. M-T measurement on bulk LSMRO sample shows that ZFC curve displays two transitions in 100 Oe field at ~223 K, followed by a cluster glass transition at ~32 K. At 5 K, the magnetic moment has a maximum value of $\sim 2.3\ \mu_B/f.u$ under 70 kOe field, lower than the B-site ordered sample i.e $\sim 6.6\ \mu_B/f.u$ for Mn^{3+} and Ru^{4+}. Therefore, the ordered double perovskites are considered to be better for improving magnetic and transport properties [2]. In this work, we have fabricated epitaxial LSMRO thin films on STO (111) substrates using pulsed laser deposition. We observed the (111) and (333) superlattice peaks at ~19° and ~61° angle in the x-ray pattern of the film, respectively, for various thicknesses, which indicates B-site ordering. From the XRR data fit, the average roughness is 0.9 nm (32.4 nm) and 1.09 nm (66.4 nm), corresponding to thin films of 32.4 nm and 66.4 nm, respectively. RSM measurement around the (330) asymmetric plane confirms compressive strain in the thin films. From ZFC magnetic measurements, we observe transitions at ~207 K for the 66.4 nm film and at ~197 K for the 32.4 nm film, followed by peaks at ~200 K and ~190 K, respectively. No peaks were observed corresponding to the cluster glass transition in bulk. Further, magnetic memory measurements at 20 K and 90 K halt temperatures confirm the absence of any glassy transition. Also, at 5 K, an increase in magnetisation was observed in both thin films relative to the bulk, confirming an increase in B-site ordering.

Keywords: Double perovskite thin films; B-site ordering; Magnetic anisotropy; Epitaxial strain.

References:

[1] P. M. Woodward, J. Goldberger, M. W. Stoltzfus, H. W. Eng, R. A. Ricciardo, P. N. Santhosh, and P. Karen, J. Am. Cerum. Soc. 96 (6), 1796 (2008).

[2] J. E. Kleibeuker, E. M. Khoi, E. D. Jones, T. M. Yu, B. Sala, B. A. MacLaren, D. Kepaptsoglou, D. H. Maldonado, Q. M. Ramasse, L. Jones, J. Barthel, I. MacLaren, and J. L. M. Driscoll, NPG Asia Materials 9, 406 (2017).

Abstract ID: 381

MULTI-JUMP MAGNETIC SWITCHING IN EPITAXIAL Fe/MgO (001) FILMS: IN-SITU STUDY UNDER UHV CONDITION

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Abstract: The Fe/MgO system has attracted considerable interest in spintronics due to its functionalities such as perpendicular magnetic anisotropy (PMA), large tunnel magnetoresistance (TMR), exchange bias, and interlayer coupling. In this work, we investigate the evolution of magnetic hysteresis and unusual magnetization switching in epitaxial Fe (3 nm)/MgO(0001) thin films using *in-situ* magneto-optical Kerr effect (MOKE), reflection high-energy electron diffraction (RHEED), and x-ray scattering measurements. While MOKE probes the magnetic response, RHEED and x-ray scattering reveal the structural and morphological evolution of the film, enabling direct correlation between magnetic behaviour and film structure. Electron transport during growth indicates that Fe follows a Volmer–Weber growth mode, where epitaxial islands nucleate, grow, and coalesce into a continuous film at ~1.8 nm thickness. At 3 nm thickness, unusual multistep hysteresis loops appear along different in-plane azimuthal directions. Temperature-dependent measurements along the (110) direction show that the number of magnetization-reversal steps increases with temperature. This behaviour is reversible, and the initial magnetic state is recovered upon returning to room temperature. The temperature-driven transformation of the hysteresis loops is attributed to the combined effects of cubic (K_c) and uniaxial (K_u) magnetic anisotropies together with domain-wall pinning. As the temperature increases from room temperature to 250 °C, the ratio *Ku/Kc* increases from 0.17 to 0.34, while the domain-wall pinning field decreases from 19 Oe to ~8.5 Oe. These changes promote multistep magnetization reversal in the epitaxial Fe layers.

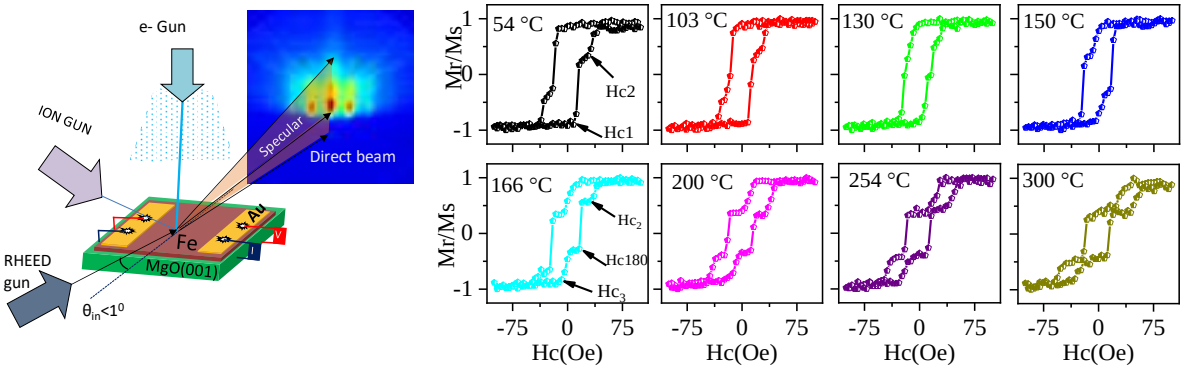


Fig. 1: (a) Schematic of the in-situ measurements geometry and (b) MOKE loops taken with increasing temperature.

Abstract ID: 382

SYNTHESIS OF ACTIVATED CARBON FROM BIOWASTE MATERIALS FOR ENERGY STORAGE APPLICATIONS

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Abstract: The growing demand for sustainable energy storage has intensified the search for cost-effective, environmentally friendly electrode materials. This study reports the synthesis of activated carbon from renewable biowaste precursors for advanced energy storage applications. Biowaste materials with high carbon content were carbonized and activated under optimized conditions to develop a porous carbon framework. Key synthesis parameters, including activation temperature, activating agents, and processing duration, were tuned to enhance surface area and pore distribution. Physicochemical characterization confirmed activated carbon with a well-developed pore structure, high specific surface area, and suitable pore size, enabling efficient ion transport and charge storage. Electrochemical evaluation using cyclic voltammetry, galvanostatic charge–discharge, and impedance spectroscopy revealed high specific capacitance, good rate capability, and excellent cyclic stability, demonstrating potential for supercapacitors and hybrid energy storage devices. This work highlights a sustainable approach to convert waste biomass into functional carbon materials, offering scalability, low cost, and environmental compatibility, making biowaste-derived activated carbon a promising alternative for next-generation energy storage.

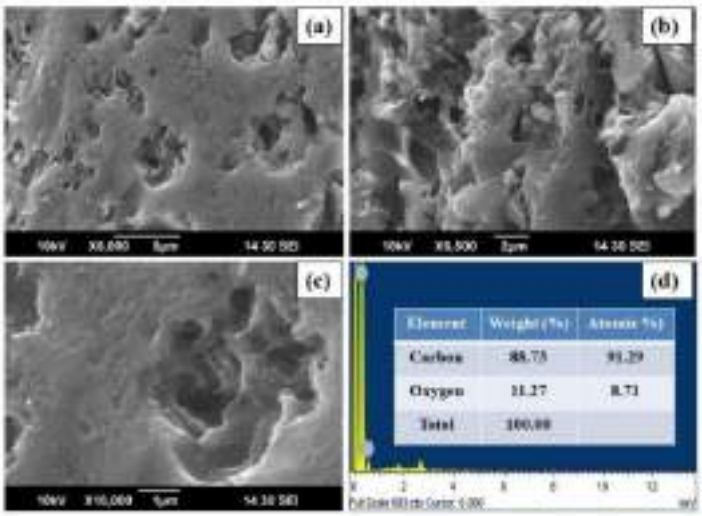


Fig. 1: SEM and EDX analysis of activated carbon from walnut-shell biowaste.

Keywords: Activated carbon; Biowaste; Energy storage; Supercapacitor; Porous carbon; Sustainable materials.

References:

[1] S. Zhang et al., Nanomaterials 13 (2023) 456.
[2] Y. Zhao et al., Carbon Trends 8 (2024) 100285.
[3] R. Bose, T.K. Mandal, J. Energy Storage 93 (2024) 112134.

Abstract ID: 383

LOW-FREQUENCY NOISE SCALING AND DETECTIVITY IN CoFeSiB FREE LAYER-BASED TUNNEL MAGNETORESISTIVE SENSORS WITH ENGINEERED FREE-LAYER THICKNESS AND ANNEALING CONDITIONS

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Abstract: Low-frequency 1/f noise limits the performance of tunnel magnetoresistive (TMR) sensors used for detecting small magnetic fields. Understanding the relationship between noise spectral density and magnetoresistive sensitivity is therefore important for improving sensor detectivity and understanding magnetization reversal processes in the free layer [1]. In this work we investigate MgO-based TMR sensors employing a CoFeSiB/Ta/CoFeB composite free layer. The thickness of the CoFeSiB soft magnetic layer was varied from 10–80 nm to tune the magnetic properties and sensitivity. Increasing the thickness improved the soft magnetic properties of the free layer by reducing the anisotropy field, resulting in enhanced sensitivity. For an optimized thickness of 80 nm, a TMR ratio of 209 % and a sensitivity of 168 %/mT were obtained as shown in Fig. 1(a). Post-fabrication annealing significantly suppressed both electrical and magnetic 1/f noise, leading to a magnetic field detectivity of 0.8 nT/$\sqrt{\text{Hz}}$ at 10 Hz [2]. Figure 1(b) shows the dependence of the noise voltage spectral density on MTJ sensitivity. The dashed lines show $\sqrt{S_v} = a\left(\frac{dR}{dH}\right)^n$, where a is a constant and n = 0.5 and 1. The experimental data follow a different scaling relation between low-frequency magnetic noise and sensitivity, deviating from that predicted by the fluctuation–dissipation theorem for uniform magnetization fluctuations [1].

Keywords: TMR sensors, 1/f noise, magnetoresistive sensitivity, magnetic sensors.

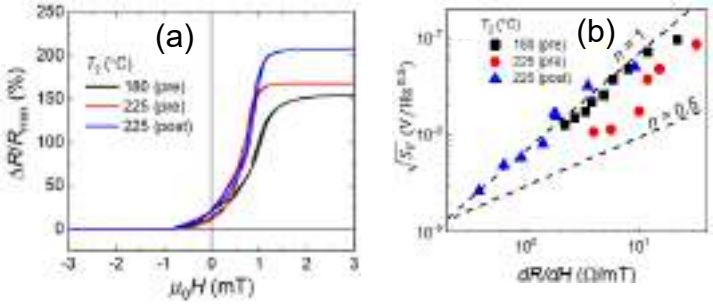


Fig. 1: (a) Magnetoresistance response of the TMR sensor. (b) Noise voltage spectral density versus MTJ sensitivity. (pre) and (post) in the legends denotes the second annealing performed before and after device fabrication, respectively.

References:

[1] S. Ingvarsson et al., Phys. Rev. Lett. 85, 3289 (2000).
[2] M. K. Manikketh et al., J. Appl. Phys. 136, 203901 (2024).

Abstract ID: 384

ENHANCED DAMPING-LIKE TORQUE EFFICIENCY IN HM/FM SYSTEMS USING TITANIUM AS A NOVEL ORBITAL CURRENT SOURCE

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Abstract: The spin Hall effect generates transverse spin currents in heavy metals with strong spin-orbit coupling, aiding magnetization switching in spintronic devices but with limited material choices. In contrast, the less-explored "orbital current" provides greater flexibility with lighter materials and boosts torque efficiency. The "orbital Hall effect," driven by orbital textures in momentum space, exists independently of the material's spin-orbit coupling. A significant challenge is the non-existence of coupling between orbital angular momentum and local magnetic moments. Therefore, it is essential to convert orbital current into spin current in order to effectively control magnetization dynamics. In this study, we systematically investigated the effectiveness of titanium (Ti) as an orbital current source in a heavy metal/ferromagnetic (HM/FM) system. We used a very thin heavy metal layer, which does not produce a noticeable inverse spin Hall effect (ISHE) voltage drop when interafced with a ferromagnetic layer. Consequently, the small voltage drop observed suggests the influence of the spin-orbit coupling (SOC) in the heavy metal layer. When we combined the titanium layer with the heavy metal, the resulting voltage drop became significantly larger, indicating a pronounced combined effect of the Ti/HM layers as shown in Figure. The symmetric component extracted from measured voltage drop, which serves as a proportional indicator of spin (or orbital) Hall efficiency, was found to be nearly ten times larger with the inclusion of titanium. Therefore, it is evident that titanium can be utilized as an effective orbital current source to significantly enhance spin-orbit torque efficiency in a HM/FM system. The effect of Ti layer thickness on spin-torque effeciency will be discussed.

Keywords: Light metals, Spin orbit coupling, Orbital currents, Inverse spin Hall effect.

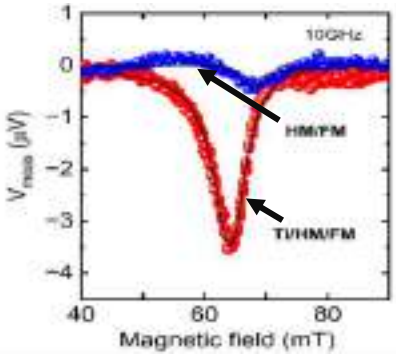


Fig. 1: The figure displays the measured voltage drops for HM/FM (blue) and Ti/HM/FM (red). A Lorentzian fit shown as black lines to extract both symmetric and anti-symmetric components.

References:

[1] Xinkai Xu, Dainan Zhang, Yixin Wang, Lei Zhang, Yuanjing Qu, Zhiyong Zhong, Feiming Bai, Xiaoli Tang, Qinghui Yang, Huaiwu Zhang, and Lichuan Jin. Small 2025, 21, 2408721.

Abstract ID: 385

FLEXIBLE ELECTRO-SPUN HO_6FeSb_2–PVDF COMPOSITE FIBERS EXHIBITING MAGNETOCALORIC EFFECT FOR SOLID STATE REFRIGERATION

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Abstract: Magnetocaloric materials have been proven as eco-friendly and energy-efficient substitute for traditional vapor-compression cooling for refrigeration, which in generally involves no dangerous refrigerants and enhanced performance[1]. $HoFeSb_2$ arc melted alloy was powdered and incorporated into electrospun PVDF fibers with weight percentage. Further, structural, magnetic, and magnetocaloric characteristics were investigated. The significant magnetocaloric effect of the $HoFeSb_2$ alloy is retained in the polymer-based composites. The electrospun fibers exhibit an isothermal entropy change (ΔS_m) of around 10 $J \cdot kg^{-1} \cdot K^{-1}$ and a relative cooling power (RCP) of approximately 550 $J \cdot kg^{-1}$ under applied magnetic fields. Which provides flexibility and moldability for useful device integration. Key issues in solid state cooling systems can be addressed by encapsulation within the polymer matrix, which improves corrosion resistance and streamline fluid management[2]. These results show that Ho_6FeSb_2-based electrospun composites in combination with magnetocaloric efficiency and mechanical flexibility, makes Ho6FeSb2 composite promising candidates for next-generation solid-state refrigeration.

Keyword: Alloy, magnetic refrigeration, flexible nanofibers, magnetocaloric effect.

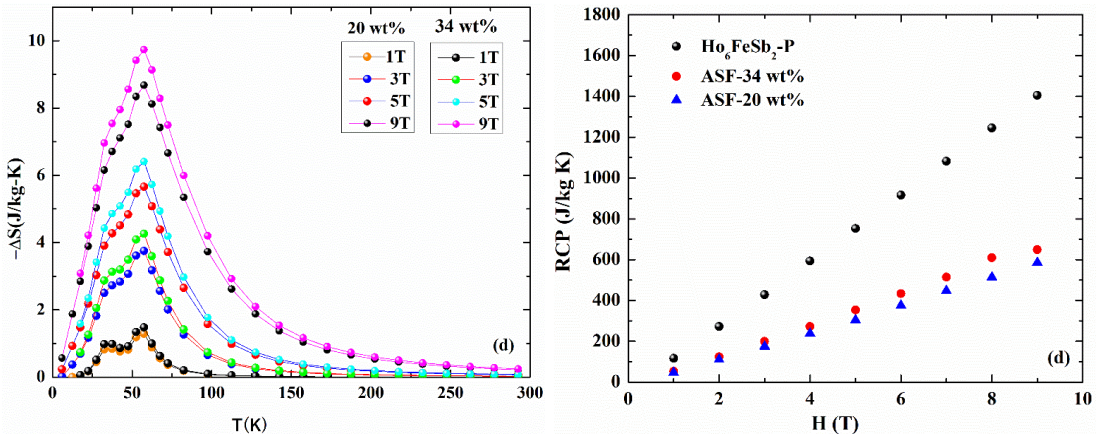


Fig. 1: Isothermal entropy change for the composite prepared with different loading of alloy (left side), variation of RCP with applied magnetic field (right side).

References:

[1] Athul. S. R, Arun. K, Swathi. S, Remya U. D, A. Dzubinska, M. Reiffers, R.nagalakshmi, Phys. B Condens. Matter **673** (2024) 415471.

[2] Anurag. Kumar. Singh, Swathi. S, A. Dzubinska, M. Reiffers, R. Nagalakshmi, Mater. Today Nano **32** (2025) 100718.

Abstract ID: 386

SUPERPARAMAGNETIC NANOCUBES OF Co AND Cu CO-DOPED Mn-BASED FERRITES AS MICROWAVE ABSORBING MATERIAL

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Abstract: The requirements for resolving electromagnetic (EM) problems in stealth warhead technologies are excellent absorption ability, lightweight, and thin dimensions. In this direction, this study provides a straightforward hydrothermal one-pot method to synthesise superparamagnetic Mn-based ferrite co-doped with Co and Cu (MCCF), and the article presents its microwave absorption properties. Using cutting-edge techniques, the MCCF nanocomposite phase structure, morphological, superparamagnetic, and microwave absorption properties were measured and analyzed. MCCF-822 ferrite shows superparamagnetic properties simultaneously with a high Ms value 71.4 emu/g. Vector network analysis of MCCF-822 with 70 wt% loading demonstrates an effective absorption bandwidth (EAB) of 5.2 GHz with a maximum reflection loss (RLmax) of -19.2 dB at 2 mm thickness, and it spans almost 92.77% frequency region (3.3 to 18 GHz range with RL< -10dB) by varying the thickness 1.7 mm to 6 mm. At 60 wt% loading, it covers the whole X & Ku band with a thickness range from 2 to 9 mm with a good EAB of 4.3 GHz at 2.5 mm thickness with RLmax of -16 dB. The dual absorption bands are also present in MCCF-613, which increases the EAB with RLmax -52.99 dB at 9 mm, fulfilling the superparamagnetic properties. Thus, MCCF-822 is proposed as a cost-effective, superior ferrite nanocomposite for microwave absorption applications.

Keywords: Superparamagnetic, Microwave absorbing material, Nanoparticle, Maximum reflection loss, Electromagnetic wave.

Abstract ID: 387

MAGNETOCALORIC CROSSOVER AND EXCHANGE BIAS IN NOVEL RUTHENIUM BASED DOUBLE PEROVSKITES

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Abstract: The mutual dependence of lattice symmetries and magnetic exchange interactions helps in tuning the magnetic ground states in double perovskites. Here we report the nature of 3d-4d interaction and role of anti-site disorder in governing the magnetic ground state of a novel double perovskite R_2CoRuO_6 (R = rare-earth atom). Theoretical electronic structure calculation reveals Co-O-Ru interaction to be ferromagnetic in ordered structure. However, lack of saturation in the magnetization measurements indicate presence of anti-site disorder. Temperature dependent magnetization study uncovers the coexistence of ferromagnetic (Ru-O-Co) and antiferromagnetic (Ru-O-Ru and Co-O-Co) phases. Interestingly, magnetic entropy change ($-\Delta S_M$) exhibits positive to negative crossover below 40 K as shown in Fig. 1. In addition, exchange bias is also observed in the same temperature window. Both phenomena are facilitated by the metamagnetic behavior of disordered Co-Co and Ru-Ru regions. The simultaneous occurrence of magnetocaloric crossover and exchange bias phenomena in 3*d*-4*d* double perovskite opens up possibilities of self-cooled spintronic devices [1,2].

Keywords: Magnetocaloric effect, Exchange bias, metamagnetism, DFT calculation.

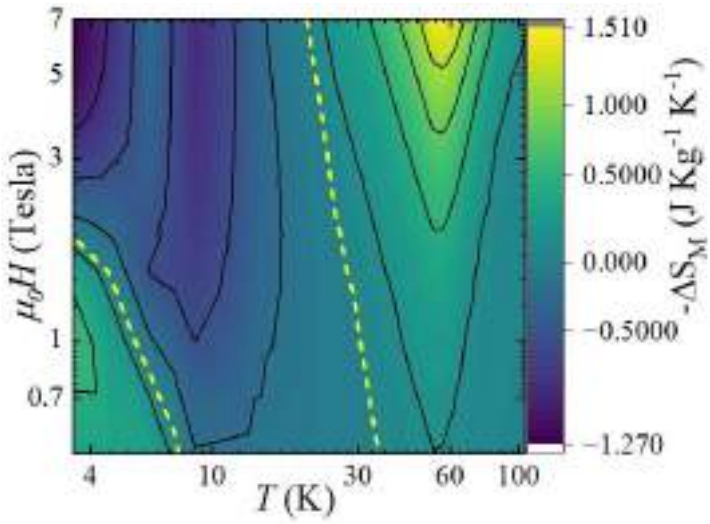


Fig. 1: 2D color plot of magnetic entropy change ($-\Delta S_M$) as a function of field ($\mu_0 H$) and temperature (T). The region bordered by solid dotted yellow curves corresponds to negative $-\Delta S_M$.

References:

[1] M. Bansal, W. Akram, S. K. Giri, and T. Maity, Twisted magnetocaloric effect by spin-glass driven large exchange bias, Phys. Rev. B 111, L140418 (2025).

[2] B. Maji, M. K. Ray, K. G. Suresh, and S. Banerjee, Large exchange bias and magnetocaloric effect in TbMn2Si2, J. Appl. Phys. 116 (2014).

Abstract ID: 388

ANISOTROPY-DRIVEN STRIPE DOMAIN FORMATION IN $Ni_{95}Cr_5$ THIN FILMS AT REMANENCE

Krishna Begari[1], Rohiteswar Mondal[2], Nitesh Singh[1], Chandrasekhar Murapaka[2], Bishwanath Bhoi[3], Banasree Sadhukhan[1], Anil Annadi[1], Panagiotis Grammatikopoulos[4], Murtaza Bohra[1]*

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Abstract: Spintronic materials utilize both the charge and spin of electrons, enabling highly energy-efficient technologies for memory, logic, and sensing, with significant potential for artificial intelligence and quantum information applications [1]. Understanding how magnetic domain structures and their dynamic behavior evolve with film thickness at remanence is crucial for designing tunable and reconfigurable spintronic materials. In this study, micromagnetic simulations of Ni–Cr thin films with thicknesses ranging from 10 to 100 nm successfully reproduce the stripe-domain patterns observed experimentally using magnetic force microscopy. A representative example is the 40 nm film, where a characteristic stripe-domain width of approximately 150 nm is obtained, supported by a perpendicular anisotropy of Kp ≈ 75kJ/m3 [2]. Simulated hysteresis loops reveal a thickness-dependent transition in magnetization reversal, evolving from conventional in-plane switching in thinner films (10–20 nm) to a transcritical behavior above about 40 nm due to the emergence of perpendicular magnetic anisotropy (PMA). Broadband ferromagnetic resonance measurements performed over the 2–18 GHz range further demonstrate a systematic change in magnetization dynamics. Thin films exhibit a single uniform resonance mode, while the 40 nm sample shows mode splitting, and the 100 nm film displays pronounced perpendicular standing spin-wave modes. These results agree with simulated remanent-state resonances of approximately 1.1–2.4 GHz. Kittel analysis yields an effective magnetization of $4\pi M_{eff} \approx 1462$G and an anisotropy field $H_k = -194$Oe in thinner films, with a sign reversal to positive HkH_kHk at larger thicknesses, confirming the onset of PMA. These findings link remanent domain morphology, magnetization reversal mechanisms, and GHz spin dynamics in NiCr thin films, highlighting their tunability for spintronic and magnonic applications.

Keywords: Stripe domain, Perpendicular magnetic anisotropy, Magnetization dynamics, OOMMF.

References:

[1] K. Szulc, S. Tacchi, A. Hierro-Rodríguez, et al., "Reconfigurable Magnonic Crystals Based on Imprinted Magnetization Textures in Hard and Soft Dipolar-Coupled Bilayers", *ACS Nano* **16**, no. 9 (2022): 14168–14177.

[2] N. R. Álvarez, J. E. Gomez, M. V. Mansilla, et al., "Magnetic Coupling of Stripe Domains in FePt/Ni80Fe20 Bilayers", *J. Phys. D* **50** (2017): 115001.

Abstract ID: 390

STRUCTURAL AND MAGNETIC MODIFICATIONS IN MoS_2 INDUCED BY He^+ ION IRRADIATION

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Abstract: Two-dimensional transition metal dichalcogenides (TMDs), particularly MoS_2, have attracted significant attention due to their unique electronic, optical, and spin-related properties [1]. Pristine MoS_2 is intrinsically non-magnetic; however, theoretical and experimental studies have shown that defect engineering can induce localized magnetic moments in its lattice. Ion irradiation is an effective technique to introduce controlled defects in layered materials, enabling the modification of their structural and magnetic properties. In this work, we investigate the influence of low-energy helium (He^+) ion irradiation on the structural and magnetic behaviour of MoS_2 [2]. Low-energy He ion irradiation is expected to generate lattice defects such as sulphur vacancies, molybdenum vacancies, and local lattice distortions without significantly disrupting the layered crystal framework. These irradiation-induced defects can modify the electronic structure and produce localized magnetic moments associated with unsaturated bonds and defect states [3]. Structural changes and defect formation in irradiated samples are analyzed using X-ray diffraction (XRD) and Raman spectroscopy to examine lattice disorder, peak shifts, and variations in characteristic vibrational modes. The magnetic properties of pristine and irradiated MoS_2 are further investigated using vibrating sample magnetometry (VSM) or SQUID magnetometry to probe defect-induced magnetic ordering. This study aims to establish a correlation between irradiation-induced defects and the emergence of magnetism in MoS_2. The findings provide insight into defect-engineered magnetism in two-dimensional materials and highlight the potential of ion irradiation as an effective tool for tailoring the magnetic properties of TMDs for future spintronic applications.

Keywords: Transition metal dichalcogenide, MoS_2 He ion irradiation.

References:

[1] G. Was, "Fundamentals of Radiation Materials Science: Metals and Alloys," Fundamentals of Radiation Materials Science: Metals and Alloys, pp. 1–827, Jan. 2007, doi: 10.1007/978-3-540-49472-0.

[2] G. W. Jeon, K. W. Lee, and C. Lee, "High-Energy Proton-Irradiation Effects on the Magnetism of the Transition-Metal Dichalcogenide MoS2," Journal of the Korean Physical Society, vol. 76, pp. 93–96, Jan. 2020, doi: 10.3938/jkps.76.93.

[3] M. Chhowalla, H. S. Shin, G. Eda, L. J. Li, K. P. Loh, and H. Zhang, "The chemistry of two-dimensional layered transition metal dichalcogenide nanosheets," Apr. 2013. doi: 10.1038/nchem.1589.

Abstract ID: 391

Gd^{3+}-INDUCED STRUCTURAL AND MAGNETIC MODULATION IN Sr_2CrMoO_6 DOUBLE PEROVSKITES SYNTHESIZED VIA THE PECHINI SOL–GEL ROUTE

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Abstract: Double perovskite oxides with the general formula $A_2BB'O_6$ have attracted significant attention due to their tunable structural and magnetic properties arising from ordered transition-metal sublattices [1,2]. However, rare-earth substitution effects in Sr_2CrMoO_6 synthesized via the Pechini method remain relatively unexplored [3]. In this work, Gd^{3+}-substituted Sr_2CrMoO_6 compounds with compositions $Sr_{2-x}Gd_xCrMoO_6$ (x = 0.0, 0.1, 0.2, 0.3) were synthesized via the Pechini method. The synthesis method favours enhanced phase formation and uniform cation distribution at relatively lower calcination temperatures [4]. The structural properties were analyzed using X-ray diffraction, and Rietveld refinement confirmed the formation of the crystalline double perovskite phase with slight variations in lattice parameters upon Gd substitution. The incorporation of the smaller Gd^{3+} ion at the Sr^{2+} site leads to a reduction in the effective A-site ionic radius, which in turn gradually decreases the Goldschmidt tolerance factor. This resulted in enhanced lattice distortion and octahedral tilting within the perovskite framework. Microstructural characteristics and particle morphology were examined using Scanning Electron Microscopy and Transmission Electron Microscopy. Magnetic measurements performed using Vibrating Sample Magnetometry reveal modified magnetic behaviour with increasing Gd content due to variations in Cr–O–Mo exchange interactions caused by structural distortion. In addition, optical properties investigated using UV-Vis spectroscopy indicate slight changes in the electronic structure. These results demonstrate that rare-earth substitution provides an effective route to tune the structural distortion and magnetic response of Sr_2CrMoO_6 double perovskites for potential magnetic material applications.

Keywords: Double perovskite oxides, Sr_2CrMoO_6, Gd substitution, Pechini method, Magnetic properties.

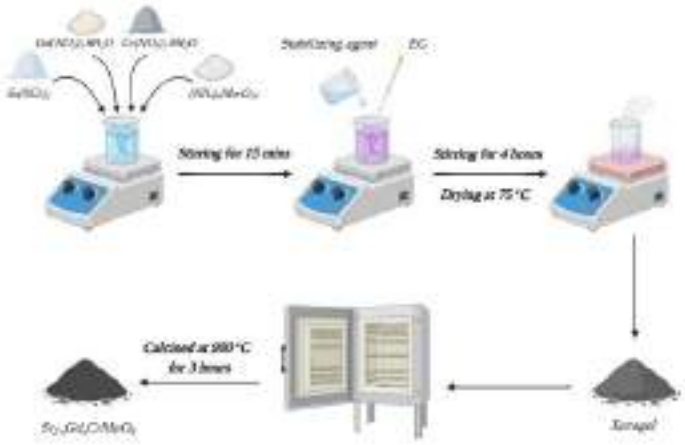


Fig. 1: Schematic representation of the Pechini sol–gel synthesis route for $Sr_{2-x}Gd_xCrMoO_6$.

References:

[1] Z.-C. Wang, L. Chen, S.-S. Li, J.-S. Ying, F. Tang, G.-Y. Gao, et al., npj Quantum Mater. 6 (2021) 53.
[2] A. Arulraj, K. Ramesha, J. Gopalakrishnan, C.N.R. Rao, J. Solid State Chem. 155 (2000) 233–237.
[3] J.A. Khan, J. Ahmad, S.H. Bukhari, U. Nissar, Phys. Scr. 97 (2022) 125810.
[4] M. Cernea, F. Vasiliu, C. Plapcianu, C. Bartha, et al., J. Eur. Ceram. Soc. 33 (2013) 2483–2490.

Abstract ID: 392

INTERPLAY OF CHARGE ORDER AND MAGNETISM IN A BIPARTITE SQUARE LATTICE IN AN EXTENDED HUBBARD MODEL

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Abstract: Transition metal oxides are interesting not only due to the presence of strongly electron correlations, but also due to the intricate interplay between charge, spin, orbital and lattice degrees of freedom. The competing nature of these interactions rise to novel and exotic electronic and magnetic ground states like the colossal magnetoresistance, superconductivity and non-trivial topological behavior to name a few. This study pertains to the investigations on the coupling between the spin and charge degrees of freedom in a two sub-lattice model. We employ an extended Hubbard model that incorporates site energy, on-site and inter-site Coulomb interactions, as well as the Hund's direct exchange. The model is solved using a mean-field approach to understand various electronic and magnetic ground states of the model by varying the model parameters. The phase diagram of the model obtained in various parametric planes reveal exotic phases like the charge-ordered antiferromagnetic (CO+AFM) phases, non-charge-ordered magnetic phases, besides a fully charge-ordered phase. It will be shown that the CO+AFM (AM) phase is in fact an antiferromagnetic phase in which Kramer's degeneracy is lifted in the momentum space, akin to the Rashba effect but in the absence of spin-orbit interactions. The projected band structure analysis further reveals that the altermagnetism originates from the strong coupling between the charge and spin degrees of freedom of the A- and B-sites. The various electronic and magnetic phases of the model will be described using the site spin and charge densities as well as the electronic band structures. This work thus presents a tunable framework for engineering novel altermagnetic materials.

Keywords: Altermagnetism; extended Hubbard model; mean-field approach.

Reference:

[1] D. Dey, S. Choudhary, S. Ramasesha, R.Raghunathan, Phys. Rev. B 111, 214439 (2025)

Abstract ID: 393

MELT-SPUN Co SUBSTITUTED Mn_5Sn_3 RIBBONS FOR MAGNETIC REFRIGERATION

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Abstract: The modern world is in an immediate need for an alternate eco-friendly, efficient and economical refrigeration method. Manganese-based magnetocaloric is one such option. To further increase the heat transfer efficiency of these materials, Melt spinning is a versatile synthesis technique that produces rapidly solidified ribbons with a suitable morphology for heat transfer. The arc-melted $Mn_{5-x}Co_xSn_3$ (X = 0.1, 0.2, and 0.3, indicated as sample 1, sample 2, and sample 3 polycrystals) were melt-spun into ribbons. These ribbons have shown multiple magnetic transitions, initially paramagnetic to ferromagnetic transition at T_c = 210 K, 185 K, and 150 K followed by ferromagnetic to ferrimagnetic transition at T = 21 K, 24 K, and 35 K for sample 1, sample 2, and sample 3, respectively. All the above transitions are second-order in nature, as confirmed by Arrott's plot. The ribbons show the maximum magnetic entropy change(ΔS_M^{Pk}) for samples 1, 2, and 3 are 1.9 J/KgK, 1.7 J/KgK, and 1.45 J/KgK, respectively, at an applied magnetic field of 0- 5 T, and the relative cooling power of 222 J/Kg, 190.4 J/Kg, and 148.4 J/Kg, respectively. These ribbons have magnetocaloric properties comparable to their bulk counterparts, but their superior morphology for heat transfer makes them suitable for commercial applications.

Keywords: Melt-spun ribbons; Magnetic refrigeration; Magnetocaloric effect; Second-order transition.

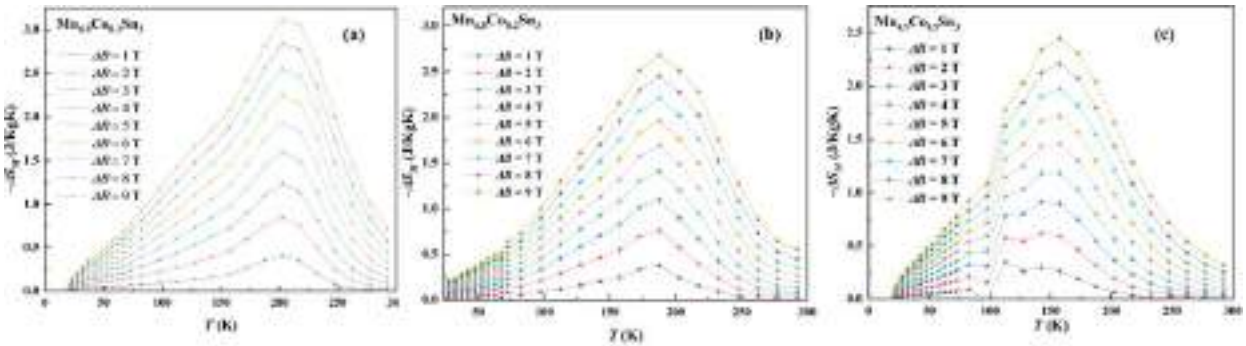


Fig. 1: The magnetocaloric response of (a) sample 1, (b) sample 2, and (c) sample 3 over range of fields from 1 T to 9 T.

Abstract ID: 394

TUNABLE MAGNETIC FRUSTRATION IN THE COPPER-RUTHENATE DOUBLE PEROVSKITE OXIDE

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Abstract: Geometrically frustrated magnetic systems often exhibit suppression of conventional long-range order, giving rise to complex low-temperature behaviors such as spin glasses. The double perovskite (DP) oxide framework ($A_2BB'O_6$) provides a versatile platform to explore such phenomena, particularly when the B and B′ sites are occupied by distinct magnetic ions [1]. In this study, we investigate the structural, magnetic, and electronic properties of the copper-ruthenate series $La_{2-x}Sm_xCuRuO_6$ (x = 0, 1, 2) synthesized via the solid-state reaction method. X-ray diffraction analysis confirms that all compounds crystallize in a monoclinic symmetry, with structural distortion increasing upon the substitution of La^{3+} by the smaller Sm^{3+} cation. While both the parent La_2CuRuO_6 and the fully substituted Sm_2CuRuO_6 exhibit ordered ferrimagnetic ground states, they present strikingly different spin dynamics [2,3]. Detailed DC and AC magnetization, alongside heat capacity measurements, reveal that La_2CuRuO_6 exhibits glassy-spin characteristics indicative of strong magnetic frustration. Conversely, this glassy behavior is completely absent in Sm_2CuRuO_6. First-principles density functional theory (DFT) calculations elucidate the microscopic origin of this transition. We find that strong, antiferromagnetic second-nearest-neighbor Ru-Ru interactions over the faces of edge-sharing tetrahedra drive the frustration in the La-compound. The substitution of Sm induces structural distortions that create significantly unequal Ru-Ru bond lengths, drastically weakening the frustration. These findings demonstrate the critical role of extended 4d orbital interactions and highlight the tunability of magnetic frustration in insulating double perovskites through A-site cation substitution.

Keywords: Double Perovskite, Magnetic Frustration, Spin Glass, Density Functional Theory.

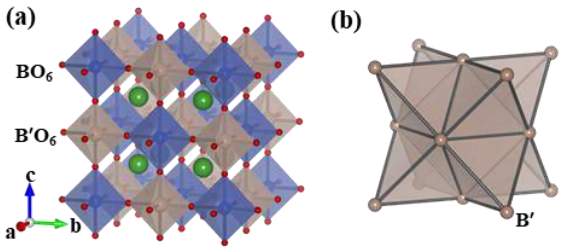


Fig. 1: (a) Cubic DP structure showing BO_6 and $B'O_6$ octahedra forming inter-penetrating fcc lattice. (b) B′ ions form a frustrated fcc sublattice with edge-sharing tetrahedra.

References:

[1] J. E. Greedan, In Functional Oxides (John Wiley & Sons, Ltd, 2010) Chap. 2, pp. 41–117.
[2] P. A. Kumar, R. Mathieu, R. Vijayaraghavan, et al., Phys. Rev. B 86, 094421 (2012).
[3] X. Chen, B. Li, J. Cheng, L. Wang, F. Chi, C. Liu, et al., Solid State Commun. 327, 114203 (2021).

Abstract ID: 395

ROLE OF THULIUM IN MODULATING MAGNETIC DAMPING OF YIG THIN FILM

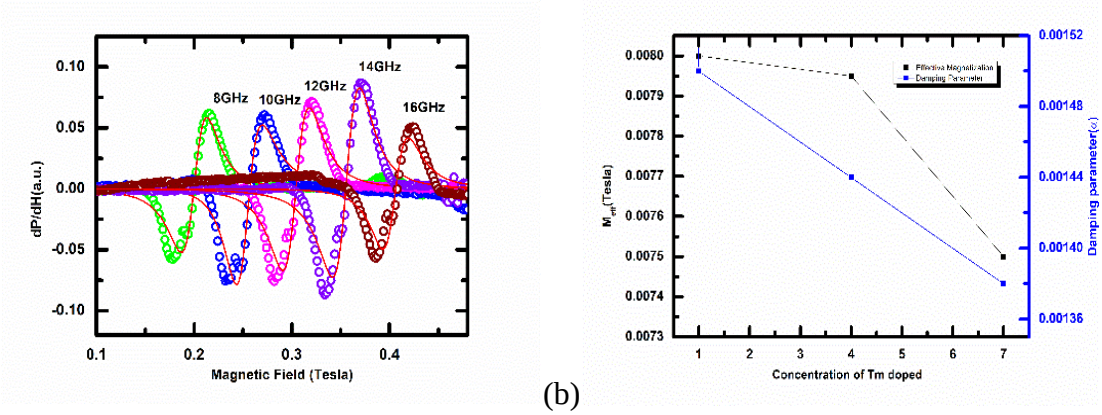
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Abstract: Magnetic garnet thin films offer an unique platform for exploring low-damping spin dynamics, making them as key materials in modern spintronics and magnonics. Prior studies shows YIG possess basic characteristics such as cubic structure, $Ia\bar{3}d$ space group, critical temperature (Tc) around 560K [1,2]. Here, we report the effect of Tm substitution at the Y-site of YIG, prepared via the sol–gel method and spin coated on SiO_2 substrates. The effects of Tm^{3+} ion incorporation on key magnetic parameters such as Gilbert damping, ferromagnetic resonance (FMR) linewidth, and magnetic anisotropy are investigated. A comparative study of different percentage Tm doped YIG has been done to see how the parameters like saturation magnetization and damping parameter evolve. Angle dependent FMR study has been done to see the magnetic anisotropy. The FMR data was analysed using Kittel formulae along in-plane direction. These findings provide crucial insights into engineering of the magnetic relaxation mechanisms in garnet-based thin films, with implications for the design of high-frequency, low-power magnonic devices [3]. Fig.1a shows FMR spectra for 1% Tm -YIG. Similarly, other concentration of Tm doping FMR data was taken, and their corresponding effective magnetization (M_{eff}) and Gilbert damping (α) was estimated. Fig.1b shows a comparative graph of Tm-YIG for M_{eff} and α.

Keywords: Garnet,Thin film, Magnonic, Tm-YIG, Magnetization.



(a) (b)

Fig. 1:(a) FMR spectra of 1% Tm-doped YIG, (b) M_{eff} and α vs concentration of Tm doping.

References:

[1] R.Sharma , P.K. Ojha , S K Mishra ,Thin Solid Films 764 (2023) 139625.
[2] V. Cherepanov, I. Kolokolov , and V. L'vov Physics Reports, 229 (1993) 81.
[3] E.R. Rosenberg ,K. Litzius , J.M.Shaw, G.A Riley, G.S.D. Beach, H.T. Nembach, and C.A. Ross ,Adv Elect Materials, **7** (2021) 2100452.

Abstract ID: 396

MAGNETOCALORIC STABILITY OF $Mn_{4.8}Cu_{0.2}Ge_3$ IN CYCLIC MAGNETIC FIELDS

Nagalakshmi Ramamoorthi[1]* Mani Barathi A[1], Athul S R[1], Fredrick Jean Paul J[1], Anvar Kadirbardeev[2], Swathi Sakthivel[3], Adler Gamzatov[2*]

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Abstract: Magnetocaloric properties of materials are conventionally studied by indirect methods under the application of a unidirectional magnetic field. But the commercial refrigerators work by repeated cycles of magnetization and demagnetization. Some materials have shown degradation or even loss of properties after repeated cycles of the magnetic field and time. So it is necessary to study the effect of the application of cyclic magnetic fields on $Mn_{4.8}Cu_{0.2}Ge_3$ and for a period of time. Polycrystalline $Mn_{4.8}Cu_{0.2}Ge_3$ undergoes a second-order transition from ferromagnetic to paramagnetic phase at T_c = 276.5 K. The alloy exhibits a maximum adiabatic temperature change ΔT_{ad} of 1.7 K, which remains stable over a long period of 15 minutes and up to 190 cycles studied under the cyclic field of 1.8 T with the frequency of 0.2 Hz, establishing its commercial value. The sample also exhibits a unaccounted frequency dependence, with a 16% reduction in ΔT_{ad} over a frequency change of 1Hz to 10 Hz. Even though there is a loss in ΔT_{ad} the alloy shows a considerable cooling power Q_c = 5.38 W/g at a frequency of 10 Hz at an applied cyclic field of 1.2 T. The alloy shows good magnetocaloric properties, which are stable even after several cycles of refrigeration operation, making it a better candidate than several materials showing a giant magnetocaloric effect with a first-order transition.

Keywords: Magnetocaloric effect; Adiabatic temperature change; Direct measurements; Cyclic magnetic field; Heat capacity.

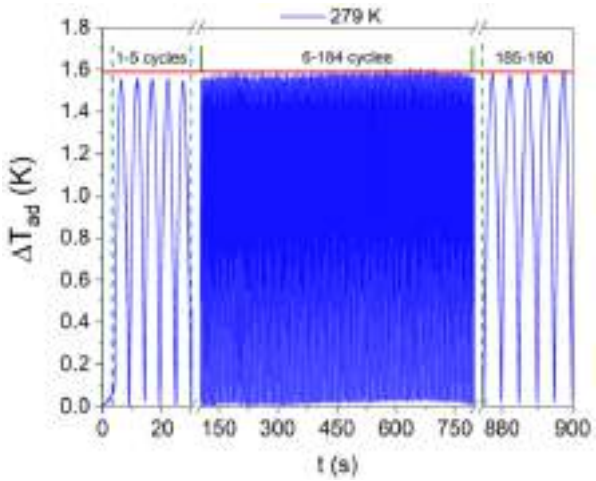


Fig. 1: Time dependence of adiabatic temperature change over 190 cycles near the transition temperature.

Abstract ID: 398

MICROWAVE SHIELDING PROPERTIES OF W-TYPE HEXAFERRITE $Sr_{0.95}La_{0.05}Co_2Fe_{16}Al_{0.5}O_{27}$ AND COMPOSITES

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Abstract: W-type hexaferrite are well-known members of the soft magnetic ferrite family, which are typically being used in high-frequency applications. These polycrystalline magnetic semiconductors exhibit low eddy currents and electrical conductivity, which makes them great candidates for various applications, including microwave shielding and absorption. In this research article, $Sr_{0.95}La_{0.05}Co_2Fe_{16}Al_{0.5}O_{27}$ has been synthesized via the following sol-gel auto combustion method. Furthermore, carbon black (CB) and cellulose microfibers (CMF) have been added to further enhance the microwave shielding behavior of the $Sr_{0.95}La_{0.05}Co_2Fe_{16}Al_{0.5}O_{27}$. It has been observed that the addition of CB greatly enhances the total shielding effectiveness (SET) of $Sr_{0.95}La_{0.05}Co_2Fe_{16}Al_{0.5}O_{27}$ and $Sr_{0.95}La_{0.05}Co_2Fe_{16}Al_{0.5}O_{27}$/CMF composites. The $Sr_{0.95}La_{0.05}Co_2Fe_{16}Al_{0.5}O_{27}$/CB composite shows an average SET value of 30.56 dB at a thickness of 2 mm, whereas at a thickness of 5 mm, this value was doubled, reaching an average value of 64.45 dB in the X-band frequency region. Furthermore, it was observed that $Sr_{0.95}La_{0.05}Co_2Fe_{16}Al_{0.5}O_{27}$/CB/CMF also showed great improvement in SET value, reaching an average value of 22.81 dB. All these results show the potential of THE SR0.95LA0.05CO2FE16AL0.5O27/CB composite for microwave shielding applications.

Keywords: W-type Hexaferrite, Microwave Shielding, Carbon Black, Cellulose Microfibers.

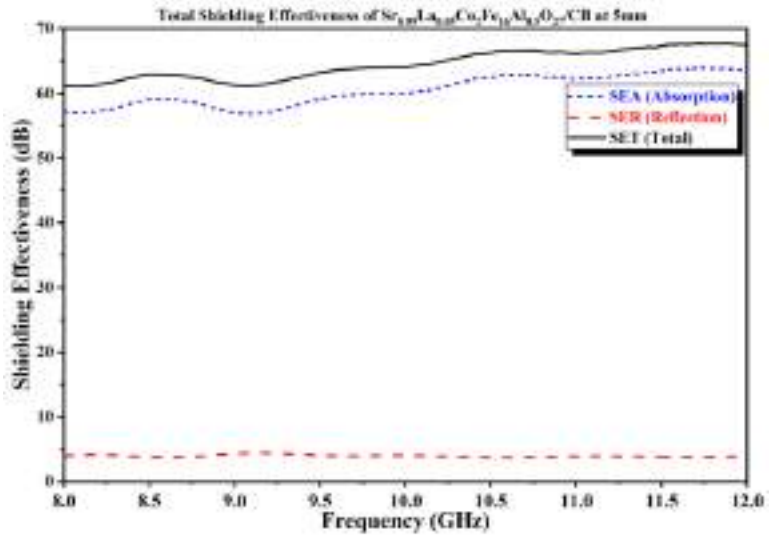


Fig. 1: Total shielding effectiveness of $Sr_{0.95}La_{0.05}Co_2Fe_{16}Al_{0.5}O_{27}$/CB at 5 mm thickness.

Abstract ID: 399

OVERLAYER INDUCED MORPHOLOGY AND MAGNETIC ANISOTROPY IN POLYCRYSTALLINE THIN FILM

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Abstract: Magnetic anisotropy plays a crucial role in fine-tuning spin-dependent properties of spintronic devices, magnetic memory, sensor. Achieving strong in-plane magnetic anisotropy through interface design, strain engineering, and stacking control will enable next-generation magnetic devices[1]. In the present work, the effect of Pt overlayer thickness and morphology on the in-plane magnetic anisotropy of ~ 40 nm thick polycrystalline Co film on SiO_2 substrate has been studied. Variation in the overlayer thickness of Pt induced anisotropy in the magnetostructive polycrystalline Co layer. Deposited Co films were capped with a Pt layer of three thicknesses, 10, 20, and 30 nm, using electron-beam evaporation. The samples were assigned as CoPt1, CoPt2, and CoPt3, respectively. Out-of-plane X-ray diffraction studies reveal that all thin films are in fcc and hcp phases for Pt and Co, respectively. Moreover, the Pt (111) and Co (002) diffraction peaks shifted to higher angles due to a decrease in the lattice parameters with Pt layer thickness increases. This can be due to compressive stress produced in the plane of thin films. Longituanal Magneto-optical kerr effect (MOKE) studies show that increasing the Pt overlayer thickness increases the in-plane uniaxial anisotropy of the Co film. As the thickness of the overlayer increases from 10 nm to ~30 nm, the magnetic anisotropy field increases by ~ 69%**.** Surface morphologies of the samples were observed by Atomic Force Microscopy, which showed an increase in Pt layer thickness with larger, elongated grains in CoPt3.

Keywords: In-plane magnetic anisotropy, Crystal structure, Overlayer, Surface morphology

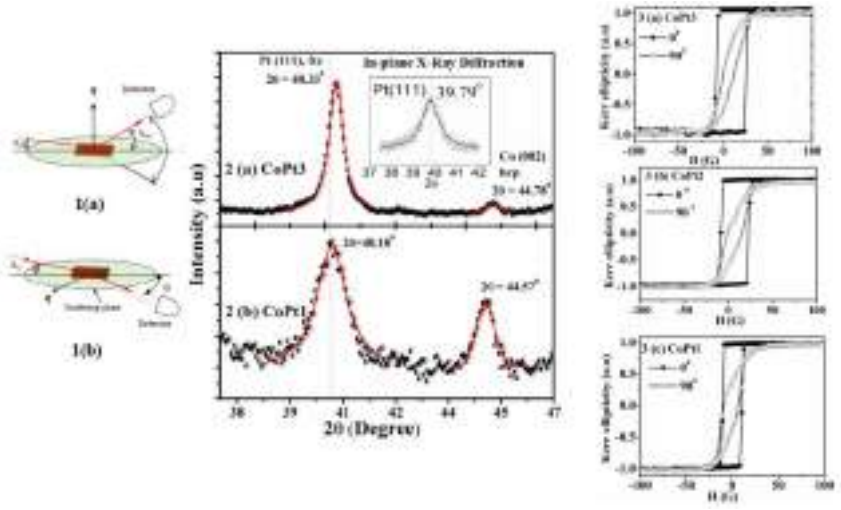


Fig. 1: (a) Out-of-plane, 1(b) in-plane XRD schematics; Out-of-plane XRD of 2 (a) CoPt3 (inset: In-plane), 2(b) CoPt1; MOKE hysteresis loops measured at 0° and 90° for 3(a) CoPt3, 3(b) CoPt2, 3(c) CoPt1.

References:

[1] N. Martin, J. McCord, A. Gerber, T. Strache, et al., Appl. Phys. Lett. 94 (2009) 062506

Abstract ID: 400

FRUSTRATION-DRIVEN MAGNETISM AND STRUCTURAL PROPERTIES OF SPINEL VANADATE CoV_2O_4

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Abstract: We report the magnetic frustration and structural properties of the spinel vanadate CoV_2O_4 prepared by solid-state reaction. In a broader framework, we investigated CoV_2O_4 samples prepared at different sintering temperatures to elucidate sintering-temperature-dependent structural and magnetic characteristics using complementary experimental techniques. Powder X-ray diffraction studies revealed a spinel cubic structure with the $Fd\bar{3}m$ space group. The calculated average crystallite size and lattice constants were in the range 44.2 – 44.5 nm and 8.382-8.384 Å, respectively. Temperature-dependent magnetization showed a paramagnetic to collinear ferrimagnetic transition (T_C) at 161 K and an orbital glass state transition at 60 K (T_1) for a CoV_2O_4 sample sintered at 1000 °C for 24 h. The observed transition at 161 K is a paramagnetic-to-ferrimagnetic transition, in which the Co^{2+} spins are antiparallel to the V^{3+} spins. This configuration results in a robust antiferromagnetic exchange interaction between the two sublattices and the observed ferrimagnetic configuration at the V^{3+} site. Conversely, the transition at 60 K corresponded to the canted spins of V^{3+} undergoing additional spin orientation and freezing due to strong geometric frustration. Field-dependent magnetization investigations demonstrated a paramagnetic state at 300 K, while a ferrimagnetic state was observed at 100 K and 10 K. Notably, the enhanced coercivity of 0.206 T and saturation magnetization of 0.035 emu/g were realized for CoV_2O_4 at 10 K, implying the long-range ferrimagnetic ordering with strong magnetic anisotropy. The present study provides a new insight into the structural and magnetic properties of spinel vanadate CoV_2O_4.

Keywords: Spinel vanadate, CoV_2O_4, Cubic structure, Ferrimagnetism, Frustration, Spin-freezing.

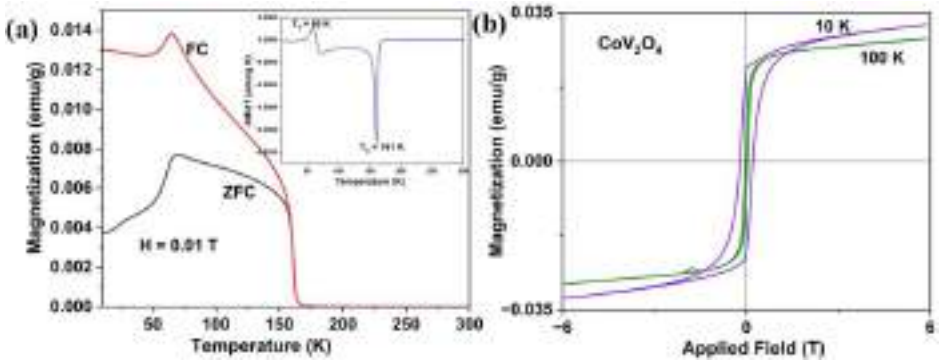


Fig. 1: **(a)** Temperature-dependent magnetization of the CoV_2O_4 measured with a field of H = 0.01 T (Inset shows the graphical plot of dM/dT versus T). **(b)** Field-dependent magnetization of the CoV_2O_4 measured at 100 and 10 K.

References

[1] M. Nakano, T. Kobayashi, T. Katsufuji, Phys. Rev. Lett. 135 (2025) 186701.

Abstract ID: 401

VACANCY-ASSISTED ENHANCEMENT OF ROOM TEMPERATURE FERROMAGNETISM IN (Cr, Al) CO-DOPED ZnO DMS

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Abstract: Pure and (Al, Cr) co-doped ZnO compounds with composition $Zn_{1-x-y}Cr_xAl_yO$ (x=0.04; y=0.01-0.04) were synthesied by solid state reaction method to investigate the magnetic behaviour induced by transition metal co-doping and defect engineering. X-ray diffraction analysis confirms the hexagonal wurtzite structure of ZnO without secondary phases, indicating successful icorporation of Al^{3+} and Cr^{3+} ions into Zn^{2+} lattice sites[1]. Shift in diffraction peaks with dopant concentration suggest lattice distortion and generation of intrinsic defects such as oxygen vacancies, which plays vital role in mediating magnetic interactions. Photoluminescence spectra further support the presence of defect states associated with zinc interstitials, zinc vacancies, and various charge states of oxygen vacancies[2]. Room-temperature magnetic measurements reveal weak but distinct S-shaped hysteresis loops for all samples, confirming the coexistence of ferromagnetic and paramagnetic components typical of dilute magnetic semiconductors(DMS). The magnetic response is noticeably enhanced with increasing Cr and Al co-doping, where the saturation magnetization increases significantly compared to pure ZnO. This improvement in ferromagnetism is attributed to defect-mediated exchange interactions described by the bound magnetic polaron (BMP) mechanism. In this model, electrons trapped at oxygen vacancy-related F-centres interact with localized magnetic moments of Cr^{3+} ions, forming magnetic polarons[3]. As the density of these polarons increases, their overlap leads to long-range ferromagnetic ordering. The combined effect of transition-metal substitution and vacancy-induced defect states, therefore, plays a crucial role in strengthening the room temperature ferromagnetism in the studied ZnO system, highlighting its potential for dilute magnetic semiconductor and spintronic applications.

Keywords: (Al, Cr) co-doped ZnO DMS, oxygen vacancies, room temperature ferromagnetism, spintronic applications

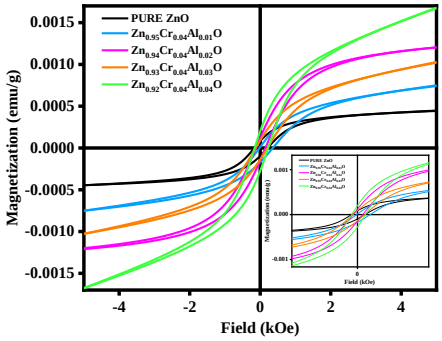


Fig. 1: Ferromagnetic behaviour of pure and (Al, Cr) co-doped ZnO.

References:

[1] A.H. Shah, M. Basheer Ahamed, D. Neena, F. Mohmed, A. Iqbal, J. Alloys Compd. 606 (2014) 164–170. https://doi.org/10.1016/j.jallcom.2014.04.040

[2] H.S. Lokesha, A.R.E. Prinsloo, P. Mohanty, C.J. Sheppard, J. Alloys Compd. 960 (2023) 170815. https://doi.org/10.1016/j.jallcom.2023.170815

[3] S.M. Abo-Naf, S. Ibrahim, M.A. Marzouk, Appl. Phys. A 127 (2021) 404. https://doi.org/10.1007/s00339-021-04583-w

Abstract ID: 402

COMPARATIVE STUDY OF SOFT AND HARD MAGNETIC MATERIALS

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Abstract: Magnetic materials are mainly categorized into soft and hard in the basis of how effortlessly they can be magnetized and demagnetized and this difference appears straightforward on the surface but possesses complexities in how we design and use magnetic devices. This paper reviews the basic distinctions between the two materials, analysing the structural origins, properties and the domains where each one is most relevant. The primary problem is that both the materials are indispensable yet presents opposing purposes: soft magnetic materials have low coercivity and high permeability, are vital in transformer cores as well as inductors where the magnetization state must change rapidly and with least energy loss, on the other hand hard magnetic materials retain their magnetization robustly and it is the fundamental component of permanent magnets used in electric motors. High thermal stability and the balance of energy efficiency remain ongoing challenge. This review sustains through examining various published literature that focuses on hysteresis behaviour, remanence, coercivity, and representative materials like soft ferrites and Fe-Si alloys and NdFeB and Alnico alloys. The findings shows that the performance gap between the two magnetic material is primarily varies through magnetic anisotropy and microstructure instead of composition alone, a distinction that also opens up the possibility of engineering intermediate or composite magnetic systems [1]. Such hybrid configuration holds sustainable for the future generation.

Keywords: Soft magnetic materials, Hard magnetic materials, Coercivity, Permeability, Hysteresis.

References:

[1] P. Narayanan, R. Pramanik, A. Arockiarajan, Smart Mater. Struct. 33 (2024) 043001.

Abstract ID: 403

SURFACE LIGAND ENGINEERING OF VS_2 QUANTUM DOTS: A COMPARATIVE STUDY OF MPA AND L-CYSTEINE FUNCTIONALIZATION

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Abstract: Quantum dots of vanadium disulfide (VS_2) are one of the transition metal dichalcogenide nanomaterials that have gained considerable interest due to their unique optical properties, nanoscale dimensions, and high surface volume ratio, making them suitable candidates for optoelectronic device applications, sensor technology, and biomedical engineering. Surface ligand engineering is an important area of study that helps modify the surface chemistry of these nanomaterials, thereby affecting their optical properties. In this study, a comparative analysis of 3-mercaptopropionic acid (MPA) and L-cysteine-functionalized vanadium disulfide quantum dots was performed to evaluate the effects of various surface ligands on the structural and optical properties of VS_2 QDs. The synthesized QDs were characterized using transmission electron microscopy, Raman spectroscopy, Fourier transform infrared spectroscopy, and fluorescence spectroscopy. The TEM analysis confirmed that uniformly distributed nanoscale VS_2 QDs were formed for both ligands. The Raman spectra indicated that the inherent crystal structure of VS_2 QDs was preserved even after ligand functionalization. The FTIR spectra confirmed that thiol-based ligands MPA and L-cysteine were successfully attached onto the surface of the QDs. The fluorescence spectra indicated that ligand functionalization significantly affects the radiative recombination processes of VS_2 QDs. From the results of the comparative analysis, it can be concluded that both ligands are efficient for the stabilization of the quantum dots, whereas the surface interaction for the ligand-functionalized quantum dots, as a result of the presence of multifunctional groups, can be enhanced with the use of the L-cysteine ligand.

Keywords: VS_2 QDt's; L-cys; 3-mercaptopropionic acid (MPA); Surface functionalization; Raman spectroscopy; FTIR; Fluorescence spectroscopy; Nanomaterials.

Abstract ID: 405

CURRENT-INDUCED SPIN-ORBIT TORQUE AND THERMAL EFFECTS IN CoFe/Pt HETEROSTRUCTURES VIA SECOND AND THIRD HARMONIC HALL MEASUREMENTS

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Abstract: The coexistence of current-induced spin–orbit torque (SOT) and thermally driven effects requires careful disentanglement for reliable interpretation and the development of spintronic devices. Second harmonic Hall voltage measurements are widely used to probe electrically generated spin torques together with thermoelectric contributions such as the anomalous Nernst effect and thermomagnetic effects including the spin Seebeck effect in ferromagnet (FM)/heavy metal (HM) heterostructures [1]. Recently, third harmonic Hall voltage measurements have emerged as a promising technique to investigate nonlinear SOT effects and thermally induced magnetization dynamics [2, 3]. In this work, we investigate the third harmonic Hall response in Pt/CoFe heterostructures, where CoFe ($Co_{0.66}Fe_{0.34}$) possesses a relatively large magnetostriction coefficient [4]. Harmonic Hall measurements were performed under varying magnetic field strengths and applied current amplitudes to analyze the nonlinear voltage response. Our results reveal that the third harmonic voltage captures two dominant mechanisms associated with thermally driven spin torques: thermal expansion mediated by magnetoelastic coupling and thermally induced reduction of magnetization. These mechanisms significantly influence the nonlinear Hall signal observed in the device. The present study demonstrates that third harmonic Hall measurements provide an effective approach to probe nonlinear spin–orbit torque phenomena and thermal effects in FM/HM heterostructures, offering valuable insight into thermally driven spin transport in metallic systems.

Keywords: Heavy-metal/Ferromagnet, Spin-orbit torque, Thermal effect, Second and Third Harmonics Hall, Magnetostriction coefficient

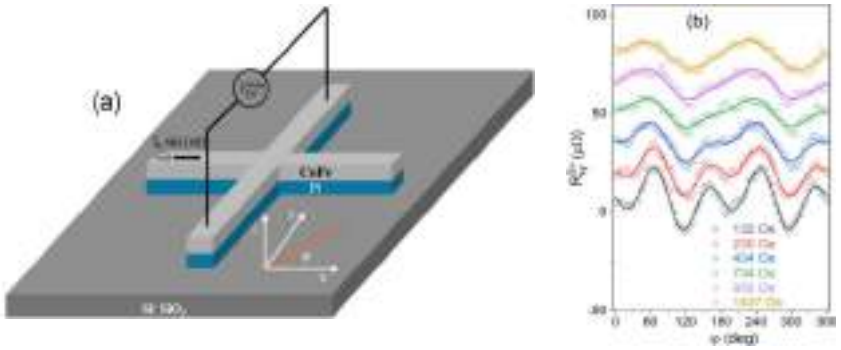


Fig. 1: (a) Schematic diagram of harmonic Hall resistance measurements in Pt/CoFe device. (b) In-plane angular variations of third harmonic Hall resistances for Pt (5 nm)/CoFe(3 nm) device under various magnetic fields with I_0 = 15 mA.

References:

[1] L. Liu, C.-F. Pai, Y. Li, H. Tseng, D. Ralph, and R. Buhrman, Science **336**, 555 (2012).
[2] Q. Zhang, Z. Yan, A. Ying, J. Zhang, B. Zhang, J. Cao, M. Si, L. Xi, et al., Rev. B **109**, 064427 (2024).
[3] Y. Ma, H. Xie, Y. Si, B. Rong, J. Wang, H. Zheng, Y. Liu, et al., Phys. Rev. B **111**, 094409 (2025).
[4] D. Hunter, W. Osborn, K. Wang, N. Kazantseva, et al., Nat. Commun. **2**, 518 (2011).

Abstract ID: 406

MAGNETIC NANOPARTICLE ASSISTED MAGNETOIMPEDANCE BIOSENSOR FOR GLUCOSE DETECTION

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Abstract: There is a significant demand for magnetic sensors in the biomedical field for patient diagnosis. The diagnostic reports should be accurate and require less time, making them highly desirable. The Magnetoimpedance (MI) is the absolute change in electrical impedance of the soft ferromagnetic material when it is subjected to a uniform DC magnetic field [1]. Magnetic iron oxide (Fe_3O_4) particles have been extensively employed in diagnostic applications and biosensing platforms [2]. In the present work, Fe_3O_4 magnetic nanoparticles were drop-cast onto the surface of a 2 cm long $Co_{77}Si_5Cu_1Nb_2B_{15}$ melt-spun ribbon, and glucose oxidase (GOx) was immobilised on top of these magnetic nanoparticles to facilitate glucose sensing. Later, the ribbons were exposed to 1 mM, 5 mM, and 10 mM glucose concentrations. The MI measurements were carried out using an IM 3536 LCR meter with an AC of 10 mA at a frequency of 5 MHz. A DC magnetic field ranging from −100 Oe to 100 Oe was applied using a Helmholtz coil. An MI ratio of 15% was observed for the as-quenched ribbon. The MI increased to 19% after drop-casting Fe_3O_4 particles on the ribbon, indicating an enhancement in the surface magnetic response of the ribbons.
Figure 1 shows the MI curves of the as-quenched ribbon, Fe_3O_4 drop-cast ribbon, and Fe_3O_4 drop-cast ribbons exposed to different concentrations of glucose. An increased MI response of 20%, 22%, and 23% was observed for the ribbons exposed to 1 mM, 5 mM, and 10 mM glucose concentrations, respectively.

Keywords: Biosensors, magnetic nanoparticles, magnetoimpedance, enzyme.

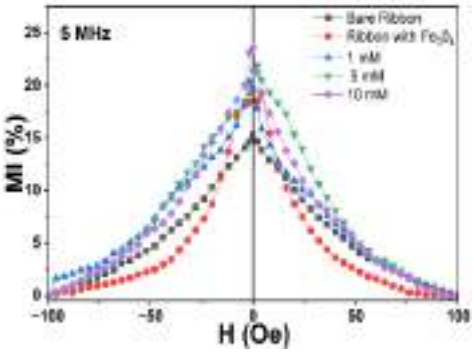


Fig. 1: MI curves of the as-quenched ribbon, Fe_3O_4 drop-cast ribbon, and Fe_3O_4 drop-cast ribbons exposed to 1 mM, 5 mM, and 10 mM concentrations of glucose.

References:

[1] L.V. Panina, K. Mohri, Appl. Phys. Lett. 65 (1994) 1189-1191.
[2] S. E. Kim, M. V. Tieu, S. Y. Hwang, and M.-H. Lee, Micromachines. 11 (2020) 302.

Abstract ID: 407

OBSERVATION OF RAMAN ANOMALY IN vdW FERROMAGNET Fe_5GeTe_2

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Abstract: Two-dimensional (2D) van der Waals (vdW) ferromagnet Fe_5GeTe_2 has garnered significant interest due to its high Curie temperature (T_C), large saturation magnetization, and complex magnetic behavior arising, in part, from multiple inequivalent iron sites and vacancies. While several aspects of its complex magnetic and structural characteristics have been examined through careful experiments and first principles studies, much of it remains debatable. In this study, we investigated the intricate structural and magnetic properties of bulk Fe_5GeTe_2 crystal through X-ray diffraction, Raman spectroscopy, and various magnetization measurements. Interestingly, our Raman study reveals a hitherto unknown anomaly at 150 K but surprisingly does not show any pronounced signature of the anomalous lattice expansion around 110 K initially observed in neutron diffraction studies [1]. Moreover, while the magnetization (M) versus temperature (T) curve shows a distinct feature around 110 K suggesting a coupling between the structural and magnetic degrees of freedom, the Raman peak shift anomaly at 150 K leaves no distinct signature in the M(T) curve. We rationalize these observations in the light of thermal stability and charge transport measurements.These findings will prove crucial for the use of Fe_5GeTe_2 in high-performance spintronic devices.

Keywords: 2D ferromagnetism, vdW magnets, magnetic anomalies, Raman spectroscopy

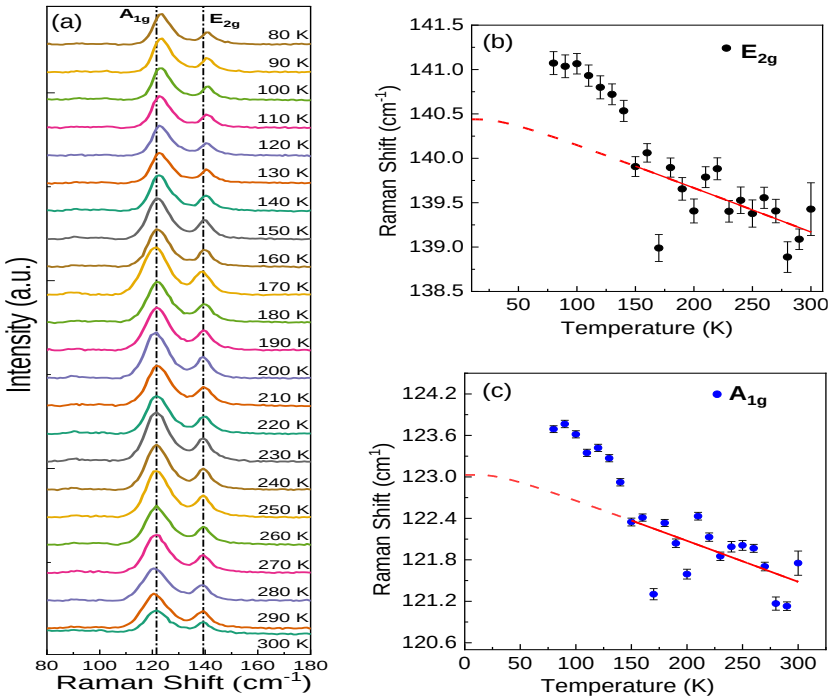


Fig. 1: Temperature-dependent Raman spectroscopy of bulk Fe_5GeTe_2 crystal.

References:

[1] May A F, Ovchinnikov D, Zheng Q, Hermann R, Calder S, Huang B, Fei Z, Liu Y, Xu X, McGuire M A, ACS nano 13 (2019) 4436–4442.

Abstract ID: 408

STRUCTURAL, MAGNETIC AND THERMOELECTRIC PROPERTIES OF Al-Cu-Fe QUASICRYSTAL MECHANICALLY MILLED AT VARIOUS CONCENTRATION OF CARBON NANOTUBE (CNT)

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Abstract: In the present work, mechanically milled Carbon nanotube (CNT) and Al-Cu-Fe icosahedral quasicrystal (IQC) nanocomposites with 1 and 2 Wt% of CNT (named as IQC, IQC-1CNT and IQC-2CNT) were synthesized using a mechanical milling approach to examine the effect of CNT incorporation on structural, magnetic, and transport behaviour. Structural characterization confirms the preservation of the quasicrystalline phase after CNT addition, demonstrating the phase stability of the IQC matrix. Microstructural analysis reveals grain size reduction and strengthened interfacial bonding between the CNTs and the quasicrystal matrix. Magnetic investigations reveal soft ferromagnetic behaviour in all samples, accompanied by a distinct bifurcation between zero-field-cooled (ZFC) and field cooled (FC) magnetization curves, indicating spin glass-like behaviour at lower temperatures. This behaviour is further confirmed by the observed shift in freezing temperature in AC susceptibility measurements. An increase in saturation magnetization (1.6 emu/g at 2 K for IQC-2CNT) and magnetic anisotropy (15 $\times 10^3$ erg/g at 2 K for IQC-2CNT) with increasing CNT concentration is attributed to enhanced spin disorder and strengthened interfacial exchange coupling, which is supported by the increased line-width observed in electron paramagnetic resonance (EPR) spectra. Although CNT incorporation improves the electrical-to-thermal conductivity ratio (σ/κ), the obtained values remain lower than that of the IQC sample, which may limit thermoelectric optimization. This study provides valuable insights into tailoring the magnetic and transport properties of quasicrystal based nanocomposites through nanoscale filler, which may enable their potential utilization in advanced energy conversion systems, magnetic sensing technologies, and multifunctional electronic devices. The interplay between structural anisotropy, filler type, and concentration critically governs the coupled thermoelectric and magnetic behavior of IQCs. The results confirm that magnetic anisotropy plays an important role in determining thermoelectric efficiency, particularly in quasicrystalline systems where electron–phonon and spin interactions are strongly interlinked.

References:

[1] Shadangi, Y., Bhatt, S., Pradhan, P., Tiwari, A., Tripathi, A., Chattopadhyay, K. and Mukhopadhyay, N.K., 2023. *Journal of Alloys and Compounds*, *960*, p.170586.

[2] Krifa, M., Mhadhbi, M., Escoda, L., Saurina, J., Suñol, J.J., Llorca-Isern, N., Artieda-Guzmán, C. and Khitouni, M., 2013. *Powder technology*, *246*, pp.117-124.

[3] Bhatt, S., Sherpa, P.C., Shadangi, Y., Tiwari, R.S., Mukhopadhyay, N.K., Tripathi, A. and Tiwari, A., 2025. *Journal of Alloys and Compounds*, p.183961.

Abstract ID: 409

RARE-EARTH (Nd^{3+}) INDUCED TUNING OF STRUCTURAL, MAGNETIC AND DIELECTRIC PROPERTIES IN $MgFe_2O_4$ SPINEL FERRITES THROUGH MICROWAVE HYDROTHERMAL APPROACH

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Abstract: The $MgFe_{2-z}Nd_zO_4$ (z = 0.0 - 0.10) nanoparticles were prepared using the microwave hydrothermal method at 200ºC/60 min. The Rietveld refinement of all the diffraction patterns confirms the cubic phase with space group Fd-3m. The lattice constant (a) decreased from 8.375 Å (z = 0.0) to 8.343Å (z = 0.08) and then increased to 8.359 Å for z = 0.10. The average grain size is increased with Nd doping from 116 nm (z = 0.0) to 460 nm (z = 0.10). The vibrational bands of octahedral and tetrahedral were observed at frequencies of 416 – 430 cm^{-1} and 625 – 637 cm^{-1}. The UV-Vis spectra showed absorption bands at ~470 nm and ~650 nm corresponding to tetrahedral and octahedral transitions in the spinel structure. The calculated optical band varied from 2.40 to 2.71 eV (tetrahedral) and 1.84 to 1.99 eV (octahedral), indicating that Nd doping influences the optical properties. In X-ray photoelectron spectra (XPS), the Nd $3d_{5/2}$ peaks at 986.41 eV & 990.26 eV, providing evidence for the existence of Nd^{3+} within the $MgFe_2O_4$ crystal structure. The saturation magnetization (M_s) value varied nonlinearly with doping. The coercivity (H_c) increased from 1.95 Oe (z = 0.0) to 41.44 Oe (z = 0.10). The values of ε' exhibited an increase with the addition of Nd. The value of ε' for z = 0.02 is 30.03, and it subsequently rose to 35.29 for z = 0.10. The dielectric loss (tanδ) is 4.42 for z = 0.02 and significantly higher at 6.07 for z = 0.10. Thus, Nd^{3+} doping effectively tunes the material properties, making it a promising candidate for advanced optical and electronic applications.

Keywords: Magnesium ferrite, Microwave-Hydrothermal, Rietveld refinement, XPS, Magnetic and Dielectric properties.

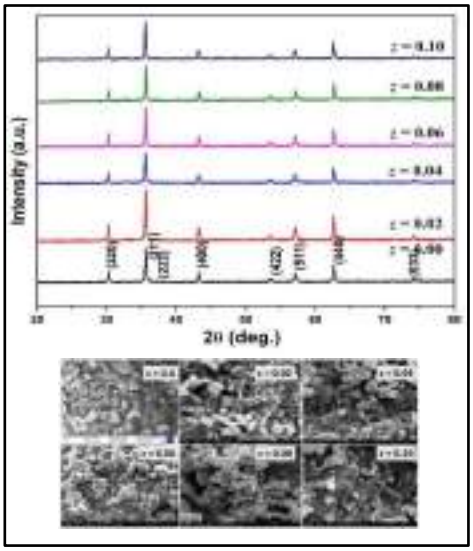


Fig. 1: XRD patterns of $MgFe_{2-z}Nd_zO_4$ (z = 0.0 - 0.10) nanoparticles synthesized via the microwave-assisted hydrothermal method. The Inset shows the FESEM images of the samples.

Abstract ID: 410

SPATIAL SELF PHASE MODULATION IN COBALT FERRITE AND NICKEL FERRITE

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Abstract: Magnetic ferrite nanoparticles have attracted considerable interest due to their unique combination of magnetic and optical properties, which make them promising candidates for nonlinear optical applications. In the present work, the nonlinear optical behavior of cobalt ferrite ($CoFe_2O_4$) and nickel ferrite ($NiFe_2O_4$) nanoparticles has been investigated through spatial self-phase modulation (SSPM) studies. When a continuous wave laser beam was propagated through the nanoparticle suspensions, distinct diffraction ring patterns were observed, indicating the occurrence of spatial self-phase modulation arising from intensity-dependent refractive index changes in the medium [1, 2]. The number of diffraction rings and their evolution with incident laser intensity were analyzed to evaluate the nonlinear refractive index, thermo-optic coefficient and third-order nonlinear susceptibility of the samples. A comparative analysis of $CoFe_2O_4$and $NiFe_2O_4$ nanoparticles reveals differences in their nonlinear optical responses, which can be attributed to variations in their magnetic properties, particle size, and electronic structure. The results demonstrate that ferrite nanoparticles exhibit significant nonlinear optical behavior, highlighting their potential for applications in optical limiting, optical modulators, photonic devices, and nonlinear optical materials.

Keywords: Ferrites, Nanoparticles, Spatial Self Phase Modulation, Cobalt, Nickel.

References:

[1] Karimzadeh, Rouhollah, Journal of optics 14.9 (2012) 095701.

[2] Wu, Leiming, Xixi Yuan, Dingtao Ma, Ye Zhang, Weichun Huang, Yanqi Ge, Yufeng Song, Yuanjiang Xiang, Jianqing Li, and Han Zhang, Small 16, no. 35 (2020) 2002252.

Abstract ID: 411

CONTROLLING THE IRREVERSIBILITY OF THE MARTENSITE-AUSTENITE PHASE TRANSITION IN THE $Ni_{47}Mn_{40}Sn_{12}Cu_1$ HEUSLER ALLOY: DIRECT MEASUREMENTS IN CYCLIC MAGNETIC FIELDS AND FIRST-PRINCIPLES CALCULATIONS

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Abstract: The potential for using the giant inverse magnetocaloric effect (GIMCE) in Heusler alloys for magnetic refrigeration has received considerable attention. However, its practical application is hampered by hysteresis, irreversibility, and, especially, degradation of the effect under cyclically applied magnetic fields. In this study, we propose managing the irreversibility of the martensite-austenite magnetostructural phase transition rather than combating it. Specifically, we conduct a comprehensive study of the dynamics of the irreversible phase transition in the $Ni_{47}Mn_{40}Sn_{12}Cu_1$ alloy using direct measurements of the adiabatic temperature change (ΔT_{ad}) in cyclic fields up to 8 T, in-situ XRD analysis, and theoretical DFT and Monte Carlo calculations. It was found that the irreversibility of the phase transition provides an additional contribution to the GIMCE, increasing the overall effect by up to 35%. A critical dependence of the magnitude and sign of ΔT_{ad} on the field change rate and thermal history was revealed, which is related to the kinetics of nucleation and growth. Rapid cooling is shown to lead to kinetic arrest and the formation of a mixed two-phase state with similar proportions of martensite and austenite, in which the direct and inverse MCE compensate each other, explaining the "collapse" of the GIMCE. Our results demonstrate a new approach to enhancing and stabilizing the GIMCE through the controlled use of irreversibility and optimization of the operating cycle kinetics. This opens the way to the controlled synthesis of magnetic materials and protocols for high-performance magnetic refrigerators.
The study was supported by the Russian Science Foundation, grant No. 25-12-20024.

Keywords: Heusler alloy, magnetocaloric effect, cyclic magnetic fields, adiabatic temperature change, phase transition.

Abstract ID: 412

INTERFACIAL SPIN COUPLING DRIVEN NEGATIVE MAGNETIZATION AND CANTED ANTIFERROMAGNETISM IN *$LaNiO_3$* NANOPARTICLES

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Abstract: Rare-earth nickelates $RNiO_3$ (R=Pr–Lu) have attracted considerable attention due to their intriguing electronic and magnetic properties arising from the high Ni^{3+} oxidation state and bandwidth-controlled metal–insulator transition coupled with antiferromagnetic ordering. Among them, bulk $LaNiO_3$ possesses paramagnetic metal down to low temperatures, primarily due to the large ionic radius of La^{2+} and the nearly 180˚ *Ni–O–Ni* bond angles that support strong electronic bandwidth [1]. However, nanoscale confinement can significantly modify lattice distortions and magnetic interactions, leading to emergent magnetic phenomena. In the present study, temperature-dependent magnetization measurements of $LaNiO_3$ nanoparticles reveal an unusual magnetization reversal in the zero-field-cooled (ZFC) curve. It possesses negative magnetization at low temperatures and becomes positive near ~42K under an applied field of 100Oe. Conversely, the field-cooled magnetization remains positive throughout the measured temperature range but shows a pronounced bifurcation from the ZFC curve below ~70K, indicating magnetic irreversibility and the formation of a frozen magnetic state. The negative magnetization observed in the ZFC curve is attributed to nanoscale distortions of the Ni–O–Ni bond angles that induce canted antiferromagnetic spin configurations together with surface spin disorder. During zero-field cooling, these canted moments become pinned and align opposite to the applied magnetic field, resulting in negative magnetization. Magnetization–field measurements at 5K exhibit weak hysteresis with small coercivity, consistent with canted antiferromagnetic behavior and possible surface-induced exchange interactions [2]. These results highlight the crucial role of nanoscale structural distortions and competing magnetic interactions in governing the emergent magnetic properties of $LaNiO_3$ nanoparticles.

Keywords: $LaNiO_3$, negative magnetization, antiferromagnetic, ZFC, exchange interactions.

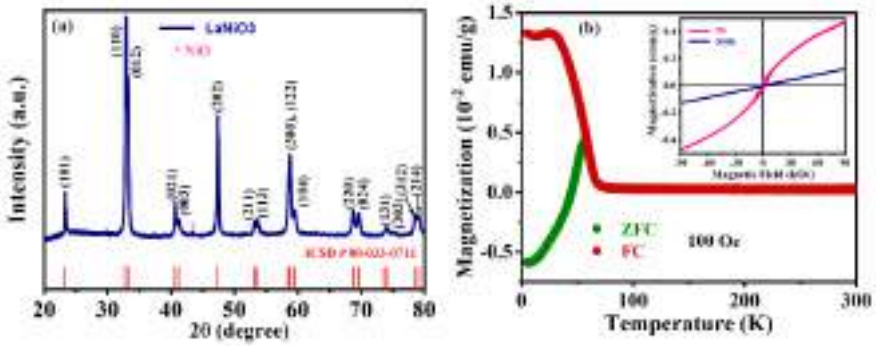


Fig. 1: (a) XRD pattern, and **(b)** Temperature dependent Magnetization curve obtained at 100 Oe magnetic field; **inset:** Magnetic hysteresis loop obtained at 5K and 300K.

Reference:

[1] H. Guo, Z.W. Li, L. Zhao, Z. Hu, C.F. Chang, C.-Y. Kuo, W. Schmidt, A. Piovano, T.W. Pi, O. Sobolev, Nat. Commun. 9 (2018) 43.

[2] A.A. Shah, S. Ahmad, A. Azam, J. Magn. Magn. Mater. 494 (2020) 165812.

Abstract ID: 413

DIRECT MEASUREMENTS OF ADIABATIC TEMPERATURE CHANGE IN $La_{0.8}Pr_{0.2}Fe_{13.7}Si_{1.3}$-$H_\delta$ ALLOYS IN CYCLIC MAGNETIC FIELDS UP TO 8 T

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Abstract: We present a study of the effect of low-frequency cyclic magnetic field with amplitude up to 8 T on the magnetic, magnetocaloric and thermophysical properties of the $La_{0.8}Pr_{0.2}Fe_{13.7}Si_{1.3}$-$H_\delta$ alloys [1]. Direct measurements of the adiabatic temperature change ΔT_{ad} were performed in cyclic magnetic fields. The specific heat and thermal diffusivity were measured in magnetic fields of 0, 0.62 and 1.8 T in the vicinity of Curie temperature T_C. An anomalous peak and satellite anomalies temperature dependence of the specific heat in a magnetic field are observed in a close vicinity of T_C. These anomalies are the result of sample degradation in cyclic magnetic field during corresponding ΔT_{ad} measurements. We interpret this as a consequence of a multiphase state (magnetic phase separation) with spatially distributed critical temperatures caused by a cyclic magnetic field. Long-term exposure to a 1.8 T cyclic magnetic field at a frequency of 0.2 Hz leads to a slight decrease in ΔT_{ad} of 0.13 and 0.57 K for $La_{0.8}Pr_{0.2}Fe_{13.7}Si_{1.3}$ and $La_{0.8}Pr_{0.2}Fe_{13.7}Si_{1.3}H_\delta$, respectively, followed by a stabilization of the effect. In a magnetic field of 8 T, ΔT_{ad} shows good stability up to 1000 cycles. The maximum value of ΔT_{ad} reaches 12.7 and 10.9 K at magnetic field value H=8 T for $La_{0.8}Pr_{0.2}Fe_{13.7}Si_{1.3}$ and $La_{0.8}Pr_{0.2}Fe_{13.7}Si_{1.3}H_\delta$, respectively. In contrast to the case of small magnetic fields, the value of ΔT_{ad} for both samples exhibits the temporal stability in strong cyclic magnetic fields with amplitude 8 T.
The study was supported by the Russian Science Foundation, grant No. 24-43-00156.

Keywords: Magnetocaloric effect, specific heat, cyclic magnetic fields, adiabatic temperature change, phase transition.

References:

[1] A. Gamzatov, N. Abdulkadirova, P. Igoshev, et.al., J. Alloys Compd. 1040 (2025) 183453.

Abstract ID: 414

MULTIPLE MAGNETIC TRANSITIONS IN A Gd–Fe–Sb ALLOY FOR CYCLIC MAGNETOCALORIC APPLICATIONS

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Abstract: Magnetic refrigeration is emerging as an eco-friendly alternative to conventional gas-compression refrigeration. Materials exhibiting multiple magnetic transitions over a wide temperature range are attractive for cyclic magnetocaloric applications. In this work, a Gd–Fe–Sb based polycrystalline alloy was synthesized using the arc melting technique, and its structural and magnetic properties were investigated. X-ray diffraction analysis and Rietveld refinement reveal Gd_5Sb_3 as the predominant phase with a hexagonal crystal structure ($P6_3/mcm$), along with minor secondary phases of Gd (hcp, $P6_3/mmc$) and $GdFe_2$ (Laves phase, Fd-3m). The multiphase nature of the sample is further confirmed by EDS-BSE imaging. Temperature-dependent magnetization measurements indicate multiple magnetic transitions, including a paramagnetic-ferromagnetic transition at $T_1 = 294$ K, followed by a ferrimagnetic transition at $T_2 = 109$ K. The presence of multiple transitions is expected to produce a table-like magnetocaloric effect over a wider operating temperature range. Further studies under cyclic magnetic fields will help evaluate the efficiency of this material for practical magnetic refrigeration applications.

Keywords: Magnetocaloric effect, Ferrimagnetism, Ferromagnetism, Cyclic magnetic Field, Magnetic refrigeration.

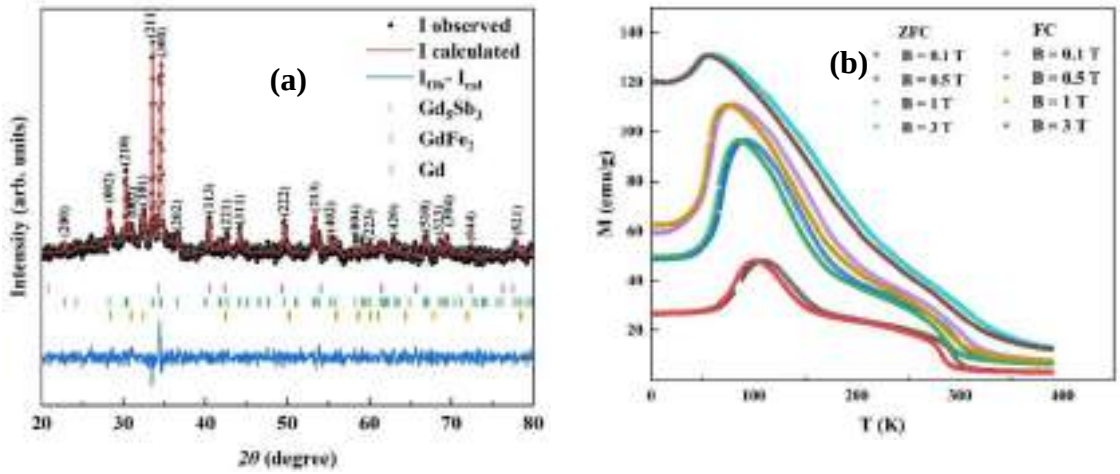


Fig. 1: (a) Rietveld refinement XRD pattern and (b) Temperature-dependent magnetization measurements for B = 0.1 T, 0.5 T, 1 T and 3 T.

Abstract ID: 415

ANISOTROPIC METAMAGNETISM AND COMPLEX EXCHANGE INTERACTIONS IN SINGLE CRYSTALLINE $Gd_2Pt_3In_6$

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Abstract: We present the study of magnetic properties of single-crystalline $Gd_2Pt_3In_6$, crystallizing in a $La_2Zn_3Ge_6$-type, orthorhombic structure (space group *Pmcm*). The existence of two crystallographically inequivalent sites for Gd in the crystal structure provides a unique platform for studying complex magnetic interactions involving magnetic ions at different environments. The compound orders antiferromagnetically around 14 K and the magnetization data reveal significant magnetocrystalline anisotropy, with the easy axis of magnetization being close to the *c* axis. For H∥*c*, a sharp field-induced metamagnetic transition occurs at 40 kOe in the magnetization data. Curiously, for H⊥*c*, this feature is suppressed and a change in slope emerges accompanied by a weak reversible hysteresis loop. No tendency of magnetic saturation observed in the magnetization data up to 140 kOe confirming the presence of robust antiferromagnetic exchange interactions in this system.

Keywords: Magnetic anisotropy, single crystals, metamagnetic transitions.

Abstract ID: 416

BIO-DERIVED MAGNETIC-DIELECTRIC HYBRID VITRIMER NANOCOMPOSITES FOR EFFICIENT X-BAND WAVE ATTENUATION

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Abstract: Incorporating magnetic particles together with dielectric fillers is an effective approach to significantly enhance electromagnetic wave (EMW) absorption by enabling simultaneous dielectric and magnetic loss mechanisms [1]. In this work, a sustainable vitrimeric EMW-absorbing composite is developed using a bio-derived matrix, reinforced with graphene oxide (GO), carbon nanotubes (CNTs), and magnetic cobalt ferrite ($CoFe_2O_4$) particles. The inclusion of $CoFe_2O_4$ introduces magnetic loss characteristics, while GO and CNTs contribute to dielectric behavior and impedance matching. The composite exhibits a well-organized sea-island morphology in which GO promotes interlayer spacing and uniform dispersion of fillers. Moreover, the morphological difference between the one-dimensional CNTs and $CoFe_2O_4$ facilitates efficient intercalation within the matrix and reduces agglomeration. The conductive three-dimensional CNT network enhances electromagnetic wave propagation within the material, increasing internal reflections and interfacial polarization. In addition to dielectric losses, the magnetic $CoFe_2O_4$ particles contribute to attenuation via eddy-current losses and magnetic resonance mechanisms, thereby improving EMW dissipation. As a result, the optimized composite achieves a minimum reflection loss of −20 dB at a thickness of 2.7 mm in the X-band with relatively low filler loading. Furthermore, the vitrimeric matrix enables rapid self-healing, allowing complete surface crack recovery within 7 minutes under microwave irradiation via a dynamic trans-esterification mechanism. The presence of hydrolysable ester linkages also allows rapid degradation of the polymer backbone in alkaline and alcoholic-alkaline environments, supporting sustainability. Overall, this study presents a sustainable strategy for designing efficient EMW absorbers by integrating a bio-derived vitrimer matrix with synergistic magnetic-dielectric filler architecture.

Keywords: Magnetic-Dielectric composites, X-band absorption, Bio-epoxy vitrimer, Self-healing.

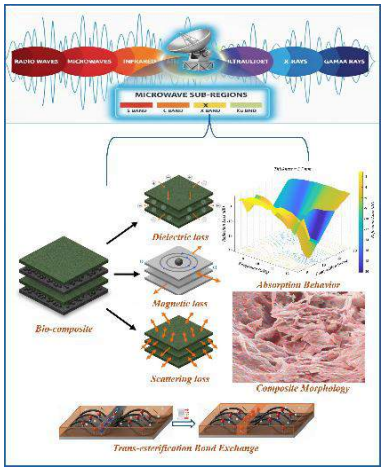


Fig. 1: Magnetic-Dielectric synergistic EMW absorbing composites.

References:

[1] R. Che, L. M. Peng, X. Duan, Q. Chen, X. Liang, Adv. Mater. 2004, 16, 401.

Abstract ID: 417

ANOMALOUS MAGNETO-DIELECTRIC RESPONSE DUE TO OFF-STOICHIOMETRY IN A GEOMETRICALLY FRUSTRATED SYSTEM

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Sudhindra Rayaprol[3], Kalobaran Maiti[1,4*]

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Abstract: Study of the structural and magnetic properties of the compounds belonging to the family $(Sr, Ca)_3MXO_6$ (M and X represent magnetic or non-magnetic metallic ions) have drawn a lot of attention in the recent literatures due to their anisotropic magnetic properties arising from geometrical frustration involving inter-chain and intra-chain interactions. In this work, we present the comparative study of the magnetodielectric properties of oxygen-annealed stoichiometric and off-stoichiometric compositions of Ca_3CuMnO_6, to understand how disorder influences polarization processes in this class of quasi-one-dimensional spin-chain oxides. At low temperatures (~2.5–100 K), the dielectric response of the stoichiometric sample remains nearly unchanged with temperature and frequency suggesting strongly localized charge carriers and the suppression of dipolar or interfacial polarization processes, thereby reflecting the intrinsic dielectric background of the system. In contrast, the off-stoichiometric compound exhibits larger dielectric values along with a broad relaxation feature in the 120–200 K region, which provides clear evidence of thermally activated charge carrier hopping associated with structural disorder. There are additional features seen in the dielectric properties at higher temperatures (~330 K) in both the samples, the origin of which are still unknown. Magnetodielectric measurements further show a more systematic and well-defined field response in the stoichiometric sample, whereas the off-stoichiometric system is largely dominated by disorder-induced charge dynamics.

Keywords: Ca_3CuMnO_6, Geometrical Frustration, Quasi One Dimensional, Magnetodieletric, Spin Chain Oxides.

References:

[1] S. Rayaprol, S.D. Kaushik, K.K. Iyer, E.V. Sampathkumaran, Solid State Communications.223(2015) 67-73.
[2] T. Basu, K. K. Iyer, P. L. Paulose and E. V. Sampathkumaran, J. Phys.: Condens. Matter 28, 166001 (2016).
[3] Upadhyay, S. K., Sampathkumaran, E. V., Rayaprol, S., and Hoser, A., Materials Research Express, 6, 036107 (2019).

Abstract ID: 418

MAGNETIC AND THERMAL PROPERTIES OF SINGLE CRYSTALLINE Ce_2NiGa_{12}

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Abstract: We present the study of magnetic and thermal properties of single crystalline Ce_2NiGa_{12} crystallizing in a layered tetragonal structure (space group P4/nbm). The Ce atoms occupy unique crystallographic position at Wyckoff site 4*g* in the crystal structure, resulting in square lattice arrangement of Ce atoms, making this compound interesting to probe the magnetic properties. Magnetic susceptibility shows a sharp peak around 10 K in the c || H orientation with an additional subtle feature around 5.5 K. The magnetization data for c⊥H orientation is complex with suppressed susceptibility indicating strong magneto-crystalline anisotropy. A huge field induced metamagnetic transition is seen in the c || H orientation around 35 kOe with an additional step around 40 kOe along with a small hysteresis at the step. These features get suppressed in the magnetization data for c⊥H orientation with a weak change of slope around 35 kOe. These results suggest c axis as the easy axis of magnetization. Heat capacity data measured in the c || H orientation reveals presence of both the magnetic features and these features shift to lower temperatures with increasing magnetic field, which is a signature of antiferromagnetic interactions. Interestingly, the low temperature feature becomes dominant at higher field. The magnetization data do not show tendency to saturate even for an applied magnetic field of 70 kOe as expected for the antiferromagnetic interactions.

Keywords: Single Crystals, Magnetic anisotropy, magnetization, heat capacity, magnetic interactions.

Abstract ID: 419

MULTIFUNCTIONAL MAGNETIC AND TRANSPORT PROPERTIES IN e/a = 8.105 DESIGNED $NiCoMnSn_{1-x}Si_x$ HEUSLER ALLOYS

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Abstract: Ni–Mn based Heusler alloys exhibit strong magnetostructural coupling, resulting in multifunctional properties such as magnetocaloric effect, magnetoresistance, exchange bias, and magnetic shape memory behavior [1, 2]. In the present work, a series of $NiCoMnSn_{1-x}Si_x$ (x = 0, 0.5, 1 and 1.5 at.%) full-Heusler-type magnetic shape memory alloys were designed with a fixed valence electron concentration (e/a) of 8.105 to systematically investigate the influence of Si substitution on their functional behavior. The alloys were prepared by arc melting followed by homogenization annealing to ensure chemical uniformity. Structural characterization using room-temperature and temperature-dependent X-ray diffraction enables clear identification of the crystal structures corresponding to the martensitic and austenitic phases, while differential scanning calorimetry reveals a systematic decrease in the martensitic transformation temperature with increasing Si concentration. Magnetization measurements reveal a first-order magnetostructural transition with a noticeable magnetocaloric response near the martensitic transformation, tuned toward room temperature through Si substitution. Consistent thermodynamic signatures of the phase transition are also observed in the specific heat measurements. Magnetoresistance studies near the martensitic transformation temperature, highlighting the sensitivity of electron scattering to coupled structural and magnetic changes. Microstructural observations show characteristic martensitic twin variants whose distribution evolves with Si substitution. The emergence of exchange bias at low temperatures suggests underlying magnetic inhomogeneity in the system, further contributing to the multifunctional behavior of the alloys. These results demonstrate that compositional tuning at constant e/a effectively tailors the multifunctional properties of NiCoMnSn-based Heusler alloys for magnetic refrigeration and related applications [3].

Keywords: Ni–Mn Heusler alloys; Magnetocaloric effect; Magnetoresistance; Martensitic transformation; Martensitic twins; Exchange bias.

References:

[1] T. Krenke, E. Duman, M. Acet, E.F. Wassermann, X. Moya, L. Mañosa, A. Planes, Nat. Mater. 4 (2005) 450–454.
[2] L. Mañosa, A. Planes, M. Acet, J. Mater. Chem. A 1 (2013) 4925–4936.
[3] V.K. Pecharsky, K.A. Gschneidner Jr., Phys. Rev. Lett. 78 (1997) 4494–4497.

Abstract ID: 420

$ZnFe_2O_4$ ANCHORED ON ZnO NANOROD HETEROSTRUCTURE FOR VISIBLE LIGHT PHOTOCATALYTIC DEGRADATION OF ORGANIC POLLUTANTS

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Abstract: A $ZnFe_2O_4$ anchored on ZnO nanorod heterostructure was synthesized through a one pot hydrothermal method using annealed $ZnFe_2O_4$ (750°C) as the precursor. $ZnFe_2O_4$/ZnO heterostructures have attracted significant attention due to their improved photocatalytic performance arising from enhanced interfacial charge separation and reduced electron–hole recombination [1]. X-ray diffraction (XRD) analysis predominantly revealed the characteristic diffraction peaks of cubic spinel $ZnFe_2O_4$. The average crystallite size calculated using the Scherrer equation was ~16 nm. Fourier transform infrared spectroscopy (FTIR) confirmed the characteristic metal–oxygen vibrational bands corresponding to $ZnFe_2O_4$ and ZnO. UV–visible spectroscopy was used to examine the optical absorption behaviour of the heterostructure. High-resolution transmission electron microscopy (HR-TEM) images showed $ZnFe_2O_4$ nanoparticles anchored onto ZnO nanorods, confirming the formation of the heterostructured system. Magnetic measurements performed using vibrating sample magnetometry revealed a saturation magnetization (M_s) of 3.6 emu g^{-1}, coercivity (H_c) of 0.046 kOe, and remanent magnetization (M_r) of 1.14 × 10^{-2} emu g^{-1}, indicating the soft magnetic characteristics. The photocatalytic activity of the synthesized heterostructure was evaluated for the degradation of Rhodamine B dye under visible light irradiation, achieving 50.19 % degradation for high concentrated 15 ppm dye solution. The enhanced photocatalytic activity can be attributed to the synergistic interaction between $ZnFe_2O_4$ and ZnO in the heterostructure, which facilitates efficient charge carrier transfer and suppresses recombination of photo-generated electrons and holes [2]. These results demonstrate that the synthesized $ZnFe_2O_4$ anchored on ZnO nanorod heterostructure is a promising photocatalyst for environmental remediation, with the added advantage of magnetic recoverability and reusability.

Keywords: $ZnFe_2O_4$/ ZnO, Heterostructure, Rhodamine B, Magnetic recoverability, Reusability.

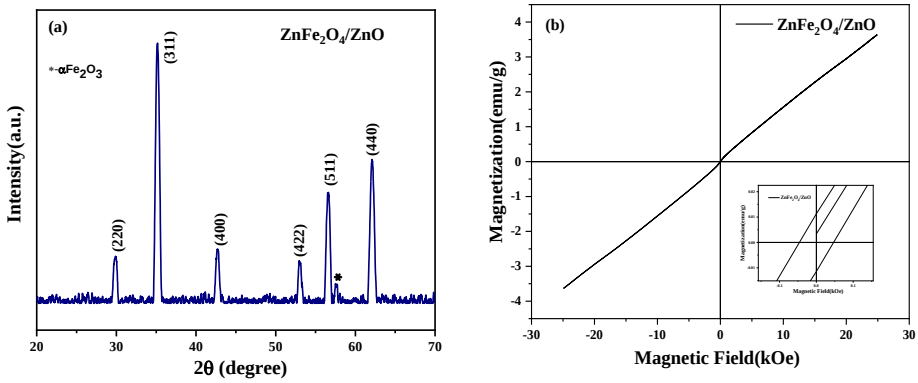


Fig. 1: (a) XRD patterns and (b) M-H hysteresis loops of $ZnFe_2O_4$/ ZnO heterostructure.

References:

[1] Choudhary, S., Hasina, D., Saini, M., Ranjan, M., J. Alloys Compd. 884 (2021) 161067.
[2] Hu, P., Chen, C., Song, J., & Tang, Z., Mater. Sci. Semicond. Process. 81 (2018) 31–39.

Abstract ID: 421

TUNING MAGNETOCALORIC PROPERTIES OF (1-*x*)$La_{0.67}Sr_{0.33}MnO_3$+(*x*)$Nd_{0.67}Sr_{0.33}MnO_3$ MANGANITE COMPOSITES FOR MAGNETIC REFRIGERATION APPLICATIONS

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Abstract: Perovskite manganite composites are considered promising candidates for magnetic refrigeration (MR) applications due to their outstanding magnetocaloric properties [1]. This study examines the structural, microstructural, magnetic, and magnetocaloric properties of (1-*x*)$La_{0.67}Sr_{0.33}MnO_3$(LSMO)+(*x*)$Nd_{0.67}Sr_{0.33}MnO_3$(NSMO) composites. Initially, the parent compounds LSMO and NSMO were synthesized individually via the sol-gel method and subsequently mixed in appropriate molar ratios (*x* = 0.25, 0.5, 0.75) using the solid state route. Room temperature X-ray diffraction study along with Rietveld refinement confirms the absence of detectable impurities in the prepared samples. LSMO crystallized in a rhombohedral structure with $R\bar{3}c$ space group, whereas the NSMO crystallized in orthorhombic structure with the *Pnma* space group. Temperature-dependent magnetization studies reveal a transition from ferromagnetic to paramagnetic states, with Curie temperatures approximately at 359 K for LSMO and around 252 K for NSMO. The composite samples exhibit transition temperatures lying between those of the parent compounds. Analysis of magnetization versus applied field reveals that coercivity is increasing with *x*. A broadening of the maximum magnetic entropy change (ΔS_{max}) is found for composites. The Relative Cooling Power (RCP) and ΔS_{max} values are increasing with an increase in the external magnetic field. The maximum value of RCP and ΔS_{max} are 469 J/kg and 2.47 J/kgK at 7 T observed for *x* = 0.25 composite, indicating its potential usability for magnetic refrigeration applications [2].

Key words: Magnetic refrigeration, Magnetic entropy, Relative cooling power, Magnetocaloric effect.

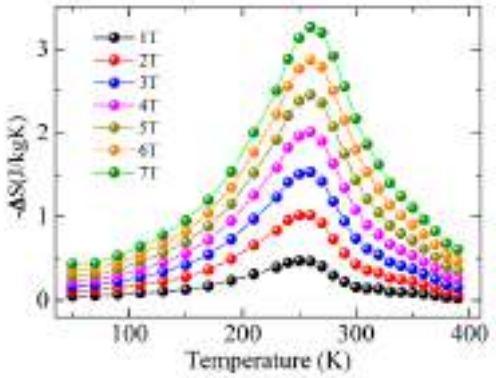


Fig. 1: Magnetic entropy change versus temperature graph at different external magnetic fields for *x* = 0.75 composite.

References:

[1] M. H. Phan, S. C. Yu, J. Magnetism and Magnetic Materials. 308 (2007) 325-340.
[2] M. Jeddi, H. Garsaallah, M. Bekri, E. Dhahri, E.K. Hlil, RSC Advances. 50 (2018) 28649-28659.

Abstract ID: 422

INDIRECT EXCHANGE INTERACTION MEDIATED MAGNETIC ORDERING AND ENTROPY CHANGE IN LAVES PHASE $Ho_{0.35}Nd_{0.54}Co_2$

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Abstract: Magnetocaloric materials are studied for low temperature cooling applications. The magnetic entropy change depends on the type of magnetic transition and exchange interactions present in the material. In this work, polycrystalline $Ho_{0.35}Nd_{0.54}Co_2$ alloy was prepared by arc melting method under an argon atmosphere. The alloy crystallizes in $MgCu_2$-type cubic Laves phase. It shows two magnetic transitions at T_1 = 97 K and T_2 = 20 K, corresponding to paramagnetic to ferromagnetic and ferromagnetic to ferrimagnetic transitions respectively. Isothermal magnetization and heat capacity measurements were carried out to understand the nature of these transitions. The alloy exhibits two peaks in magnetic entropy change ($-\Delta S_M$) at 20.5 K and 95.5 K with values 3.03 J kg^{-1} K^{-1} and 3.12 J kg^{-1} K^{-1}, respectively, for a magnetic field change of 5 T. The heat capacity curve shows a sharp peak at 97 K, and its strong field dependence indicates the influence of indirect Ruderman–Kittel–Kasuya–Yosida (RKKY) type exchange interaction leading to long range magnetic ordering. A spin-flop transition is also observed between 213 K and 273 K. This feature shifts towards lower temperatures with increasing field, suggesting the presence of short-range antiferromagnetic clusters in the paramagnetic region. As the material exhibits magnetocaloric behaviour in the low temperature region, this can be used for low temperature cooling systems like nitrogen liquefaction and other systems that require a pre-cooling stage.

Keywords: Magnetocaloric effect, rare earth, Cubic Laves phase, spin-flop transition

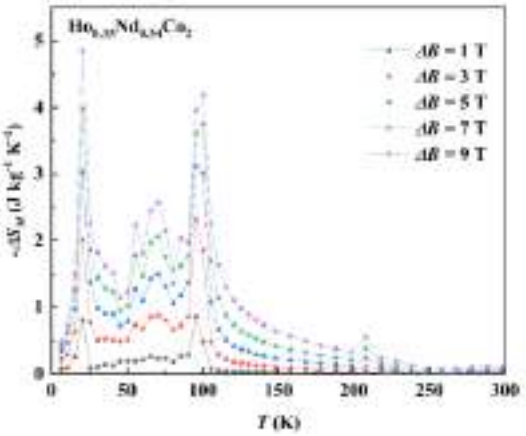


Fig. 1: Adiabatic temperature change curves for field change of 1, 3, 5, 7, and 9 T.

Abstract ID: 423

STRUCTURAL AND MAGNETIC PROPERTIES OF EXCHANGE COUPLED HEXAGONAL M-TYPE/Y-TYPE COMPOSITE FERRITE

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Abstract: Hexagonal ferrites with perpendicular and planar anisotropies have gained significant attention due to their inherited magneto-electric, magneto-dielectric, and nonreciprocal properties. Among the family of hexaferrites, M-type ($SrFe_{12}O_{19}$) ferrite, with high saturation magnetisation (M_s), coercivity (H_c), and uniaxial anisotropy along the *c*-axis, exhibits high ferromagnetic resonance frequency (FMR), making it operable up to W-band *V.G harris et al.* [1], *G.Albanese et al.* [2]. On the other hand, Y-type ($Ba_2Co_2Fe_{12}O_{22}$) ferrites exhibit *c*-plane anisotropy with low coercivity, and hence their applications are limited to few GHz *J.Smith* [3]. Composites with planar and perpendicular anisotropy are plausible candidates due to their ease of processing and wide difference in their magnetic properties. Moreover, the wide flexibility of composition variation as compared to substitution may further provide a broad operating frequency band. In the present study, structural and magnetic properties of $SrFe_{12}O_{19}/Ba_2Co_2Fe_{12}O_{22}$ composites in the weight ratios of 98/2, 96/4, 94/6, and 92/8 were examined. XRD patterns confirmed the coexistence of SrM and Co_2Y phases, which was further supported by Raman spectra. Notably, the characteristic peaks of the Co_2Y phase appear as the Y content increases from 6% to 8%. Smooth hysteresis loops were observed for exchange-coupled composites, whereas non-exchange-coupled composites showed stepped loops for all studied compositions. Enhanced magnetisation (M) and reduced H_c with increasing Co_2Y content indicate strong interfacial coupling between the M-type and Y-type phases in comparison with pristine SrM. The presence of exchange coupling in hexagonal/hexagonal composites with enhanced properties suggests their suitability for the microwave applications.

Keywords: Hexaferrites, Exchange coupling, Magnetic properties, Structural properties

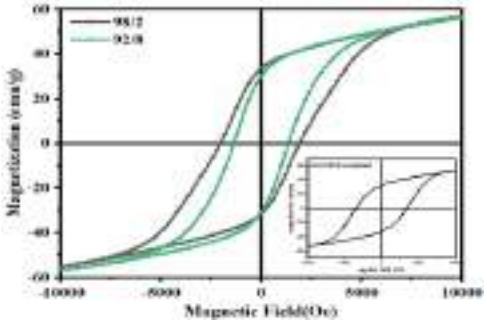


Fig. 1: *M-H* loops of exchange-coupled SrM/Co_2Y composites; inset represents *M-H* loop of as-mixed composite.

References:

[1] V.G. Harris, A. Geiler, Y. Chen, S.D. Yoon, et al., J. Magn. Magn Mater. 321 (2009) 2035–2047.
[2] G. Albanese, A. Deriu, Ceramurgia Int. 5 (1979) 3–10.
[3] J. Smit, H.P.J. Wijn, SmitWijn-Ferrites, pdf, 1959, pp. 136–175.

Abstract ID: 424

LONGITUDINAL MOKE STUDY OF EXFOLIATED Fe_5GeTe_2

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Abstract: Fe_5GeTe_2 is a metallic vdW ferromagnet that has attracted attention because its Curie temperature is relatively high and can shift with composition, structural disorder or thermal history (reported values in different samples fall roughly in the ~270–310 K range)[1]. Studies have shown that Fe_3GeTe_2 produces strong, intrinsic spin–orbit torques: second-harmonic Hall measurements on exfoliated FGT flakes reveal clear damping-like and field-like effective fields whose symmetry points to a bulk (not merely interfacial) origin[2]. In this study we present longitudinal MOKE hysteresis measured on an exfoliated Fe_5GeTe_2 (Fig. 1) flakes. We measured Kerr loops for 450 nm probe wavelengths at room temperature. In the next stage, systematic spin–orbit torque (SOT) characterization will be carried out on the Fe_5GeTe_2 sample. The measurements will involve current-induced magnetization switching under controlled in-plane bias fields to evaluate both damping-like and field-like torque components.

Keywords: Fe_5GeTe_2, van der Waals ferromagnet, longitudinal MOKE

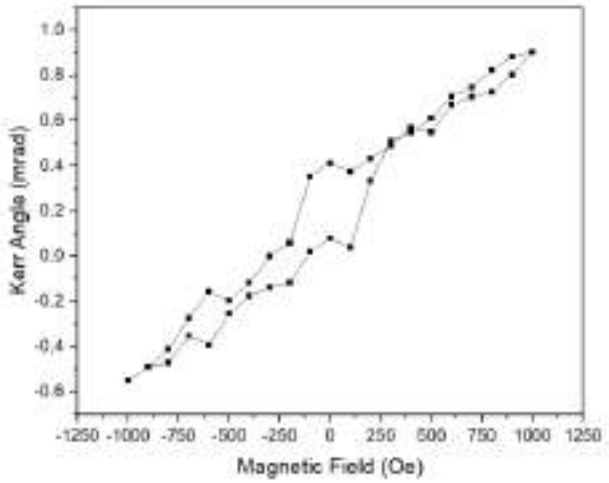


Fig. 1: Longitudinal MOKE for 450 nm.

References:

[1] May, A. F., Bridges, C. A., McGuire, M. A. (2019). Physical Review Materials, 3(10), 104401

[2] Martin *et al.* (2023). *Materials Research Letters, 11*(1), 84–89

Abstract ID: 425

FIELD INDUCED METAMAGNETIC TRANSITION AND SPIN CROSSOVER IN QUASI-1D Na_4NiTeO_6

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Abstract: We report the synthesis via solid-state reaction and comprehensive characterization of triclinic (P-1) Na_4NiTeO_6, featuring quasi-one-dimensional zigzag chains of edge-sharing NiO_6 octahedra along the a-axis, magnetically isolated by Na^+ and Te^{6+} ions [lattice parameters: a = 5.398(0) Å, b = 5.664(0) Å, c = 9.553(0) Å, α = 73.019(2)°, β = 89.670(2)°, γ = 80.491(0)°][1]. X-ray and neutron powder diffraction confirm the structure, while DC magnetization, AC susceptibility, and heat capacity reveal a robust second-order antiferromagnetic transition at $T_N \approx 7$ K. Curie–Weiss analysis yields dominant ferromagnetic interactions (θ_{CW} = 8.2 K) and enhanced effective moment μ_{eff} = 3.2 μ_B/Ni^{2+}. Isothermal M–H at 2.5 K exhibits S-shaped metamagnetic response with $H_c \approx 1.5$ kOe (upper inset Fig 1a.) and two-step spin flips; dM/dH(lower inset Fig 1a) shows broad enhancement indicative of field-induced crossover. Saturation reaches 1.9 μ_B/Ni (59.4% of μ_{eff}) at 9 T. Specific Heat capacity shows field-suppressed λ-like peak and vanishing Schottky anomaly above 3 T, as shown in Figure 1b, signaling towards non-collinear magnetic ground state. AC Susceptibility measurement did not show frequency dispersion ruling out the presence of glassy phase in this sample. This Ni^{2+} (S = 1) tellurate, distinct from Co/Cu analogs, emerges as a prime platform for quasi-1D quantum magnetism and frustration [2,3].

Keywords: Quantum Magnetism, Bulk Magnetization, Specific Heat, AC Susceptibility.

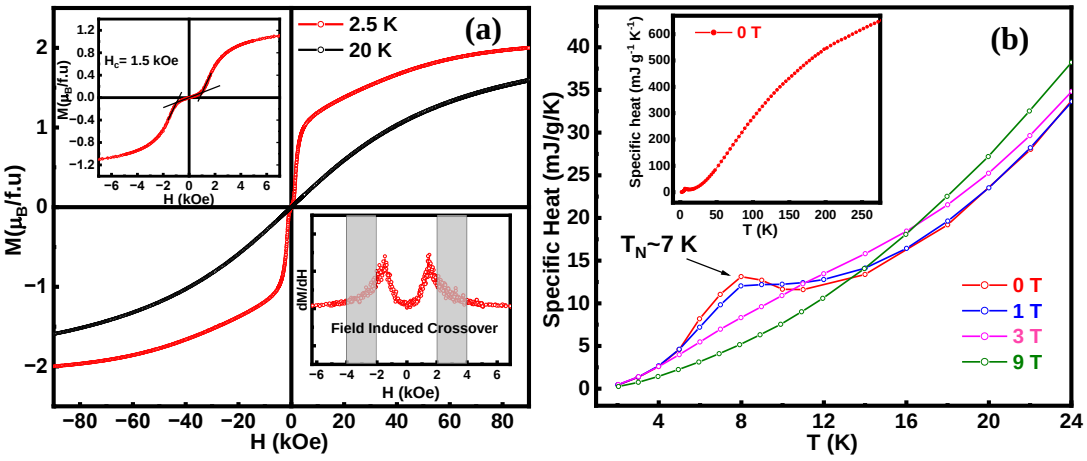


Fig. 1: (a) Isothermal magnetization curves at 2.5 K and 20 K. Upper inset showing critical field of 1.5 kOe and lower inset signifying field induced crossover around similar field. (b) Specific heat capacity at different fields as a function of temperature. Inset shows the zero field data from temperature range 2.5 K to 280 K .

References:

[1] C. Su et al., Phys. Rev. B 65, 297511 (2022).

[2] Z. He, W. Guo, M. Cui, and Y. Tang, Dalton Trans. 46, 5076 (2017).

[3] Z. He, M. Cui, and C. Qiu, J. Alloys Compd. 748, 794 (2018).

Abstract ID: 426

EXPLORING MAGNETIC AND ELECTRICAL TRANSPORT BEHAVIOUR IN Fe DOPED Mn_3Sn_2

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Abstract: Here we report the magnetic and electronic properties of arc metlted polycrystalline $Mn_{3-x}Fe_xSn_2$ (x = 0.3 and 0.7) compounds. In these compounds Mn at *4c* and 8d Wyckoff sites order at different temperatures [1], namely 4*c* site at T_{C1}~254 K(261 K) and 8*d* site at T_{C2} ~ 205 K(185 K) for x = 0.3(0.7). Figure 1(a) shows typical ZFC-FC magnetization data for x = 0.3 which is also similar to x = 0.7. The M vs H isotherms indicated fully FM nature between T_{C1} and T_{C2} and canted antiferromagnetic like behaviour below T_{C2}. Electrical transport measurements indicates both samples are metallic in nature and a clear slope change was noticed around magnetic transitions. Negative magnetoresistance (MR) was observed for temperatures below T_{C2}, it changes sign and becomes positive above T_{C2} right up to 300K. Hall measurements reveal presence of Anamolus hall effect (AHE). Detailed analyses using power- law scaling reveal that AHE in these compounds arises from side jump scattering mechanism, i.e., internsic contribution and not from skew scattering. After accounting for ordinary hall resistivity and anamoulous Hall resistivity contributions, the topological Hall (THE) resistivity was estimated from the total Hall resistivity. A clear topological Hall resistivity is seen for both the compounds as shown for example x = 0.3 in figure (b).The maximum THE was observed near T_{C2} and it decrease on either side. The decrease is more rapid for temperatures towards T_{C1}. The THE is much larger for the sample with higher Fe doping (0.7) compared to that of lower Fe (x = 0.3) concentration. Detailed analysis of topological hall resistivity in terms various formalism points to the Berry curvature of the electronic band structure as the source of observed THE in these comopounds.

Keywords: Magnetization, Magnetoresistance, Topological hall effect.

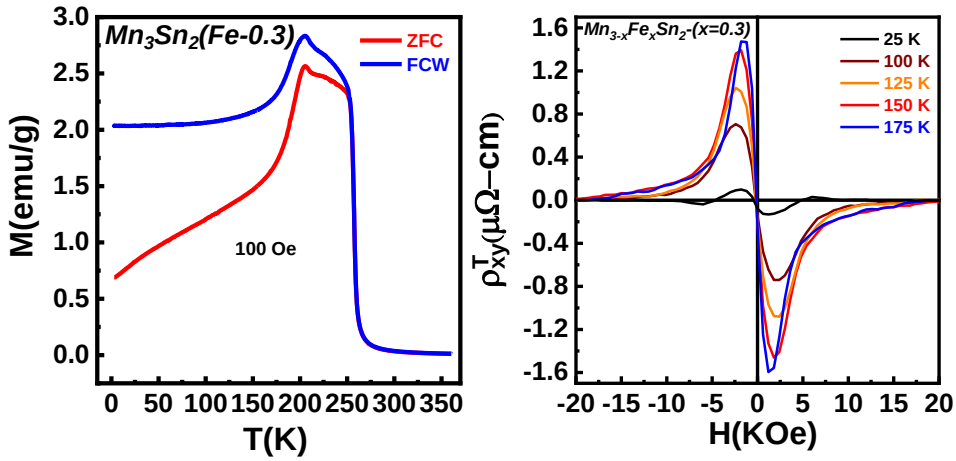


Fig. 1: (a) ZFC and FCW at 100 Oe for $Mn_{3-x}Fe_xSn_2$ (x = 0.3) (b) Topological hall effect as a function of applied magnetic field at different temperatures for $Mn_{3-x}Fe_xSn_2$ (x = 0.3).

References:

[1] Jianli Bai, Qingxin Dong, Binbin Ruan *et al.* Phys. Rev. B **109 (2024)**, 125112

Abstract ID: 428

EFFECT OF DIVALENT DOPANT IONS ON MAGNETIC, DIELECTRIC AND FERROELECTRIC BEHAVIOUR OF $Bi_{0.80}X_{0.20}FeO_3$-$CoFe_2O_4$ (X= Zn^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}) COMPOSITES

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Abstract: In this work, the effect of divalent ions (X = Zn^{2+}, Ca^{2+}, Sr^{2+} and Ba^{2+}) on the structural, morphological, magnetic, dielectric, ferroelectric, and magnetoelectric coupling properties of $0.75Bi_{0.80}X_{0.20}FeO_3$-$0.25CoFe_2O_4$ (BXFO-CFO) is studied. These materials were synthesized via the conventional solid-state reaction method. The X-ray diffraction of synthesized materials was analysed using Rietveld refinement, which confirms the coexistence of the rhombohedral perovskite phase of $BiFeO_3$ and cubic spinel phase of $CoFe_2O_4$. The Fourier transform infrared spectroscopy shows the signature of metal-oxygen (M-O) stretching bonding vibration. Field-emission scanning electron microscopy shows that the particles are spherical. The particle size decreases from Zn^{2+} to Sr^{2+} ion doped and then increases with the substitution of Ba^{2+}. Magnetic measurements show modification of magnetic behaviour governed by spin canting and interfacial exchange coupling among the BXFO and CFO phases. The maximum value of magnetization is 53 emu/g for the BZFO-CFO sample. Dielectric studies exhibit typical Maxwell-Wagner interfacial polarization and space charge effects; the dielectric constant decreases with the increase in ionic radii of the dopant ion. The ferroelectric polarization - electric field (P-E) loop shows a symmetry with the leakage current in all the synthesised samples. The magnetoelectric coupling coefficient shows a decreasing trend with increasing dopant ionic radii from Zn^{2+} to Ba^{2+}. Furthermore, the magnetoelectric coupling curve shows the decreasing trend with the increasing magnetic field as shown in the given figure.

Keywords: Solid State Reaction, Rietveld Refinement, Dielectric constant, Ferroelectric, Magnetoelectric.

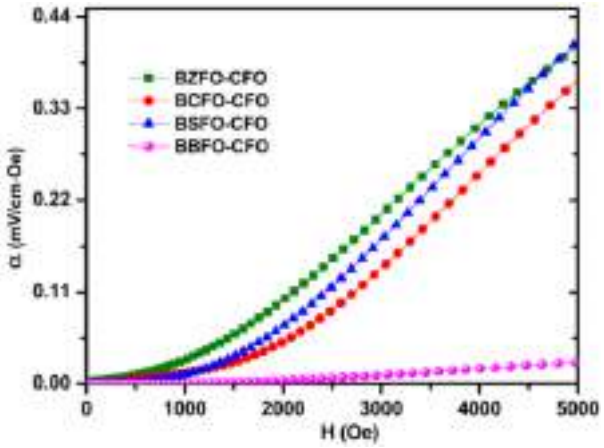


Fig. 1: Variation of magnetoelectric coupling coffecient for BZFO-CFO, BCFO-CFO, BSFO-CFO and BBFO-CFO composites.

Abstract ID: 429

INTERFACIAL COUPLING IN Cr_2O_3/rGO NANOCOMPOSITES GOVERNS STRUCTURAL AND MAGNETIC RESPONSE

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Abstract: We report the structural and magnetic properties of pure Cr_2O_3 and Cr_2O_3/reduced graphene oxide (rGO) nanocomposites (1%, 3%, and 5%) synthesized via a hydrothermal method. The decisive role of wrapping rGO on the structural and magnetic properties of Cr_2O_3/rGO nanocomposites was investigated systematically using harmonizing experimental techniques. Powder X-ray diffraction analysis revealed the rhombohedral structure of Cr_2O_3 with characteristic diffraction peaks observed at (012**),** (104**),** and (110**)** crystallographic planes**.** Furthermore, the PXRD pattern exhibited broader peaks and reduced peak intensities with increasing rGO concentration. The calculated lattice constants were a = 4.912 Å and c = 13.730 Å for 1% rGO, a= 4.959 Å, c =13.631Å for 3% rGO, and a = 4.947 Å, c = 13.66 Å for 5 % rGO wrapped Cr_2O_3 nanocomposites. The average crystallite size of the prepared nanocomposites was in the range 27.3-36.4 nm. Raman spectroscopy confirmed the rhombohedral structure of Cr_2O_3 and the hexagonal lattice of rGO, as evidenced by characteristic Raman modes. Fourier Transform Infrared (FTIR) spectroscopy demonstrated the characteristic metal–oxygen stretching vibrations of chromium (III) oxide along with additional bands associated with oxygen-containing functional groups of reduced graphene oxide, confirming the effective formation of the Cr_2O_3/rGO composite. Field-dependent magnetic measurements revealed weak ferromagnetic ordering at room temperature in all prepared samples. The wrapping of rGO with Cr_2O_3 modulates magnetic interactions via intrinsic defects and interfacial coupling, making these composites promising candidates for future spin-dependent device applications.

Keywords: Cr_2O_3, rGO, nanocomposite, rhombohedral phase, ferromagnetism.

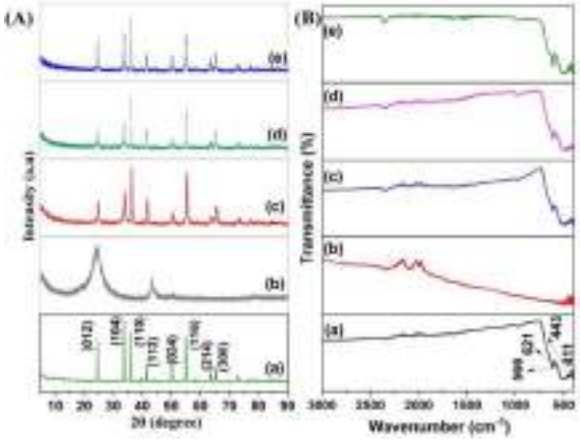


Fig. 1. **(A)** PXRD pattern and **(B)** FTIR spectra of (a) pure Cr_2O_3, (b) reduced graphene oxide (rGO), (c) 1%, (d) 3%, (e) 5% rGO wrapped/Cr_2O_3 nanocomposites.

References:

[1] J. Yang, J. Miao, Y. M. Zhu, K. K. Meng, X. G. Xu, et al., Appl. Phys. Lett. 112 (2018) 232404.
[2] S.M. Al-Moayid, H. Algarni, H. E. Ali, Y. Khairy, J. Alloy. Compd. 1010 (2025) 176949.
[3] Y. Fan, F. Wang, G. Wen, F. Li, C. Zhang, S. Zhang, H. Ma, X. Jia, J. Appl. Phys. 114 (2013) 233903.

Abstract ID: 430

INFLUENCE OF BUFFER LAYER ON MAGNETIZATION DYNAMICS OF NICKEL BASED HEUSLER THIN FILMS

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Abstract: In the present study, we have grown off-stoichiometric $Ni_{55}Fe_{14}Al_{31}$ (NFA) Heusler thin films via RF sputtering at 300°C. Very limited reported literature on this Heusler composition has prompted us to explore its possibilities in the field of spintronics[1].The sputtering target utilised for deposition, was fabricated using thin metallic sheets of Ni, Fe and Al. NFA films (15nm thick) are grown on Al_2O_3 (0001) substrate. A Ta buffer layer(10nm) is deposited to evaluate its influence on the surface morphology and magnetic properties of the films. X-ray Diffraction pattern confirms the formation of A2 phase in NFA films and β-phase in Ta films. The buffered films are found to possess smoother surfaces as compared to unbuffered films. A higher saturation magnetization (M_s) is obtained in the films with Ta buffer. The Gilbert damping constant is used to quantify dynamic magnetization in the films, which has been estimated using the ferromagnetic resonance (FMR) technique across a wide range of microwave frequencies. We have studied the variations in roughness(ρ_{rms}), saturation magnetisation (M_s) and Gilbert Damping constant (α) in NFA films as function of buffer layer.

Keywords: Heusler, Spintronics, Thin films, Gilbert Damping, Ferromagnetic Resonance.

References:

[1] Elphick, K., Frost, W., Samiepour, M., Kubota, T., Takanashi, K.,et al., (2021). *Science and Technology of Advanced Materials*, *22*(1), 235–271.

Abstract ID: 431

IMPACT OF PROGRAMMING VARIABILITY OF DOMAIN WALL-BASED ARTIFICIAL SYNAPSES ON THE INFERENCE ACCURACY

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Abstract: Several studies have explored spin–orbit torque (SOT) based domain wall (DW)-based synapses for neural network implementations [1]. In our recent work, micromagnetic modelling was employed to optimize the design of artificial synapses based on such SOT-driven DW motion along a nanotrack with carefully tuned triangular notches [Fig. 1(a)]. Quantized conductance states are obtained as the DW moves through the nanostrip. By optimizing the notch geometry, highly reliable programming and long retention times could be achieved, which are key requirements for implementing artificial synapse. Here, we show the impact of programming variability of such devices on the inference accuracy for a simple classification task. The programming reliability of a 4-level device at T = 300 K is first tested using 144 repeated simulations [Fig. 1(b)]. Next, a circuit-level behavioural model of this device is developed that reproduces the conductance response shown in Fig. 1(c). Next, extending this model to 11 levels, inference was performed on the Iris dataset using the network shown in Fig. 1(d), achieving an accuracy of ~93%. The network weights were trained in software and subsequently encoded into the model. A programming error (± 1 level of conductance state) is then added to three randomly chosen devices in the array. Across 16,192 possible realizations, the mean inference accuracy remains ~93%, while the worst-case accuracy is ~73% (without any variability-aware training schemes, which can presumably minimize such issues). Results show that well-designed DW-based synapses can provide a robust, reliable means for building efficient edge-AI hardware.

Keywords: Domain wall (DW), Artificial synapse, Artificial Neural Network, SOT.

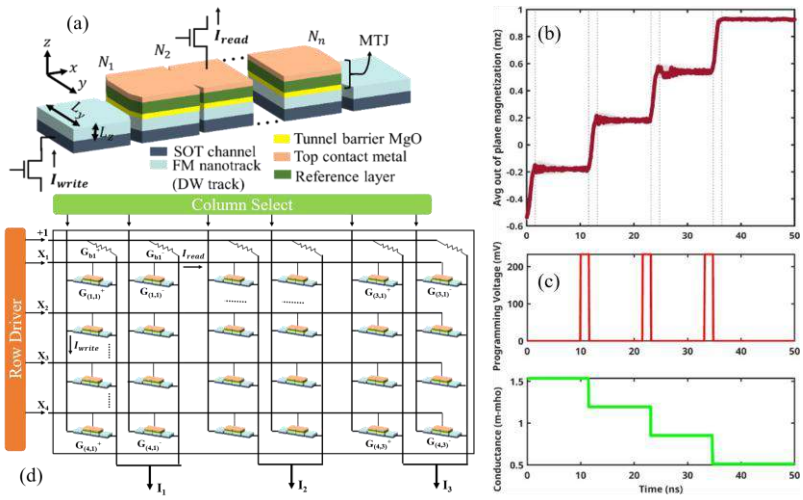


Fig. 1: (a) SOT-driven DW-MTJ synapse. (b) Magnetization dynamics during programming are calculated from finite temperature micromagnetic simulations, and (c) the resulting 4-level conductance states obtained from the Verilog-A-based behavioural model. (d) shows the ANN integration for the iris dataset classification task.

References:

[1] Liu et al., Appl. Phys. Lett. 118, 202405 (2021); Leonard et al., Adv. Electron. Mater.8, 2200563 (2022).

Abstract ID: 432

ORDERED L2₁ Co_2FeAl HEUSLER ALLOY BY POWDER METALLURGY: A HIGH-QUALITY SPUTTERING TARGET FOR MAGNETOTRANSPORT STUDIES

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Abstract: The full Heusler alloy Co_2FeAl has attracted considerable interest for spintronic applications due to its high spin polarization, low magnetic damping, and compatibility with thin-film device architectures [1]. In the present work, a bulk Co_2FeAl sputtering target was synthesized using a powder metallurgy route as a preliminary step toward the fabrication of thin films aimed at magnetoresistance studies. High-purity elemental powders were homogeneously mixed and cold-compacted, followed by a two-step sintering process. Pre-sintering was performed at 500 °C to facilitate aluminium diffusion, and the final sintering was carried out at 950 °C to promote the formation of the ordered Heusler phase. The structural characteristics of the prepared alloy were examined using X-ray diffraction, which reveals well-defined diffraction peaks corresponding to a face-centred cubic crystal structure. Rietveld refinement confirms the formation of the ordered L2₁ Heusler phase [2]. Thermogravimetric analysis up to 1000 °C indicates good thermal stability of the alloy over the investigated temperature range, demonstrating the suitability of the synthesized material for high-temperature processing conditions such as sputter deposition. Magnetic measurements performed using a vibrating sample magnetometer show that the alloy exhibits soft ferromagnetic behaviour with a low coercivity of 11.5 Oe and a saturation magnetization of 126.5 $A \cdot m^2\ kg^{-1}$. These magnetic characteristics, together with the confirmed crystallographic phase stability, indicate that the prepared bulk material is a suitable sputtering target for thin-film growth. The present work establishes the successful synthesis and characterization of a high-quality Co_2FeAl target. Ongoing work focuses on the deposition of thin films using this target and the investigation of their magnetotransport properties, particularly magnetoresistance, which is critical for spintronic and magnetic sensor applications.

Keywords: Heusler alloy, Spintronics, Sputtering Targets.

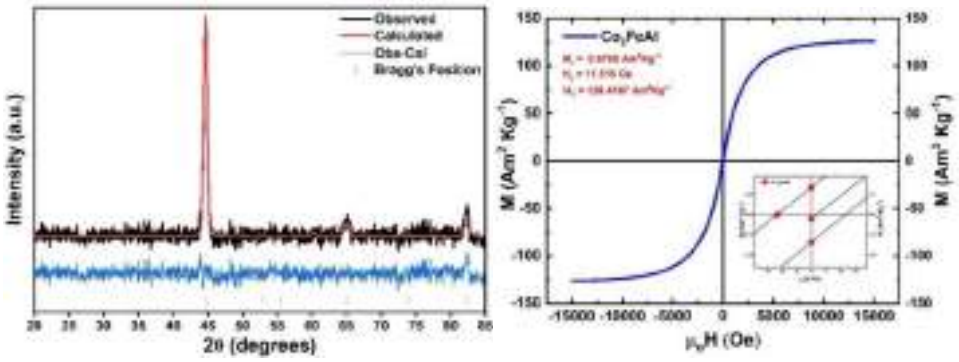


Fig a) Fig b)

Figure 1: a)X-Ray Diffraction and Rietveld Refinement of Co_2FeAl Heusler Alloy confirming the $L2_1$ ordered phase of Co_2FeAl b)M vs H loop of Co_2FeAl Heusler Alloy.

References:

[1] A. Ahmad, S. Mitra, S. et al., J. Magn. Magn. Mater., vol. 474, no. October 2018, pp. 599–604, 2019
[2] M. Belmeguenai et al., Phys. Rev. B - Condens. Matter Mater. Phys., vol. 87, no. 18, pp. 1–11, 2013

Abstract ID: 433

ENHANCEMENT IN THE PROPERTIES OF SINTERED Nd-Fe-B MAGNETS THROUGH THE GRAIN BOUNDARY DIFFUSION USING DyF_3

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Abstract: Nd-Fe-B based permanent magnets are indespensible in a plethora of various energy driving and renewable technology applications particulary in spear heading electric vehicle (EV) technology. Nd-Fe-B magnets account more than half of the market share of the permanent magnets due to its unrivalled energy product in the range of 35-55 MGOe. However, in commercial Nd-Fe-B magnets typical coercivity realized is only about ~20% of the total anisotropy field of 7.5 T for pure $Nd_2Fe_{14}B$ phase. Strategies are explored rigoursly both by industries and among the research fraternity to enhance the coercivity. In this context, grain boundary diffusion (GBD) process with rare earth (RE) elements into Nd-Fe-B magnet is a potential and commercially relaised strategy to improve the coercivity in the sintered Nd-Fe-B magnets. In the present work, the indigenously produced fine grained (< 4 μm) Dy-free sintered anisotropic Nd-Fe-B magnets processed through novel press less processing (NPLP) is chosen for the grain boundary diffusion process. The as-sintered sample when subjected to post sintered annealing (PSA) at optimum processing conditions yielded a coercivity enhancement of 50% increasing from 10 kOe to 15 kOe. While typical coercivity enhancement for Dy free commercial samples reported is only about 30%. The high coercivity enhancment is attributed to the enhanced grain boundary volume fraction owing to finer grain size of the present sample. The microstructure reveals that PSA favours in the evolution of continuous Nd-rich grain boundaries (**Fig.1.a-b**). The sample is presumed to be more suitable for the GBD process. The paper shall discuss the evolution of core shell microstructure and phase features and coercivity enhancement of the GBD carried out on these fine grained Dy free magnet and explore its suitability for EV applications.

Keywords: Nd-Fe-B; Sintered Magnets; New press less processing; Magnetic Properties; Grain boundary diffusion process.

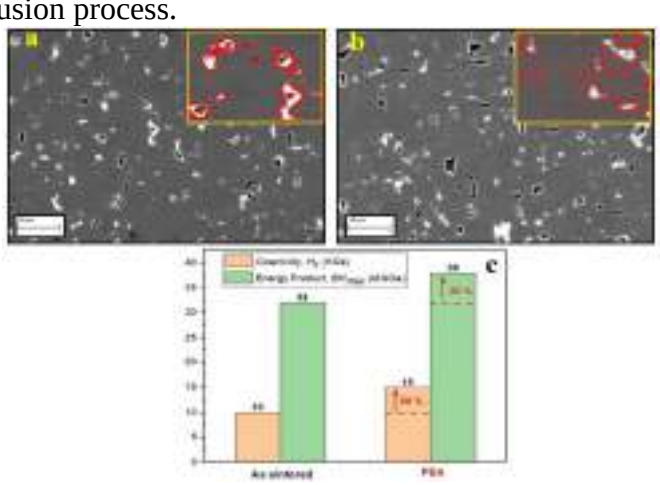


Fig. 1: Microstructure of the Nd-Fe-B magnet (a) As sinterd magnet with discontinous Nd-phase grain boundary and b) Post sintered annlealing magnet distictly showing the continous grain boundaries (Inset images showing mapping of GB phase of the magnet), and (c) Magnetic properties of the magnet showing the increase in the both H_c and BH_{max}.

Abstract ID: 434

STUDYING THE RESISTIVE SWITCHING EFFECT IN HfO_X RRAM UNDER SIMULTANEOUS APPLICATION OF ELECTRIC AND MAGNETIC FIELDS

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Abstract: Industry and academia are interested in RRAM devices for their high switching speed, low energy consumption, and simple architecture. In RRAM device, the resistive switching (RS) mechanism is mainly governed by the insulating layer. Among several binary transition-metal oxides, Hafnium oxide (HfO_X) is among the best for RRAM devices. In this study, we address the combined effects of electric and magnetic fields on the switching behavior of sputter-deposited HfO_X-based RRAM devices with various top electrodes (Ag, Pt, Ni). The devices with an active electrode Ag have shown good endurance and retention time of 10^2 cycles and 10^3 seconds, respectively, with a wider memory window (>10^3). But the devices with Pt (inert electrode) have a lower operating voltage. Furthermore, devices with Ni have exhibited the highest cycle-to-cycle stability, compared to other configurations. Further, we have investigated the effect of the magnetic field on the RS in our devices with Ag and Ni TEs. Interestingly, due to the induced magnetoresistance effect, the HRS and LRS values increased simultaneously in the presence of a magnetic field. In Ni-based devices, the magnetic-field effect is more pronounced than in other devices, and the resistance ratio increases from ~1.7 to ~2.6 under the magnetic field. Additionally, the set and reset voltages shifted toward higher values due to the Lorentz force. The resistance tuning confirms that the magnetic field can tune and improve the device's switching process when suitable electrodes are used, and it also paves the way for emerging multilevel non-volatile memory technology.

Keywords: RRAM, HfO_X, magnetoresistance, retention.

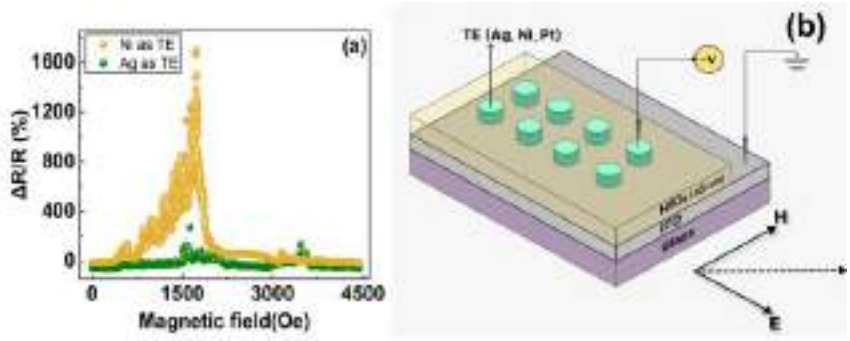


Fig. 1: (a) By sweeping the magnetic field, the magnetoresistance properties for Ni/HfO_X/ITO and Ag/HfO_X/ITO RRAM devices were examined. (b) Device architecture.

References:

[1] Biswas B, Ghosh A, Jalaluddeen S, Mondal R, Murapaka C, Garlapati SK. Effect of different top electrodes and magnetic field on HfO_X based RRAM devices. Journal of Physics D: Applied Physics. 2025 Oct 21.

[2] Otsuka S, Hamada Y, Ito D, Shimizu T, Shingubara S. Magnetoresistance of conductive filament in Ni/HfO2/Pt resistive switching memory. Japanese Journal of Applied Physics. 2015 Apr 7;54(5S):05ED02.

Abstract ID: 435

STRUCTURAL AND MAGNETOTRANSPORT STUDY OF RARE-EARTH BASED KAGOME LATTICE COMPOUND $TbMn_6Sn_6$

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Abstract: Recently, kagome materials have attracted significant attention in the condensed-matter physics community due to their unique electronic band structure, which hosts exotic features such as flat bands, Dirac cones, Chern-gapped states, and Van Hove singularities (VHs) that can give rise to unusual magnetic and topological transport phenomena. Among these materials, $TbMn_6Sn_6$ has emerged as an important magnetic kagome system where the Mn atoms form a kagome lattice and the presence of magnetism can open a Chern gap in spin-polarised Dirac bands. In this work, we investigate the crystal quality and magnetotransport behavior of $TbMn_6Sn_6$ single crystals in order to explore their potential for studying kagome-related topological transport properties. High-quality $TbMn_6Sn_6$ single crystals were grown using the self-flux method. The crystal structure and hexagonal phase were confirmed by Rietveld refinement of powder X-ray diffraction (XRD), while Energy Dispersive X-ray spectroscopy (EDX) verified the stoichiometric composition of Tb, Mn, and Sn. Temperature-dependent resistivity measurements from 330 K to 2 K and magnetoresistance measurements up to 9 T were carried out using a 9-Tesla Physical Property Measurement System (PPMS). The sample exhibits metallic behaviour over the entire temperature range. The detailed magnetotransport results will be presented at the conference and highlight the relevance of $TbMn_6Sn_6$ for investigating topological transport phenomena arising from spin-polarised Dirac fermions in kagome lattices.

Keywords: magnetic phase transition, Quantum interference phenomenon, magnetoresistance, Carrier transport mechanism

References:

[1] Jia-Xin Yin, M. Zahid Hasan et al. “Quantum-limit Chern topological magnetism in TbMn6 Sn6”, Nature 583 (2020) 533.

[2] S. X. M. Riberolles, B.G.Ueland, R. J. McQueeney et al.“Orbital character of the spin-reorientation transition in TbMn6Sn6” Nature Communications 2658 (2023) 14.

Abstract ID: 436

FIELD-TUNABLE THRESHOLD CURRENT MINIMA IN NANO-CONSTRICTION SPIN HALL NANO-OSCILLATORS

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Abstract: Spin Hall nano-oscillators (SHNOs) are promising for microwave signal generation and oscillator-network-based neuromorphic and Ising machines, where minimizing the threshold current is essential for energy-efficient operation. Here, we use COMSOL-based current and Oersted-field calculations together with MuMax3 micromagnetic simulations to investigate how constriction-width-dependent demagnetizing fields and oblique out-of-plane magnetic fields govern the onset of auto-oscillations in Pt/Py nano-constriction SHNOs with widths from 20 to 150 nm. We find that, unlike the monotonic field dependence expected from a conventional macrospin picture, the threshold current exhibits a robust non-monotonic variation with applied field, producing a tunable current-field minimum that is strongest in narrower constrictions. Analysis of the auto-oscillation spectra and spatial mode profiles shows that this minimum originates from a field-driven evolution of spin-wave localization: intermediate fields deepen the effective spin-wave potential well, enhance mode confinement within the constriction region, improve overlap with the spin-current distribution, and reduce radiative losses, whereas low and high fields weaken confinement and increase the threshold current. An extended macrospin model with a renormalized effective spin-transfer torque area captures the observed trends well. These results identify an optimal operating regime for low-current SHNO operation and provide design guidelines for scalable, thermally efficient spintronic oscillator networks.

Keywords: Spin Hall nano-oscillators, threshold current, demagnetizing fields, spin-wave localization, neuromorphic computing.

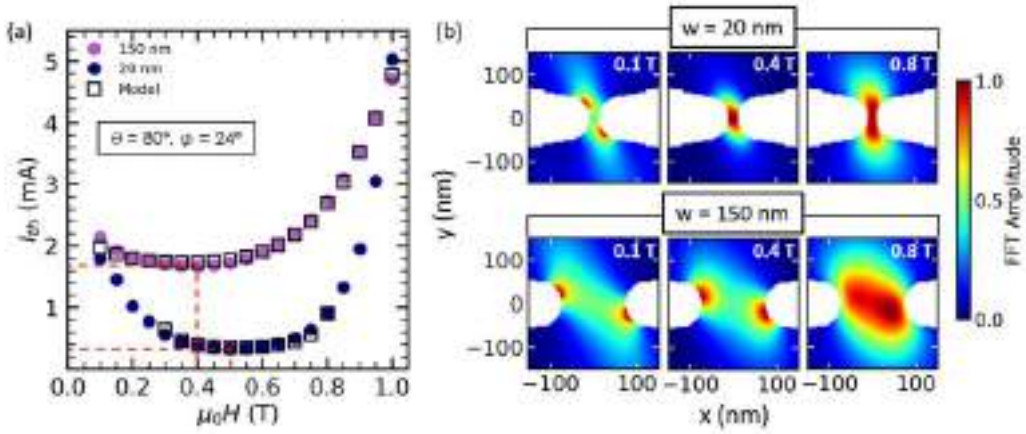


Fig. 1: (a) Threshold current versus OOP field for SHNOs with constriction widths of 20 and 150 nm, together with the analytical model. (b) FFT amplitude maps at selected fields showing the field-driven evolution of mode localization.

References:

[1] T. M. Arunima and H. Fulara, Appl. Phys. Lett. 127 (2025) 092403.
[2] M. Dvornik, A. A. Awad, and J. Åkerman, Phys. Rev. Appl. 9 (2018) 014017.
[3] A. A. Awad et al., Appl. Phys. Lett. 116 (2020) 232401.
[4] A. Slavin and V. Tiberkevich, IEEE Trans. Magn. 45 (2009) 1875–1918.

Abstract ID: 437

INFLUENCE OF RARE EARTH DOPING ON BSPT/NZFO MAGNETOELECTRIC COMPOSITES FOR MAGNETIC FIELD DETECTION

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Abstract: The magnetoelectric effect is the control of polarisation by an applied magnetic field and magnetisation by an applied electric field. The ability to switch electric polarisation and magnetisation opens the door to various applications and multifunctional devices[1], such as magnetic field sensors, energy harvesters, and microwave tunable filters. The success of these devices depends on the choice of the piezoelectric coefficient of the piezoelectric component and the magnetostrictive nature of the magnetic counterpart. In this work, the effect of rare earth (Pr^{3+} and Nd^{3+}) doping on BSPT/NZFO bilayer magnetoelectric laminate composite for magnetic field sensing is studied. The magnetoelectric coefficient (α_{DME}) of BSPT/NZFO composite is 6.77 V/cm.Oe, which is enhanced by Pr^{3+} and Nd^{3+} doping. Among the doping of Pr^{3+}, 3 mol% doping shows the highest α_{DME} of 14.76 V/cm.Oe and AC magnetic field sensitivity of 15.6 mV/μT at its radial resonance of 271.6 kHz[2]. Similarly, 2% Nd^{3+} doping achieves an α_{DME} of 12 V/cm.Oe and AC sensitivity of 22.1 mV/μT at its radial resonance of 270.7 kHz. The higher value of sensitivity in the Nd-doped composite compared to the Pr-doped composite brings factors like dielectric loss (tan δ) and piezoelectric voltage coefficient (g_{33}) into consideration. The value of tan δ in the BSPT-2%Nd/NZFO composite is 3.05, whereas in BSPT-3% Pr/NZFO is 6.42. Additionally, a higher value of g_{33} in BSPT-2%Nd/NZFO contributes to a higher value of sensitivity. The enhancement of sensitivity is due to the increase in α_{DME} after the rare-earth doping in the pristine BSPT/NZFO composite.

Keywords: Laminate composite, Dielectric loss, Magnetoelectric coefficient, Magnetic field sensing.

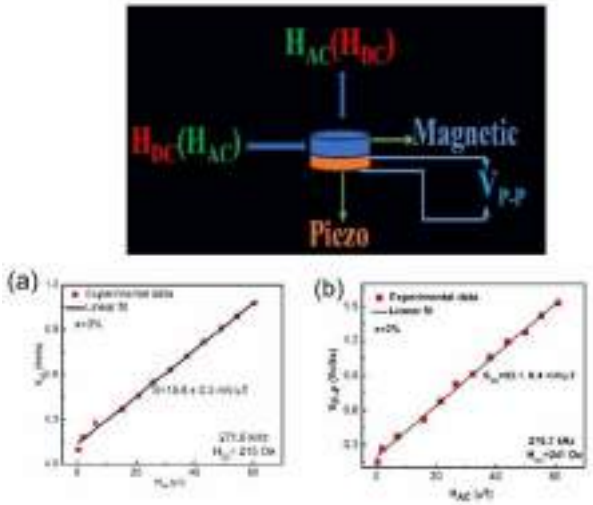


Fig. 1 Comparison of AC Magnetic field sensitivity of (a) Pr and (b) Nd doped $0.37BiScO_3$-$0.63PbTiO_3$/NZFO magnetoelectric laminate composite

References:

[1] Kimura, T., Goto, T., Shintani, H., et al., (2003), Magnetic control of ferroelectric polarization, Nature, 426, 55-58.
[2] Samantaray, S., Xavier, D., Kumar, S. D., et al., (2025). *Journal of Alloys and Compounds*, *1036*.

Abstract ID: 438

STRUCTURAL, OPTICAL AND MAGNETIC PROPERTIES OF $BaFe_{12}O_{19}/NiFe_2O_4$ NANOCOMPOSITES

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Abstract: $BaFe_{12}O_{19}/NiFe_2O_4$ (BaM/NiF) nanocomposites were prepared by sol-gel autocombustion method and were annealed at various temperatures in air. Fig.1a shows the XRD patterns of the BaM/NiF nanocomposite samples annealed at different temperature ranges from 200 °C to 900 °C. All the peaks in the Asp and annealed samples were indexed to NiF phase (JCPDS data of NiF, PDF card No. 074-2081). The average crystallite size showed ≈ 24-25 nm for all the annelaed samples. HRTEM image revealed presence of both BaM and NiF ferrite grains in the samples. Magnetic hysteresis loops exhibited wasp waisted behaviour in all the samples, as seen in Fig.1b. The magnetic behaviour in these samples is due to the presence of two magnetic phases with different anisotropies and the exchange interaction between the two magnetic phases. At 300K, the highest magnetization of 45emu/g was observed for the 900 °C annealed sample. Maximum H_C value of 227 Oe was observed at 300 K for the sample annealed at T_A = 200°C. Energy Product $(BH)_{max}$ of the ferromagnetic sample is an interesting property for magnetic storage devices. When soft and hard magnetic phases are combined in magnetically exchange coupled systems in our composite very low $(BH)_{max}$ value was observed for the BaM/NiF nanocomposites with a composition ratio of approximately 1:9, respectively.

Keywords: Hexaferrite, Nanocomposites, Magnetic hysteresis, Exchange interaction, Energy Product.

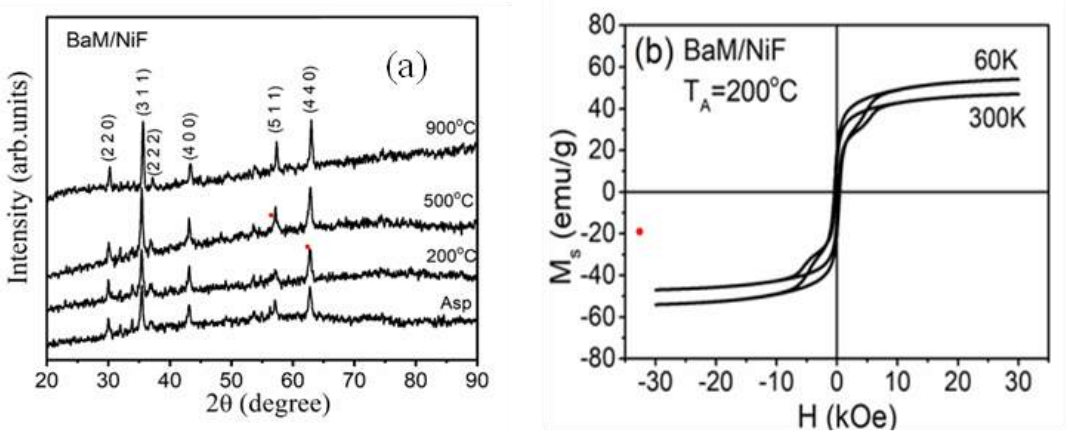


Fig. 1: a) XRD patterns of the BaM/NiF nanocomposites annealed at different temperatures and b) represents M-H loops of T_A = 200 °C BaM/NiF nanocomposite at 300 and 60 K.

Abstract ID: 439

LARGE TOPOLOGICAL HALL EFFECT IN FERRIMAGNETIC $Mn_2SbBe_{0.1}$ SINGLE CRYSTAL

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Abstract: Ferrimagnetic intermetallic compounds with multiple magnetic sublattices provide an attractive platform for exploring anisotropic transport and emergent topological spin textures. Among them, Mn_2Sb-based systems exhibit strong coupling between magnetic order and electronic transport, where slight compositional modifications can significantly alter their magneto-transport behavior. In this work, we investigate the magnetic and angle-dependent magneto-transport properties of Be-interstitially doped Mn_2Sb single crystals. $Mn_2SbBe_{0.1}$ exhibits pronounced in-plane magnetic anisotropy together with strong angular-dependent longitudinal resistivity under an out-of-plane magnetic field. The angular-dependent magnetoresistance shows a two-fold symmetry (period π) at higher temperatures that evolves into a four-fold symmetry (period $\pi/2$) below 50 K, indicating a change in magnetic symmetry at low temperatures. A large topological Hall effect is observed in the 100–300 K temperature range, attributed to a canted spin texture of Mn sublattices. The topological Hall resistivity reaches a maximum value of ~1.6 μΩ·cm at 200 K, just below the spin-reorientation transition. Furthermore, the transverse Hall resistivity exhibits strong angular dependence with nearly a 600% variation upon rotating the ab-plane under an out-of-plane magnetic field. These results establish $Mn_2SbBe_{0.1}$ as a promising system for studying anisotropic and topological magneto-transport phenomena.

Keywords: Ferrimagnetism, Angle dependent magnetoresistance, Anisotropy, Topological Hall effect.

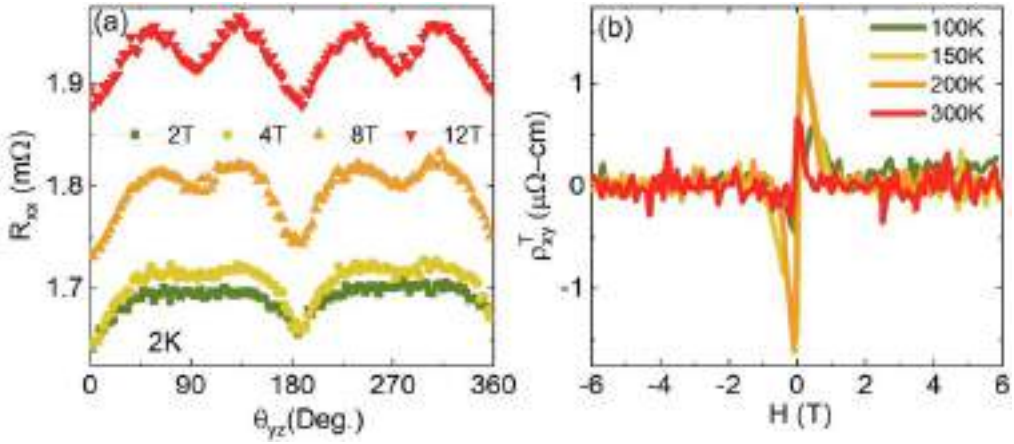


Fig. 1: (a) Angular dependency of longitudinal resistance at 2K, (b) Topological Hall contribution to transverse Hall resistivity at various temperatures.

References:

[1] W. S. Hou, M. Q. Dong, X. Zhang, Z-X Guo, Phys. Rev. B 2024, 110, 214403.
[2] S. Zhang, Q. Wu, Y. Liu, O. V. Yazyev, Phys. Rev. B 2019, 99, 035142.
[3] X. Liang, X. Zhang, L. Shen, J. Xia, M. Ezawa, X. Liu, Y. Zhou, Phys. Rev. B 2021, 104, 174421.
[4] S. K. Kim, G. S D Beach, K.-J. Lee, T. Ono, T. Rasing, H. Yang, Nat. Mater. 2022, 21(1), 24-34.

Abstract ID: 440

LAW OF APPROACH TO SATURATION IN $Ni_{50}Mn_{50-x}Sn_x$ (x = 13–17): ANISOTROPY, HOLSTEIN–PRIMAKOFF MAGNONS, AND T/T_c VALIDITY LIMITS

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Abstract: This study investigates the applicability of the Law of Approach to Saturation (LAS) analysis for determining magnetic parameters in Ni-rich $Ni_{50}Mn_{50-x}Sn_x$ Heusler alloys, where, x = 13 (N1), 14 (N2), 15 (N3), 16 (N4) and 17 (N5). The samples (N1–N5) were analyzed using five LAS model equations [1,2] applied to magnetization curves measured up to 5 T. The models enabled simultaneous estimation of saturation magnetization (M_s), structural inhomogeneity constant (a), magnetocrystalline anisotropy constants (b and c), the Holstein–Primakoff magnon parameter (d), and high-field susceptibility (χ). Model selection was performed using the Akaike Information Criterion (AIC) to identify the most statistically appropriate description of the experimental data at each temperature. The results show that reliable LAS-derived parameters are obtained only when measurements are performed well below the Curie temperature. One composition, $Ni_{50}Mn_{35}Sn_{15}$ (N3), exhibited unphysical negative saturation magnetization near 280–300 K, indicating that the alloy is at or above its Curie temperature and rendering its fitted parameters invalid. A reduced-temperature threshold of $T/T_c \approx 0.95$ is identified as the practical upper limit for physically reliable anisotropy extraction. For most compositions, the model including Ms, a, b, and χ provided the best description, while the model incorporating the Holstein–Primakoff magnon term was favoured for the Sn-rich sample at low temperatures. The temperature dependence of the magnon parameter follows the expected $T^{3/2}$ behaviour. Overall, the study establishes practical validity boundaries for LAS analysis in near-transition Heusler alloys and provides composition-dependent anisotropy benchmarks relevant to magnetocaloric and exchange-bias applications.

Keywords: Law of approach to saturation; Heusler alloys; magnetocrystalline anisotropy; Akaike Information Criterion; Holstein–Primakoff magnons.

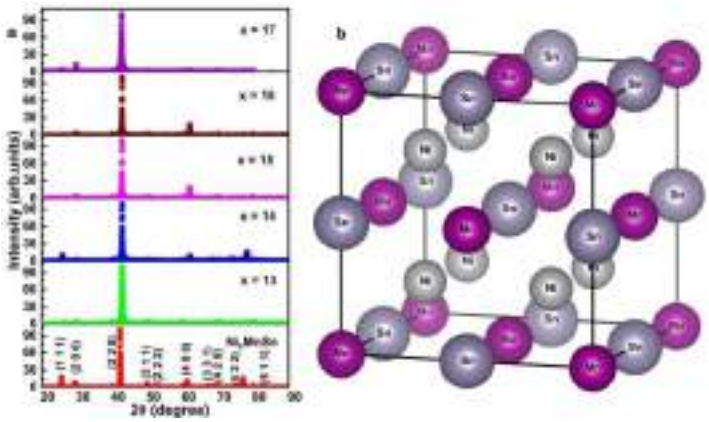


Fig. 1: (a) XRD pattern of samples along with Ni_2MnSn pattern. (b) crystal structure of Ni_2MnSn.

References:

[1] Brown Jr, W. F. (1940). *Physical Review*, *58*(8), 736.

Abstract ID: 441

SUPEREXCHANGE-INDUCED POSITIVE EXCHANGE BIAS AND FIELD-COOLING REVERSAL IN Co/CoO MULTILAYER

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Abstract: Exchange bias in magnetic multilayers plays a crucial role in stabilizing magnetic configurations through interfacial exchange coupling [1]. This interfacial interaction induces a unidirectional anisotropy that shifts the magnetic hysteresis loop, enabling controlled magnetization switching. Such behavior is important for applications in spintronic devices, magnetic sensors, and magnetic memory elements, where stable and controllable magnetic states are essential. In the present work, exchange bias in Co/CoO/Co/CoO multilayers has been investigated. The film structure is characterized in situ during growth using Reflection High-Energy Electron Diffraction (RHEED), X-ray Reflectivity (XRR), and Magneto-optical Kerr Effect (MOKE) techniques. The independent magnetic contributions of the top and bottom Co layers were separated by fitting the hysteresis loops with an appropriate mathematical function [2]. The combined analysis reveals that both Co layers exhibit positive exchange bias at room temperature (RT), whereas a transition from positive to negative exchange bias occurs under field-cooled (FC) conditions. The unusual positive exchange bias observed at RT is attributed to antiferromagnetic superexchange coupling between Co^{3+}–O–Co^{3+} at the interfaces. Under FC conditions, enhanced ordering of the antiferromagnetic (AFM) moments leads to the emergence of negative exchange bias. The increased AFM moment ordering strengthens the negative exchange bias, which eventually dominates over the interfacial superexchange coupling.

Keywords: Exchange bias, Magnetic thin film, in-situ MOKE, Superexchange coupling.

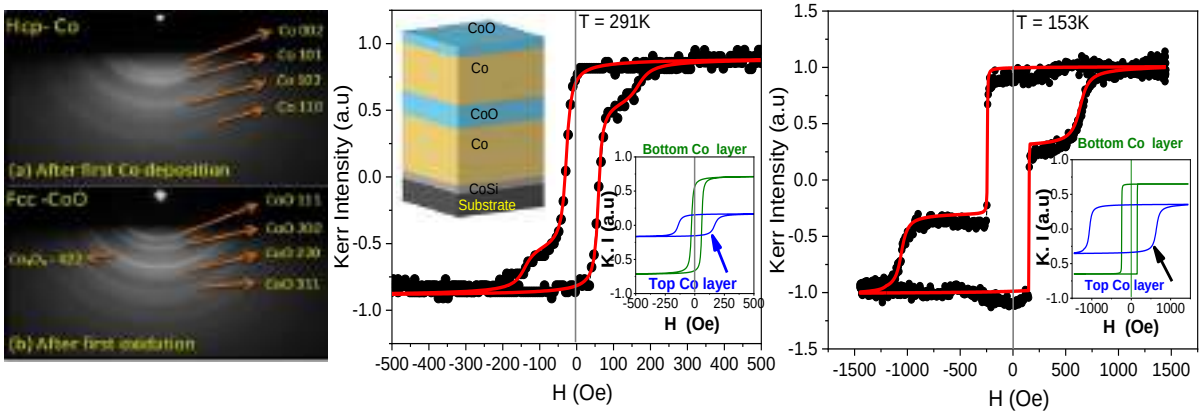


Fig. 1: (a) *RHEED* images of the Co and CoO layers recorded during growth. Magnetic hysteresis loops measured by *MOKE* at (b) RT and (c) under FC conditions. The inset shows the two separated contributions from the top and bottom Co layers.

References:

[1] W. H. Meiklejohn, C P. Bean, Physical Review. 105(1957).

[1] A. Sharma, J. Tripathi, S. Tripathi, Yogesh Kumar, K.C. Ugochukwu, D. Kumar, M. Gupta, R.J. Chaudhary, Journal of Magnetism and Magnetic Material. 510(2020) 166599.

Abstract ID: 442

IN SEARCH OF MAGNETIC SKYRMION PHASE IN 4d UNDER-DOPED MnSi

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Abstract: Magnetic skyrmions have attracted tremendous research interest due to their great potential in high-density magnetic storage applications. The magnetic properties of compounds with a non-centrosymmetric cubic B20 structure, such as MnSi and FeGe, are currently the subject of intense research. The non-centrosymmetric arrangement of magnetic atoms in a B20-type lattice leads to the formation of a spin helicoid. It is known that this structure is based on a hierarchy of interactions between spins: ferromagnetic exchange interaction, antisymmetric Dzyaloshinskii-Moriya interaction, and anisotropic exchange interaction [1,2,3]. One of the interesting features in MnSi is that the helical ordering temperature (T_{tr}) can be tuned by introducing chemical substitution of either Mn or Si site with different elements. The present study partly deals with the substitution of 4d- element Ru (two percent) for Mn as an effective means to explore the effects of negative chemical pressure. The our study investigates $Mn_{0.98}Ru_{0.02}Si$, exploring its properties through extensive temperature- and magnetic field-dependent dc and ac magnetization measurements, as well as transport measurements. A polycrystalline sample of $Mn_{0.98}Ru_{0.02}Si$ was synthesized by arc-melting method in a high purity argon atmosphere. The focus is on understanding the behavior of the magnetic transition temperature concerning variations in the applied magnetic field, leading to the construction of a detailed T-H phase diagram. The results shed light on the unique magnetic characteristics, including possible skyrmion formation, of this alloy with potential implications in the domain of magnetic spin-textured materials.

Keywords: Chiral Magnetism, field- forced spin polarization, monosilicides, spintronics

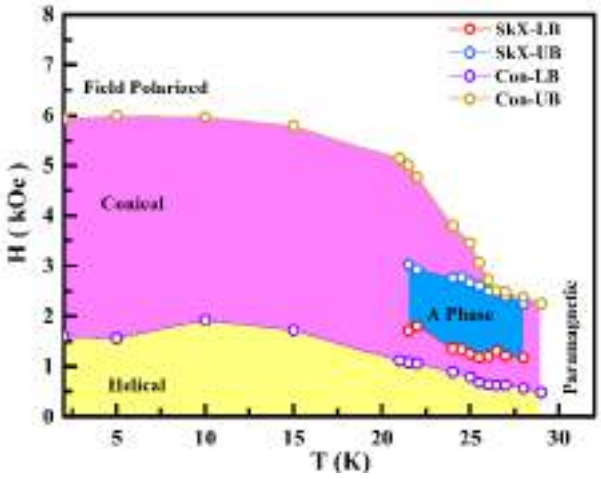


Fig. 1: T-H phase diagram of $Mn_{0.98}Ru_{0.02}Si$.

References:

[1] Samatham et al., J. Phys.: Condens. Matter. 34 (2022) 345801.
[2] J. Teyssier et al., Phys. Rev. B 82 (2010) 064417.
[3] P. Khandelwal et al., J. Phys.: Condens. Matter 36 (2024) 315803.

Abstract ID: 443

MAGNETIC AND THERMODYNAMIC INVESTIGATION OF LONG-RANGE MAGNETIC ORDER IN THE MIXED B-SITE PYROCHLORE Gd_2BiSbO_7

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Abstract: The cubic pyrochlore structure ($A_2B_2O_7$) provides an important platform for studying geometrically frustrated magnetism due to its network of corner-sharing tetrahedra. In this work, we report the synthesis and magnetic characterization of the mixed B-site pyrochlore Gd_2BiSbO_7 (GBSO). Polycrystalline samples were prepared using a conventional solid-state reaction method, and their structural and magnetic properties were investigated using powder X-ray diffraction, magnetic susceptibility, magnetization, and heat-capacity measurements down to 400 mK. Structural analysis confirms that GBSO crystallizes in a cubic pyrochlore structure with space group Fd-3m and a lattice parameter of 10.716 Å, indicating phase-pure formation. Magnetic susceptibility follows Curie–Weiss behavior at high temperatures with an effective magnetic moment of 7.93 μ_B per Gd ion, consistent with the theoretical value for Gd^{3+} (S = 7/2). The Curie–Weiss temperature $\theta_{CW} = -5.22$ K indicates dominant antiferromagnetic interactions. Isothermal magnetization measurements approach saturation near 7 μ_B/Gd at high magnetic fields, consistent with the expected behavior of Gd^{3+} ions. Heat-capacity measurements show a sharp λ-type anomaly at T = 1.76 K, indicating a transition to long-range magnetic order. At low temperatures, the magnetic heat capacity follows an approximate power-law dependence close to $C_{mag} \propto T^{3/2}$, characteristic of spin-wave excitations. However, the negative Curie–Weiss temperature suggests competing interactions, possibly leading to a non-collinear or canted magnetic structure. These results indicate that Gd_2BiSbO_7 is a promising system for studying competing magnetic interactions in geometrically frustrated pyrochlores.

Keywords: Pyrochlore Structure, Magnetic Frustration, Gd-based Compounds, Spin-Wave Excitations, Magnetic Phase Transition

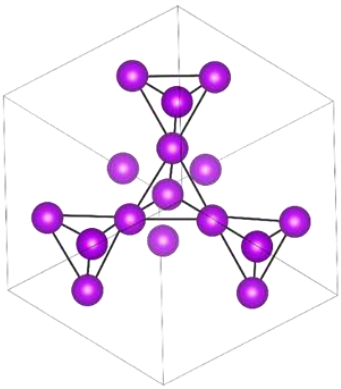


Fig. 1: Pyrochlore lattice of corner-sharing tetrahedra as occupied by the magnetic atoms (Gd).

References:

[1] Gardner, J. S., Gingras, M. J. P., & Greedan, J. E. (2010). Magnetic pyrochlore oxides. Reviews of Modern Physics, 82, 53–107.

[2] Hallas, A. M., et al. (2018). Magnetic ordering in the frustrated pyrochlore $Gd_2Pb_2O_7$. Physical Review B, 97, 054430.

Abstract ID: 444

ECO-FRIENDLY GREEN SYNTHESIS OF TiO_2 NANOPATICLES AND ITS MULTIFACETED PROPERTIES: MAGNETIC, OPTICAL, ANTIBACTERIAL AND ANTIOXIDANT

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Abstract: We report magnetic, optical, antibacterial and antioxidant properties of oxygen deficient $TiO_{2-\delta}$ NPs synthesized by environment-friendly green route using *Phyllanthus niruri* (PN) whole plant extract. Structural analysis using XRD SEM, TEM, EDS, FTIR confirms the formation of pure phase anatase TiO_2 crystals in a tetragonal structure (space group I41/amd), agglomerated spherical shape with average size ~35 nm. XPS suggest mixed oxidation states of Ti (Ti^{4+} and Ti^{3+}). A strong absorption peak (at ~250 nm) along with reduced band gap Eg ~ 2.75 eV in UV-Vis spectra is observed, possibly arises due to the surface plasmon resonance caused by *lower band gap energy* emerging from oxygen vacancies. Magnetization result (M-H) shows ferromagnetic nature at room temperature [M_S ~ 0.03 emu/g, H_C ~ 0.014 T]. The observed ferromagnetic nature may be explained by *virtual hopping* of electrons from $Ti^{3+}(3d^1)$ to $Ti^{4+}(3d^0)$-sites, however, vice versa is prohibited [1,2]. Further, antibacterial potential of TiO_2 NPs is tested against five selected bacteria (clinically dangerous to human health); *S. aureus, E. coli, K. pneumoniae, S. Typhimurium, P. aeruginosa*. Agar well diffusion and disk diffusion, MIC and MBC test confirms bactericidal nature of NPs. It makes green synthesized TiO_2 NPs a better antibacterial agent. Antioxidant experiment performed by DPPH, TEAC and FRAP method suggest significant antioxidant efficacy.

Keywords: TiO_2 Nanoparticles; Green synthesis; *Phyllanthus niruri*; Magnetic; Optical; Antibacterial and Antioxidant.

References:

[1] L. Mishra, V. K. Dwivedi et al., ACS Sustainable and Resource Management 1, 2472 (2024)
[2] L. Mishra, V. K. Dwivedi et al., Surfaces and Interfaces 72, 107047 (2025).

Abstract ID: 445

INVESTIGATING THE STRUCTURAL, MAGNETIC AND MULTIMODAL ANALYSIS OF CRYSTALLITE SIZE IN SAMARIUM-DOPED COBALT FERRITES

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Abstract: Samarium-doped cobalt ferrites have attracted significant attention due to their tunable magnetic and structural properties arising from rare-earth substitution in the spinel lattice. In this work, Sm-doped cobalt ferrite nanoparticles were synthesized via the sol-gel auto-combustion method to investigate the influence of samarium incorporation on their structural, magnetic, and microstructural characteristics. X-ray diffraction analysis confirms the formation of a single-phase cubic spinel structure. A multimodal analysis was performed to compare different crystallite-size evaluation models and to better understand the contributions of peak broadening due to both size and lattice strain. The incorporation of Sm^{3+} ions induces slight variations in the lattice parameter due to the difference in ionic radii and possible cation redistribution within tetrahedral and octahedral sites of the spinel structure. The magnetic properties were investigated using vibrating sample magnetometry. The changes in magnetic properties are attributed to modifications in superexchange interactions and structural distortions introduced by rare-earth doping. The combined structural and magnetic analysis, along with multimodal crystallite size evaluation, provides a comprehensive understanding of the role of samarium substitution in cobalt ferrites. The results demonstrate that Sm doping significantly influences the microstructural and magnetic characteristics, highlighting the potential of these materials for advanced magnetic and multifunctional applications.

Keywords: XRD, Rietveld refinement, Crystallite size, magnetic properties.

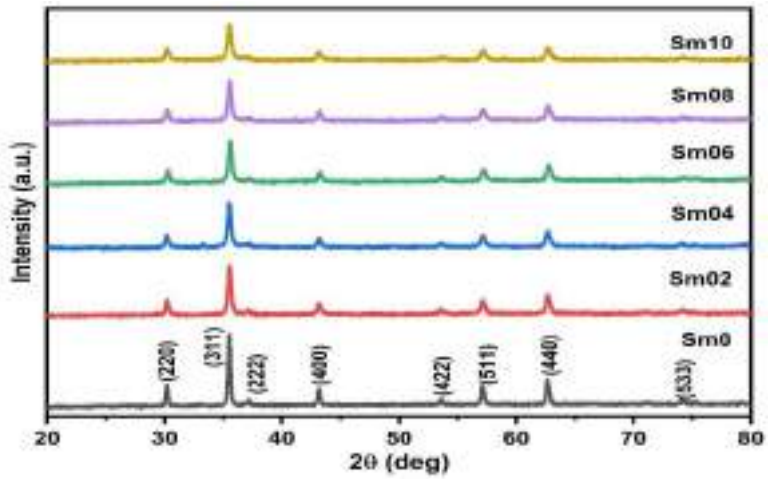


Fig. 1: XRD patterns of the synthesized Sm-doped Cobalt ferrite samples.

Abstract ID: 446

EVOLUTION OF INTERFACIAL STRUCTURE AND MAGNETIC PROPERTIES IN ANNEALED Ta/CoFeB/MgO/Ta MULTILAYERS

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Abstract: Ferromagnetic multilayer thin films capped with oxide layers can host chiral magnetic textures, including skyrmions [1], and enable spin-orbit torque-driven magnetization switching without an external magnetic field [2], making them promising for next-generation data storage. This work examines the annealing-induced evolution of structural, electronic, and magnetic properties in Ta (2.5 nm)/CoFeB (4 nm)/MgO (1.5 nm)/Ta (2 nm) multilayer systems. Atomic force microscopy confirms reduced surface roughness for 300 °C annealed stack, while XRR reveals an 86% decrease in CoFeB/MgO interface width, indicating sharper interface. In contrast, the Ta/CoFeB interface broadens by 18% after annealing. Vibrating sample magnetometry reveals that the annealed sample has a higher saturation magnetization of 1370 emu/cc (due to B diffusion into the Ta underlayer) compared to the as-deposited sample (960 emu/cc), showing a 43% enhancement. The in-plane two-fold magnetic anisotropy is analysed using angular remanent magneto-optical Kerr effect measurements. X-ray photoelectron spectroscopy shows over-oxidation of Co and Fe due to the presence of MgO in the stack. In 300 °C annealed stack prominent signatures of metallic states of Co and Fe are found as annealing drives oxygen from Co-O and Fe-O to MgO. This process is accompanied by an increase in B oxide by 85%, while Fe, Co, and Ta oxides decrease by 48%, 51%, and 66%, consistent with the Ellingham diagram, which indicates that Mg and B act as reducing agents for Co, Fe, and Ta. These findings establish a robust pathway for designing high-performance materials with tunable interfacial magnetism for in advanced spintronic applications.

Keywords: Spintronics, X-ray reflectivity (XRR), Saturation magnetization, In-plane magnetic anisotropy, X-ray photoelectron spectroscopy (XPS).

References:

[1] Z. Qin, Y. Wang, S. Zhu, C. Jin, J. Fu, Q. Liu, J. Cao, ACS Appl. Mater. Interfaces 10 (2018) 36556–36563.
[2] S. Wang, X. Dai, K. He, J. Wang, X. Zhang, Q. Guo, G. Feng, Y. Xu, Y. Deng, R. Liu, J. Du, J, Appl. Phys. Lett. 124 (2024) 112415.

Abstract ID: 447

QUANTUM SPIN LIQUID $Ba_3CuSb_2O_9$: A THIN-FILM APPROACH

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Abstract: Hexagonal perovskite materials are emerging quantum spin liquid systems that provide a fertile ground for realizing novel quantum phenomena [1]. Epitaxially grown thin films of these materials offer an attractive approach to harness exotic quantum phases for device applications, with improved control over the structure. We fabricate the intriguing quantum spin liquid triple perovskite $Ba_3CuSb_2O_9$ epitaxially on a MgO(100) substrate using pulsed laser deposition, as well as in bulk form for comparison. The presence of only (00l) parallel planes of $Ba_3CuSb_2O_9$ in X-ray diffraction confirms the epitaxial growth of the thin film. Temperature-dependent magnetization measurements of the thin film show no magnetic ordering down to 2 K, with a large antiferromagnetic Curie-Weiss temperature ($\theta CW \approx -11.68$ K). This suggests strong magnetic frustration and quantum spin liquid behavior, similar to bulk $Ba_3CuSb_2O_9$. The existence of magnetic correlations at low temperatures is further confirmed by analyzing the low-temperature magnetic isotherms. These experimental findings highlight the potential of this quantum material for use in quantum technologies.

Keywords: Quantum Spin-Liquid;Thin Film; Spin-Orbit Coupling;Hexagonal perovskite.

References:

[1] C. Broholm, R. J.Cava, S. A. Kivelson, D. G. Nocera, M. R. Norman and T. Senthil, Science. 367(2020) 0668.

[2] A. Kaipamangalath, R.Pathak, W.Akram, R. Nath, T. Maity, J. Phys.:Condens. Matter.37(2025) 085002.

Abstract ID: 448

STUDY OF MAGNETIC SHEAR AND FLUX MODULATION EFFECTS ON PLASMA STABILITY IN TOKAMAKS

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Abstract: This study investigates the interplay between magnetic field geometry and plasma stability in tokamak devices within the framework of Magnetohydrodynamics. In magnetically confined plasmas, the configuration of toroidal and poloidal magnetic fields determines the formation and stability of nested magnetic flux surfaces that sustain high temperature plasma confinement. However, perturbations in magnetic topology can trigger instabilities that disrupt these ordered structures and lead to stochastic magnetic field lines, resulting in confinement degradation. The present work examines how magnetic shear influences the onset and evolution of such instabilities, with particular attention to modes related to the Kink Instability and associated magnetic reconnection processes. By parametrizing the stability behavior within an MHD framework, we analyze the transition from coherent magnetic surfaces to stochastic field line regimes that allow enhanced plasma transport and energy loss. To explore potential stabilization strategies, we introduce the concept of a magnetic flux modulation scheme integrated into the tokamak confinement system using superconducting coils composed of Niobium Titanium. Such a configuration could enable controlled adjustment of local magnetic shear and field topology, thereby delaying instability growth and improving confinement performance. By linking magnetic topology evolution with engineered magnetic field architectures, this study provides insight into how controlled flux modulation may enhance plasma stability and support operation at higher-β regimes relevant to next-generation fusion reactors such as ITER.

Keywords: Tokamak, Plasma Stability, Magnetic Shear, Magnetohydrodynamics (MHD), Flux Modulation, Kink Instability

References:

[1] L.L. Lao, Y.Q. Liu, A.D. Turnbull, *Magnetic-Confinement Fusion-Plasma Theory: Tokamak Magnetohydrodynamic Equilibrium and Stability*, *Encycl. Nucl. Energy* (2021).

[2] M. Kikuchi, *A Review of Fusion and Tokamak Research Towards Steady-State Operation: Concepts and MHD Stability*, *Energies* 3 (2010) 1741-1789.

[3] E.J. Strait, R.J. La Haye, H. Reimerdes, et al., *Magnetic control of magnetohydrodynamic instabilities in tokamak plasmas*, *Phys. Plasmas* 22 (2015) 021803.

[4] M.R. Halfmoon, D.P. Brennan, *A Model of Energetic Ion Effects on Pressure Driven Tearing Modes in Tokamaks*, arXiv:1702.06837 (2017).

[5] C.J. Ham, J.W. Connor, S.C. Cowley, R.J. Hastie, T.C. Hender, Y.Q. Liu, *Tearing mode stability calculations with pressure flattening*, *Plasma Phys. Control. Fusion* 55 (2013) 035009.

Abstract ID: 449

INTRINSIC CLUSTER SPIN-GLASS STATE AND HIERARCHICAL SPIN DYNAMICS IN THE VAN DER WAALS ANTIFERROMAGNET NbFeTe2

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Abstract: In this study, we investigate the chemical, structural, magnetic properties of $NbFeTe_2$ single crystals, synthesized via the chemical vapor transport (CVT) method[1]. Structural characterization using X-ray diffraction (XRD) and energy-dispersive X-ray spectroscopy (EDXS) confirms the high crystalline quality and stoichiometric composition of the samples. Magnetic measurements reveal a spin-glass transition at $T_f \approx 17$ K, supported by dc and ac susceptibility studies. The spin-glass state is further validated through memory effect experiments using DC magnetization protocols. Field-cooled (FC) protocols further support the presence of aging and slow relaxation dynamics. Magnetic relaxation follows a stretched exponential form[2],

$$M(t) = M_0 \exp\left[-\left(\frac{t}{\tau}\right)^{\beta}\right]$$

where τ represents the characteristic relaxation time and β is the stretching exponent, indicative of a broad energy barrier distribution. The relaxation behavior below T_f aligns with the heirarchical model, suggesting cooperative spin dynamics. These findings make $NbFeTe_2$ as a promising van der Waals platform for studying low-dimensional magnetism and nonequilibrium spin dynamics.

Keywords: Spin-glass transition, Relaxation dynamics, Heirarchical model, Memory effect

References:

[1] Hanlin Wu, Sheng Li, Yan Lyu, *Physical Review B* 109.17 (2024): 174427.
[2] Pallab Bag, P. R. Baral, R. Nath, *Physical Review B* 98.14 (2018): 144436.

Abstract ID: 450

SPIN–ORBIT ENTANGLED GLASSY MAGNETISM AND EXCHANGE-BIAS IN Ca_3CoIrO_6 SPIN CHAINS

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Abstract: We investigate the magnetic ground state of the quasi-one-dimensional spin-chain oxide Ca_3CoIrO_6, where geometric frustration and spin–orbit coupling give rise to unconventional magnetism. Magnetization, ac susceptibility, heat capacity, transport, and Raman scattering measurements reveal a field-tunable crossover from a paramagnetic regime to a partially disordered antiferromagnetic (PDA) state below ~100 K, followed by freezing into a glassy PDA state below ~30 K. The PDA regime exhibits persistent spin-glass dynamics, slow cluster-like relaxation, and robust exchange bias, manifested by both horizontal and vertical shifts in magnetic hysteresis loops. Low-temperature measurements uncover magnetic excitations through a field-dependent Schottky anomaly in heat capacity and enhanced magnetic scattering in Raman spectra, reflecting strong spin fluctuations and short-range correlations intrinsic to the frustrated state. These results establish Ca_3CoIrO_6 as a model system where geometric frustration, spin–orbit coupling, and interchain interactions conspire to stabilize glassy magnetism and exchange bias in a quasi-one-dimensional oxide.

Abstract ID: 452

DOMAIN WALL ENGINEERING: A PATHWAY TO SOLVE THE FUNDAMENTAL PROPERTY TRADE-OFF IN SOFT MAGNETIC MATERIALS THROUGH NANOPRECIPITATION

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Abstract: Electrification in the automotive and aerospace sectors demands soft magnetic materials (SMMs) combining superior magnetic and mechanical properties. For instance, traction motors in electric vehicles require adequate mechanical strength to sustain the immense stresses at high rotational speeds [1]. However, conventional SMMs lack the necessary mechanical strength for such demanding applications. This fundamental trade-off between magnetic and mechanical properties demands the development of a new class of SMMs. One promising pathway to overcome this lies in compositional optimization coupled with microstructural engineering [2]. In this work, we report a novel Fe-rich FeCoNi alloy having excellent magnetic and moderate mechanical properties. The base alloy composition was optimized using CALPHAD to establish a single-phase ferromagnetic BCC matrix. Furthermore, controlled Ti addition to the optimized base composition led to the nucleation of ordered coherent nanoprecipitates, contributing towards a significant improvement in mechanical properties with only a minor reduction in magnetic properties. To fully understand the chemistry and structure of these precipitates, we employed advanced characterization techniques, such as transmission electron microscopy (TEM) coupled with atom probe tomography (APT). We also investigated the interaction of magnetic domain walls with the nanoprecipitates using Lorentz microscopy. Through processing optimization, the precipitate size was maintained below the magnetic domain wall width (δ), thereby minimizing detrimental domain wall pinning and preserving the soft magnetic properties. This work demonstrates that strategic compositional optimization and microstructural engineering can successfully overcome the fundamental trade-off between magnetic and mechanical properties, hence opening new pathways for the design and development of high-performance SMMs.

Keywords: SMMs, Magnetic domain walls, Nanoprecipitation, Lorentz microscopy, Transmission electron microscopy (TEM), Atom probe tomography (APT).

References:

[1] Gutfleisch, O., Willard, M.A., Brück, E., Chen, C.H., Sankar, S.G. and Liu, J.P. (2011), Magnetic Materials and Devices for the 21st Century: Stronger, Lighter, and More Energy Efficient. Adv. Mater., 23: 821-842.

[2] Han, L., Maccari, F., Souza Filho, I.R. *et al.* A mechanically strong and ductile soft magnet with extremely low coercivity. *Nature* **608**, 310–316 (2022).

Abstract ID: 453

NORMAL-STATE MAGNETOTRANSPORT AND ANISOTROPIC QUASI TWO-DIMENSIONAL SUPERCONDUCTIVITY IN IT-NbSeTe WITH A BEREZINSKII–KOSTERLITZ–THOULESS TRANSITION

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Abstract: Transition metal dichalcogenides (TMDCs) have drawn considerable research attention due to their layered structure and the emergence of a wide range of collective electronic phenomena, such as charge density waves, superconductivity, and non-trivial topological states [1,2]. In this study, we reported the structural, normal-state magnetotransport, and superconducting properties of the TMDC compound 1T-NbSeTe. Temperature-dependent resistivity and magnetic measurements reveal the onset of bulk superconductivity with a superconducting transition at (3.1 ± 0.02) K. The upper critical field was determined considering 99% normal state resistivity criteria, which were calculated to be (2.94 ± 0.06) and (7.65 ± 0.07) T for fields applied parallel and perpendicular to the crystallographic c-axis, respectively. The anisotropy parameter, $\Gamma = \frac{H_{c2}^{\parallel ab}}{H_{c2}^{\parallel c}}$, was calculated to be 2.6, indicating pronounced anisotropy in 1T-NbSeTe. Interestingly, H_{c2} exceeds the Pauli paramagnetic limit for the magnetic fields applied perpendicular to the c-axis in 1T-NbSeTe. Furthermore, the upper critical field was also determined from transverse magnetoresistance measurements, yielding H_{c2} (0) using Ginzburg-Landau theory as (3.70 ± 0.09) and (6.78 ± 0.05) T, respectively, for magnetic fields parallel and perpendicular to the crystallographic c-axis. Magnetotransport measurements reveal quasi-linear magnetoresistance without saturation, accompanied by a zero field cusp, reaching maximum values of about 0.24% and 0.20% at 8 T for magnetic fields applied parallel and perpendicular to the crystallographic c-axis, respectively, in 1T-NbSeTe. The current–voltage characteristics exhibit a power-law behavior, $V \propto I^3$ near 1.86 K, consistent with the Berezinskii–Kosterlitz–Thouless transition, suggesting quasi-two-dimensional superconductivity in 1T-NbSeTe.

Keywords: Quasi-2D superconductivity, Transition Metal Dichalcogenides, Upper critical field, Magnetotransport, Berezinskii–Kosterlitz–Thouless transition

References:

[1] S. Manzeli, D. Ovchinnikov, D. Pasquier, O. V Yazyev, and A. Kis, Nat. Rev. Mater. **2**, 1 (2017).
[2] C. Patra, S. Mondal, R. Mukherjee, and Y. Nandakishora, ACS Mater. Au **5**, 745 (2025).

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Abstract ID: 454

LIGHT-BASED 3D PRINTING OF MAGNETICALLY RESPONSIVE Fe_3O_4- BIO-VITRIMER NANOCOMPOSITES FOR SOFT ACTUATORS

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Abstract: Magnetically responsive polymers have attracted increasing interest for applications in soft robotics, adaptive structures, and remotely controllable devices due to their ability to undergo deformation under external magnetic fields without direct physical contact. Integrating magnetic responsiveness into photocurable resin systems enables the fabrication of complex, customized magneto-active structures via light-based 3D printing techniques [1]. In parallel, the incorporation of dynamic covalent networks, vitrimers, into biobased photopolymers has emerged as an effective strategy to impart healability, reprocessability, and structural adaptability in otherwise permanently crosslinked materials, for sustainable additive manufacturing of objects [2,3]. Magnetically responsive vitrimer nanocomposites were formulated for digital light processing (DLP) 3D printing using bio-derived acrylated epoxidized soybean oil, a glycerol-based reactive diluent, and thiol crosslinkers. Fe_3O_4 magnetic nanoparticles were incorporated within the thiol-acrylate vitrimer matrix to impart magnetic functionality while maintaining the dynamic covalent characteristics of the polymer network. The resulting printed networks containing hydroxyl and ester groups show vitrimer behaviour by thermally activated transesterification reactions, catalyzed by $Sn(Oct)_2$, enabling self-healing and shape-memory. The nanocomposite resins exhibit suitable rheological properties and photopolymerization kinetics for DLP printing, enabling fabrication of soft structures with uniform nanoparticle dispersion as studied by curing kinetics, viscosity studies, SAXS, and WAXS. The printed nanocomposites exhibit efficient healability and shape-memory behavior, while the incorporation of Fe_3O_4 nanoparticles enables magnetic responsiveness and field-induced actuation highlighting its potential for magnetically controlled soft robotic actuators.

Keywords: Bio-vitrimer, Magnetic actuation, 3D printing, healability, Vat-photopolymerization.

References:

[1] Rossegger, E., Höller, R., Hrbinič, K., Sangermano, M., Griesser, T. and Schlögl, S. Advanced engineering materials, 25(7), (2023) p.2200749.
[2] Bijalwan, V., Rana, S., Yun, G.J., Singh, K.P., Jamil, M. and Schlögl, S. Polymer Reviews, 64(1), (2024) pp.36-79.
[3] Bijalwan, V., Schlögl, S. and Rana, S. RSC Advances, 15(58), (2025) pp.49714-49727.

Abstract ID: 455

CRYSTAL STRUCTURE AND MAGNETISM OF INTERMETALLIC COMPOUND $Pr_{0.33}Nd_{0.33}Sm_{0.33}Ni_5$

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Abstract: This work focusses on layered rare earth (R) intermetallic compound RNi_5 (hexagonal, $CaCu_5$-type) with three equimolar light rare earth elements, i.e. Pr, Nd and Sm at R-site. Among the RNi_5 compounds, $PrNi_5$ earned a special attention for hosting strong crystalline electric field (CEF) with weaker exchange interactions between Pr^{3+} moments. This compound does not order down to a very low temperatures because of the presence of a CEF singlet ground state. In fact, a large Van Vleck susceptibility is also present because of small separations of the singlet ground state from the nearest-neighbour excited state. Therefore, this compound has been successfully used for adiabatic demagnetization based cooling technique to reach low temperature of about 1 mK [1]. Motivated by the high-entropy design of materials, polycrystalline $Pr_{0.33}Nd_{0.33}Sm_{0.33}Ni_5$ compound has been synthesized and characterized. This material is in single phase and it has parent $CaCu_5$-type hexagonal crystal structure at room temperature [Fig. 1(a)]. All three rare earth elements are homogeneously distributed in the lattice as evidenced by electron microscopy studies. Magnetization data measured in zero-field-cooled state in 5 kOe field shows a transition at about 7 K [Fig. 1(b)]. This transition is also visible in the low temperature heat capacity data. Both the structural and magnetic data mimic that of the end member compounds while the unit cell volume is intermediate to that of $NdNi_5$ and $SmNi_5$.

Keywords: Rare earth intermetallic compound, Crystal structure, Magnetic properties, Magnetocaloric effect.

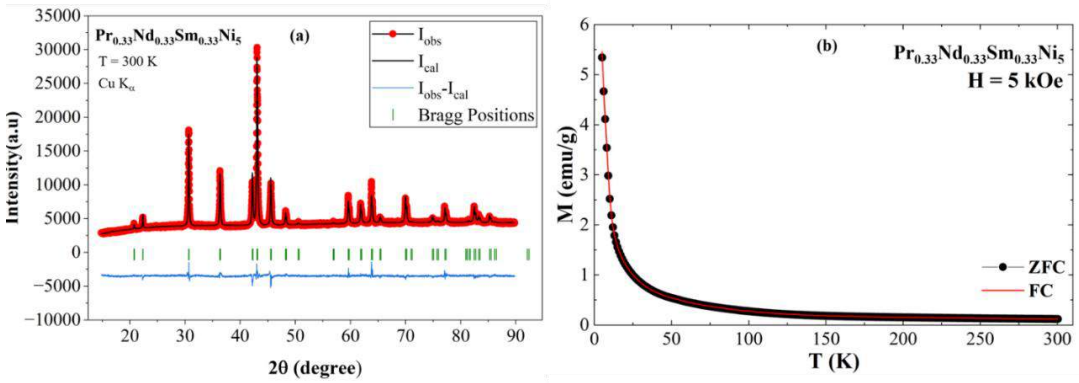


Fig. 1: (a) Powder X-ray diffraction data at 300 K and (b) Magnetization vs temperature in 5 kOe field of $Pr_{0.33}Nd_{0.33}Sm_{0.33}Ni_5$ compound.

Acknowledgement:
R. N thanks SERB, India for project grant (number: CRG/2022/007828).

Reference:

[1] K. Andres and S. Darack, Physica B 86–88 (1997) 1071-1076.

Abstract ID: 456

MAGNETOCALORIC STABILITY AND FREQUENCY INDEPENDENCE OF $GdAl_2$ UNDER CYCLIC MAGNETIC FIELD FOR REFRIGERATION

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Abstract: the magnetocaloric effect (MCE) principle has created an increasing interest because of several advantages including magnetic refrigeration as compared with classical gas compression-relaxation cooling systems. The MCE properties of the material can be studied under the application of a unidirectional magnetic field with indirect methods of calculating the maximum ΔS_m^{max} using Maxwell's relation. But it is known that magnetic materials in commercial magnetic refrigerators are subjected to the repeated cyclic action of magnetic fields. Several reported materials showing a reduction or even a loss of MCE properties after a certain number of cycles of magnetization and demagnetization [1]. Therefore, carrying out the magnetocaloric effect (MCE) investigations in cyclic magnetic fields is an important task for getting efficient cooling applications. Intermetallic compound $GdAl_2$ was prepared by arc-melting method using Arc Melting in an Ar atmosphere. X-ray diffraction (XRD) pattern for the synthesized $GdAl_2$ compound confirms that it crystallizes in a cubic $MgCu_2$-type structure, belonging to the space group $Fd\text{-}\bar{3}m$ (space group number 227). Further, The obtained lattice parameters from Rietveld refinement are as follows: $a = b = c = 7.8905$ Å, which is in close agreement with the reference. The alloy under direct measurement of magnetocaloric studies shows a maximum adiabatic temperature change(ΔT_{ad}) of 1.6 K at an applied field of 1.8 T. This magnetocaloric behaviour is stable and has no frequency dependence. The alloy shows nearly a zero reduction in the ΔT_{ad} for a frequency range of 1-10 Hz. This confirms that the material is highly suitable for commercial refrigeration applications.

Keywords: Magnetocaloric effect (MCE), Magnetic Refrigeration, Cyclic Magnetic field, second order magnetic transition, Magnetocaloric stability.

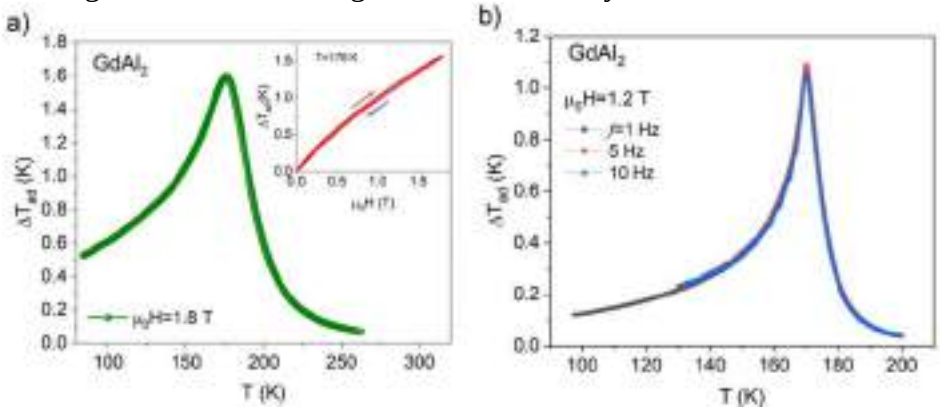


Fig. 1: (a) Dependence of ΔT_{ad} on temperature in a magnetic field of 1.8 T. Inset: dependence of $\Delta T_{ad}(H)$ at T=176 K. (b) Temperature dependence of ΔT_{ad} in a cyclic magnetic field of 1.2 T at different frequencies of the cyclic magnetic field f=1, 5 and 10 Hz.

References:

[1] O. Sari and M. Balli, *International Journal of Refrigeration*, 2014, 8–15. 10.1016/j.ijrefrig.2013.09.027

Abstract ID: 458

MECHANICAL MILLING INDUCED MICROSTRUCTURAL AND MAGNETIC PROPERTY EVOLUTION IN Co–Zr METALLIC RIBBON

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Abstract: Zr_2Co_{11} has emerged as a promising rare-earth-free magnetic material due to its ability to exhibit high energy products in thin-film nanocomposites. Powder metallurgy provides an effective approach for producing these alloys in bulk magnet form while enabling control over the microstructure and the distribution of soft and hard magnetic phases, which are important for optimizing magnetic performance. In this study, the influence of mechanical milling on the microstructure and magnetic properties of a metallic ribbon with composition $Co_{85}Zr_{15}$ is examined. The phase composition and microstructure of both the as-cast ribbon and the milled powder were characterized using transmission electron microscopy (TEM) and synchrotron X-ray diffraction (XRD). TEM analysis shows that mechanical milling reduces the ribbon into fine particles with an average size of about 11 nm. Magnetic measurements reveal that the saturation magnetization (M_s) increases, whereas the coercivity (Hc) decreases with increasing milling time. To interpret these observations, first-principles calculations based on the rhombohedral structure of Zr_2Co_{11} were performed to estimate variations in the total magnetic moment of the unit cell under isotropic compression and expansion, and to evaluate the effects of off-stoichiometry and defect formation.

Keywords: Hard magnetic materials, ZrCo metallic ribbon, ball milling, metallic ribbon, exchange coupling.

Abstract ID: 459

LOW-TEMPERATURE STRUCTURE AND MAGNETO TRANSPORT ANOMALY IN $Nd_{0.5-x}Na_xSr_{0.5}MnO_3$ MANGANITES

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Abstract: Half-doped perovskite manganites, with the general formula $RE_{0.5}AE_{0.5}MnO_3$ (where RE represents a trivalent rare-earth cation and AE a divalent alkaline-earth cation), have an equal Mn^{3+}/Mn^{4+} ratio of 1:1 have attracted considerable research interest due to their rich structural, magnetic, and electronic phase transitions. Among them, $Nd_{0.5}Sr_{0.5}MnO_3$ exhibits a temperature-dependent structural transition associated with a charge-ordering (CO) transition, where the system evolves from a ferromagnetic metallic (FMM) state at higher temperatures to an antiferromagnetic insulating (AFI) state at lower temperatures [1]. The substitution of cations at the A-site plays a crucial role in tuning these properties. In particular, the monovalent cation at A site is known to have a doubling effect of Mn^{4+} valency because of the charge difference as compared to divalent cation. This lead to inhibition of charge ordering and its associated antiferromagnetism [2, 3]. The present study reports the low-temperature structural properties in Na substituted $Nd_{0.5}Sr_{0.5}MnO_3$ and its corresponding magnetic properties. The samples were synthesized using solid-state reaction method having respective metal oxides and carbonates as starting materials. The high volatile nature of the monovalents makes it a challenging task. Moreover, the prepared samples were probed for change of crystal structure using synchrotron X-ray diffraction in the temperature range of 4 K to 300 K reveals the transition from the orthorhombic to the monoclinic structure in the $P2_1/m$ space group with the coexistence of the two phases in a wide temperature range below room temperature.

Keywords: Perovskite Manganites, Phase Transition, Magneto Transport, Orthorhombic, Monoclinic.

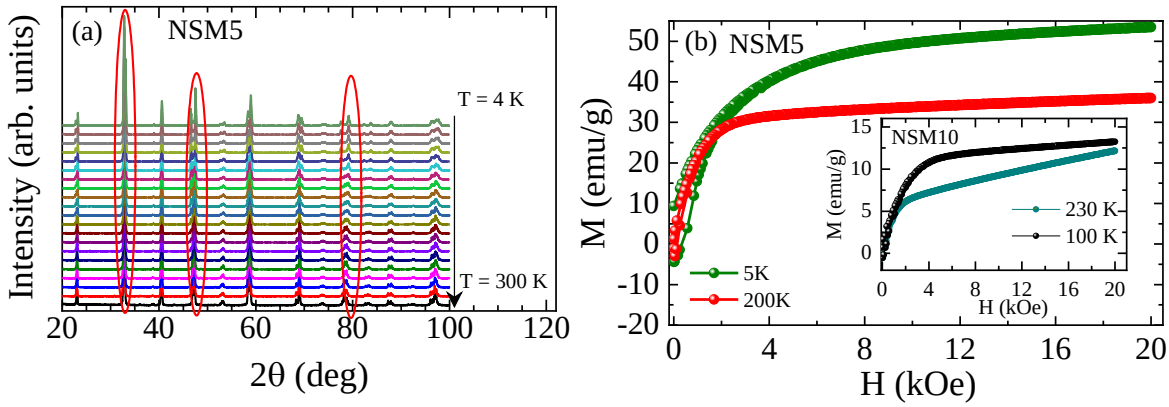


Fig. 1: (a) Synchrotron XRD pattern and (b) Magnetization (M) with the applied magnetic field (H) for $Nd_{0.45}Na_{0.05}Sr_{0.5}MnO_3$ (NSM5) and $Nd_{0.40}Na_{0.10}Sr_{0.5}MnO_3$ (NSM10) samples.

References:

[1] Shankar, Uma, Rishikesh Pandey, Akhilesh Kumar Singh, J. Appl. Phys. 123, 124301 (2018)

[2] R. Rawat, K. Mukherjee, Kranti Kumar, A. Banerjee P. Chaddah, J. Phys.: Condens. Matter 19. 25 (2007)

[3] P. M. Woodward, D. E. Cox, T. Vogt, C. N. R. Rao, A. K. Cheetham, Chem. Mater. 11.12 (1999) 3528–3538

Abstract ID: 460

TOWARD RARE-EARTH-FREE MAGNETS: IMPURITY AND DOPANT EFFECTS ON THE CUBIC-TO-TETRAGONAL TRANSFORMATION IN FENI

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Abstract: Rare-earth-free permanent magnets are intensively investigated as sustainable alternatives to rare-earth based magnetic materials. Among the proposed candidates, the ordered $L1_0$ FeNi phase is particularly attractive due to its high magnetocrystalline anisotropy and large saturation magnetization. However, the formation of the ordered $L1_0$ structure from the disordered A1 (fcc) FeNi phase remains challenging because of extremely slow atomic diffusion near the order-disorder transition temperature (T_{od}). In this work, Fe-Ni alloys were synthesized using mild steel with different impurity compositions using Vacuum Arc Melting. The structural and magnetic properties of the prepared samples were characterized using X-ray Diffraction and Vibrating Sample Magnetometry. To promote atomic ordering, the alloys were annealed at 350 °C for 15 days. The influence of impurity composition and prolonged annealing on phase stability, structural evolution, and magnetic behavior was systematically investigated to evaluate the possibility of inducing the A1 → $L1_0$ transformation. In parallel, density functional theory calculations were performed to study the role of selected dopants (C, B, Ti, Al, Mn, Cu, and P) in the A1 FeNi structure. Previous theoretical studies have shown that alloying elements such as Ti and Al can modify and even increase the T_{od}, indicating that alloy design can promote stabilization of the $L1_0$ phase [1]. Our calculations focused on their effects on key parameters governing atomic ordering, including ordering energy, vacancy effect, migration barriers, T_{od} and magnetocrystalline anisotropy. These results contribute to understanding potential pathways for stabilizing the $L1_0$ FeNi phase and advancing the development of rare-earth-free permanent magnets.

Keywords: $L1_0$ FeNi, Rare-earth-free permanent magnets, Order-Disorder transformation, Density Functional Theory, Alloying effects, Magnetocrystalline anisotropy.

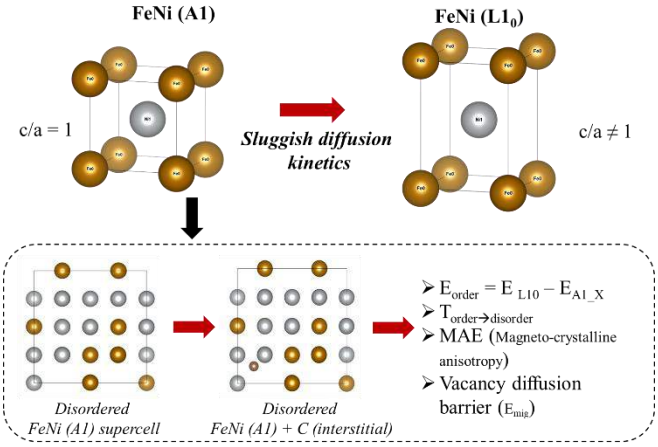


Fig. 1: Schematic representation of the structural transformation in FeNi (A1 → $L1_0$)**.**

References:

[1] Tian, Li-Yun, et al. *Scientific Reports* 11.1 (2021): 5253.

Abstract ID: 461

GEOMETRIC FRUSTRATION AND 1D MAGNETISM EXPLORED BY ^{31}P SSNMR IN A S=5/2 TRAINGULAR LATTICE SYSTEM

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Abstract: Geometric frustration and one-dimensional magnetism boost quantum fluctuations and lead to unusual states of quantum matter[1]. To explore these effects, we used solid state nuclear magnetic resonance (SSNMR), which is a strong local probe to extract the true spin susceptibility and the spin network of a magnetic system. In this work we studied the magnetic behavior of a well-separated S = 5/2 saw-tooth spin chain compound $CaFe_2O(PO_4)_2$ (CFPO), which has two different ^{31}P sites in the unit cell (Fig.1). Magnetic susceptibility, heat capacity, and ^{31}P NMR measurements show evidence of strong magnetic frustration (with a frustration parameter ≈ $|\theta_{CW}|/T_N$) about 70) in CFPO. At high temperatures, χ (T) follows Curie-Weiss behavior (θ_{CW} ≈−1073 K), indicating strong AF interactions. At low magnetic fields (0.01 T), χ (T) exhibits an upturn and a distinct bifurcation between the zero-field-cooled (ZFC) and field-cooled (FC) curves near 15.5 K (Fig.2). The bifurcation between the ZFC and FC data is strongly suppressed at 1 T, signalling weak ferromagnetic nature of the magnetic transition. The major finding of our work came from the ^{31}P NMR measurements, which show a broad maximum near 70 K (Fig.3), reflecting the low-dimensional nature and presence of short-range correlations. We note that such a broad maximum feature is not seen in the bulk χ (T) or heat capacity. Further investigating this broad maximum feature, we conclude that CFPO represents an interesting realization of a frustrated S = 5/2 sawtooth spin-chain.

Keywords: geometric frustration, low dimensional magnetism, solid state NMR, triangular lattice, strongly correlated electrons, quantum fluctations.

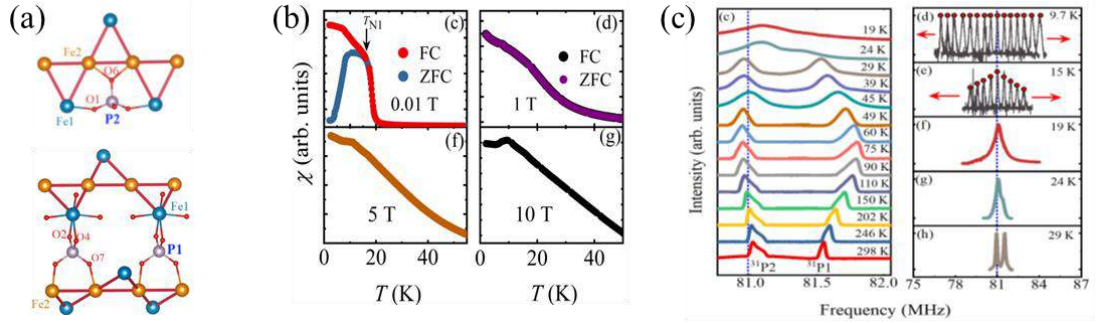


Fig. 1: (a) local environment of P_1 and P_2 in CFPO. (b) χ(T) vs. T at various magnetic fields. (c) Plot of T dependence of the normalized ^{31}P NMR spectra measured as a function of frequency.

References:

[1] A. Vasiliev, O. Volkova, E. Zvereva, and M. Markina, npj Quantum Mater. **3**, (2018) 18.

Abstract ID: 462

ADIABATIC DEMAGNETIZATION REFRIGERATION IN 3D FRUSTRATED FCC LATTICE SYSTEMS

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Abstract: Magnetic materials with geometrically frustrated spin networks often host unconventional magnetic states and retain large magnetic entropy at low temperatures, making them promising candidates for adiabatic demagnetization refrigeration (ADR). Ba_2MTaO_6 (M = Gd, Yb) hosts a three-dimensional face-centered-cubic (fcc) lattice of magnetic ions forming a frustrated network. The large spin moment of Gd^{3+} (S = 7/2) and the spin–orbit-coupled effective $J_{\text{eff}} = 1/2$ state of Yb^{3+} provide complementary platforms to explore magnetic frustration, quantum magnetism, and entropy-driven cooling. In this work, we investigate the magnetic, thermal, and electronic properties of Ba_2MTaO_6 (M = Gd, Yb) in order to evaluate their potential for ADR applications. Magnetic susceptibility and low-temperature specific heat measurements were performed to probe magnetic interactions and thermodynamic behavior. The field-dependent magnetic entropy was analyzed to assess the magnetocaloric response relevant for ADR. Magnetic susceptibility measurements reveal predominantly antiferromagnetic interactions in both systems. Specific heat measurements indicate the absence of magnetic long-range order down to 100 mK, suggesting geometric frustration in the fcc lattice [2]. A pronounced difference in magnetic entropy between zero and applied magnetic fields highlights a significant magnetocaloric effect. These results demonstrate that Ba_2MTaO_6 (M = Gd, Yb) are promising materials for ultra-low-temperature refrigeration and provide an attractive platform to explore the interplay of geometric frustration, spin–orbit coupling, and quantum magnetism in three-dimensional lattices.

Keywords: Magnetic frustration, fcc lattice, adiabatic demagnetization refrigeration, Spin-orbit-coupling.

References:

[1] T. Treu, M. Klinger, N. Oefele, P. Telang, A. Jesche, P. Gegenwart, J. Phys.: Condens. Matter 37, (2025) 013001.

[2] V. K. Sahu, Sk Soyeb Ali, M.P. Saravanan, P. D. Babu, A. Thamizhavel, S. K. Panda, B. Koteswararao, Phys. Rev. B 112, (2025) 224436.

Abstract ID: 463

MULTI LENGTH-SCALE EVALUATION OF MAGNETOELASTIC PHASE TRANSFORMATION IN MAGNETOCALORIC $(Mn,Fe)_2(P,Si)$- TYPE COMPOUNDS

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Abstract: Magnetocaloric materials exhibit temperature changes upon magnetic field application, making them promising candidates for eco-friendly magnetic refrigeration. $(Mn,Fe)_2(P,Si)$-type compounds exhibit first order magneto-structural phase transition and are particularly attractive due to their giant MCE, tunable working temperature, and low cost, but they suffer from thermal hysteresis which limits their practical applications. Previous studies have attributed hysteresis in these magnetoelastic compounds primarily to elastic strain energy barriers, based on in-situ XRD investigations [1]. However, deeper insight into magnetoelastic phase transitions and strategies to minimize thermal hysteresis are vital for practical applications. This work investigates magnetoelastic phase transformations in $(Mn,Fe)_2(P,Si)$-type alloys through multi-length scale characterization. $(Mn,Fe)_2(P,Si)$-type samples with varying hysteresis levels were studied using complementary advanced techniques: in-situ X-ray diffraction, Lorentz transmission electron microscopy in Fresnel mode, and magneto-optical Kerr effect (MOKE) imaging to evaluate and understand the difference in their microstructural and phase transition behaviour in these materials at different length scales and to get insights on how it might affect the thermomagnetic properties and thermal hysteresis. In-situ XRD results reveal direct correlations between elastic strain energy barriers and thermal hysteresis, with high-hysteresis samples exhibiting large lattice parameter shifts and high energy barriers, consistent with previous literature. Real-time Lorentz-TEM observations reveal fundamentally different transformation mechanisms between these systems. MOKE imaging confirms bulk-scale phase nucleation and propagation behavior, validating the localized TEM observations across different length scales.

Keywords: Magnetocaloric effect; Thermal hysteresis; Lorentz-TEM.

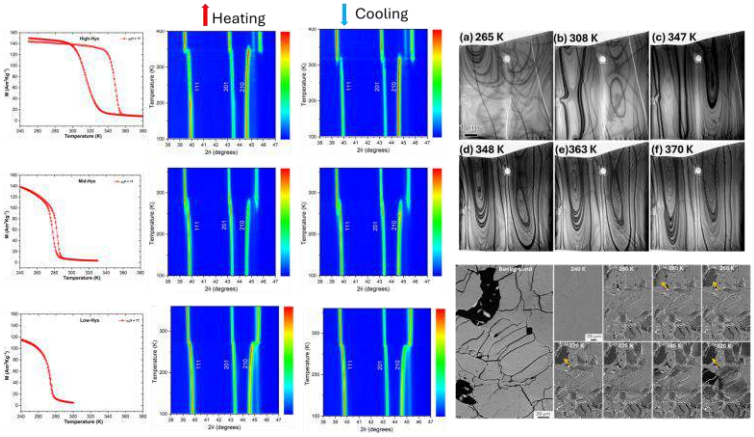


Fig. 1: Thermal Hysteresis in magnetocaloric samples, In-situ XRD and In-situ Lorentz TEM of Small, Medium and Large Hysteresis Samples.

References:

[1] X.F. Miao et al. J. Mater. Sci. Technol., 103 (2022), pp. 165-176.

Abstract ID: 464

UNDERSTANDING MAGNETO PLASMONIC EFFECTS IN ALLOY THIN FILMS AND APPLICATIONS

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Abstract: Magnetoplasmonics deals with the combined functionalities of magneto-optical coupling and surface plasmon resonance.[1] Alloy thin films have been extensively used for various applications, from data storage to photothermal heat generation.[2] The current study uses magnetron co-sputtering to fabricate Ni-Ag thin films. The film parameters, namely the thickness and composition of thin films, are tuned by optimizing deposition power and co-sputtering time. Using the optimized process, it is possible to realize films with uniform compositions with a thickness from 40 nm to 130 nm. We have also investigated the film's magneto-optical response to understand the composition-dependent response.

Keywords: Magnetoplasmonics, co sputtering, alloy thin films.

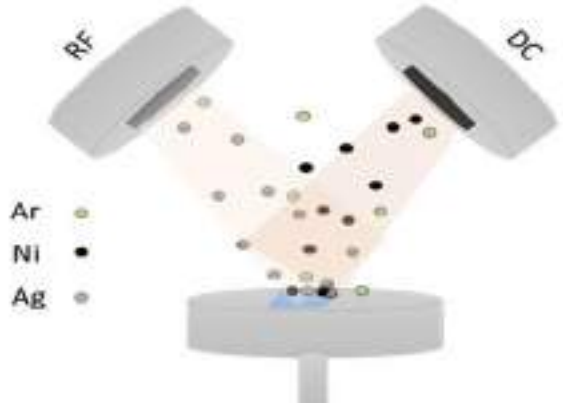


Fig. 1: Schematic illustration of deposition of thin films using magnetron co-sputtering.

References:

[1] Armelle, G. et. Al., Adv. Optical Mater. 2013, 1, 10–35.

[2] Chuqiao Song, Zhaohua Wang, Zhen Yin, Dequan Xiao, Ding Ma, Chem Catalysis, Volume 2, Issue 1, 2022.

Abstract ID: 467

REJUVENATION OF END OF LIFE NdFeB MAGNETS THROUGH Nd-Cu EUTECTIC ALLOY ADDITION AND MELT-SPINNING TECHNIQUE

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Abstract: Structurally intact end-of-life (EoL) NdFeB magnets recovered from electric vehicles (EVs) and wind turbines present a compelling opportunity for direct recycling with maximum retention of metallic value. This study investigates the feasibility of rejuvenating EoL magnets (grade N38H) sourced from EV motors and wind turbines through the incremental addition of Nd-30Cu eutectic alloy (0, 5, and 10 wt%) to produce melt-spun ribbons suitable for subsequent hot deformation processing. The EoL NdFeB magnets were systematically characterized using X-ray diffraction (XRD) and inductively coupled plasma optical emission spectrometry (ICP-OES) to establish a compositional and structural baseline of the source material. As-received EoL samples (0 wt%) and Nd-Cu-modified alloys (5 and 10 wt%) were re-melted and processed by melt spinning at a casting speed of 25 m/s to yield rapidly solidified flakes. The compositional, structural, thermal, microstructural, and magnetic properties of both the EoL magnets and melt-spun flakes were comprehensively evaluated using ICP-OES, XRD, DSC, SEM-EDS, EPMA, and PPMS. The preliminary results indicate that wind turbine magnets exhibit superior compositional and microstructural stability compared to EV motor magnets, predominantly retaining the $Nd_2Fe_{14}B$ intermetallic phase. In contrast, EV motor magnets suffer significant neodymium loss during surface preparation and re-melting, leading to the formation of secondary phases including Nd_2Fe_{17}, Fe_2B, and α-Fe. This work systematically compares EoL and melt-spun flake characteristics and establishes composition–process–property correlations to guide the effective reprocessing of EoL NdFeB permanent magnets.

Keywords: End of Life magnet; NdFeB hard Magnet; Alloy modification; Melt-spinning

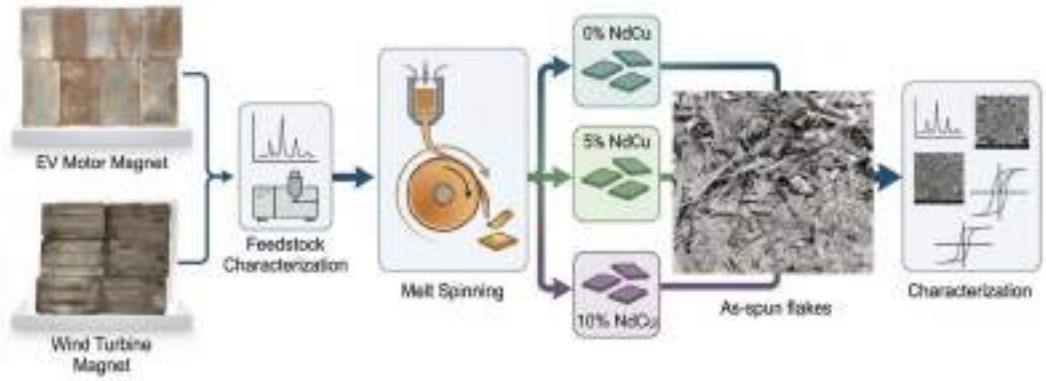


Fig. 1: Workflow of rejuvenation of End of Life EV and windmill NdFeB magnets.

Abstract ID: 472

INVESTIGATION OF STRUCTURAL, DIELECTRIC, AND MAGNETIC PROPERTIES IN COBALT-DOPED RUTHENATE PYROCHLORES

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Abstract: Geometrically frustrated magnetic materials with a pyrochlore structure offer a rich platform for exploring exotic magnetic ground states. While 4d transition metal oxides like rare earth ruthenates exhibit complex spin-glass-like behaviour, and their oxygen lability and structural properties have been effectively tuned via A-site substitution [1], the direct incorporation of a 3d transition metal into the Ru-site can significantly alter the primary magnetic exchange pathways. This study investigates the structural, vibrational, and electrical properties of Cobalt-doped rare earth ruthenates, synthesized via the standard solid-state reaction route. The incorporation of Co ions into the Ru sublattice introduces competing 3d-4d magnetic exchange interactions, perturbing the inherent geometric frustration. X-ray diffraction (XRD) confirms phase purity and the retention of the face-centred cubic Fd-3m structure, tracking the lattice parameter contraction associated with Co doping. Raman spectroscopy reveals the evolution of local structural symmetries and variations in the oxygen coordination polyhedron. Furthermore, high-temperature dielectric studies demonstrate anomalous relaxation behaviours coupled with the structural modifications. The interplay between the localized 3d magnetic moments of Co and the extended 4d orbitals of Ru provides new insights into the cooperative phenomena governing this system. These findings underscore the tunability of ruthenate pyrochlores through transition metal doping, offering a pathway toward novel functional magnetic materials.

Keywords: Pyrochlore ruthenates, Geometric frustration, Cobalt doping, 3d-4d exchange interactions.

References:

[1] D.A. Kuznetsov, M.A. Naeem, P.V. Kumar, P.M. Abdala, A. Fedorov, C.R. Müller, J. Am. Chem. Soc. 142 (2020) 7883-7888.

Abstract ID: 473

SPIN-POLARIZED THERMOELECTRIC TRANSPORT IN SPINEL FERRITE THIN-FILM DEVICES

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Abstract: Spinel ferrites have significant attention due to their tunable magnetic, electrical and structural properties arising from cation distribution and electron hopping mechanism. Despite extensive studies on their magnetic behaviour, their potential thermoelectric application remains underexplored, particularly under thin film configuration. In this research work, copper ferrite spinel nanoparticles are synthesized via hydrothermal route to achieve controlled morphology and phase purity. The synthesized Copper ferrite shows the p-type behaviour, while n-type material were achieved by optimization. As-synthesized ferrite spinels are subsequently utilized for thin-film fabrication through thermal deposition as p-type and n-type legs to construct p-n juction thermoelectric device. The phase composition, structural properties and transport properties are systematically investigated through XRD, FE-SEM and Hall measurement analysis. The fabricated samples shows the seebeck coefficient value of around 300 µV/K. The obtained results attributed to the interplay of spin-dependent charge transport, carrier hopping mechanism and phonon scattering within the spinel lattice. In particular, magnectic interactions and associated scattering processes contribute to reduced thermal conductivity and enhanced thermopower. This work highlights the potential of defect-engineered copper ferrite for p-n juction thermoelectric applications and provides insights into coupling magnetic and thermoelectric properties for improved device performance. The fabricated device shows the open circuit voltage of around 1.5 mV at the temperature difference of 5 K.

Keywords: Spinels, defects, cation distribution, electron hopping and phonon scattering

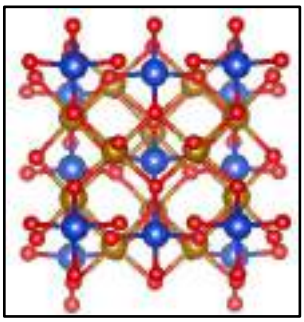


Fig. 1: Crystal structure of cubic copper ferrite spinels.

References:

[1] N Tsujii, F Garmroudi, E Bauer, T Mori, Mater. Today Phys. 48 (2024) 101568.
[2] Lakshmi Prabha Chandrasekar, Pandiyarasan Veluswamy, Hiroya Ikeda, Sivakami Mohandos, Surf. Inter. 62 (2025) 106245.

Abstract ID: 474

SYNTHESIS OF α''– $Fe_{16}N_2$ HARD MAGNETIC PHASE VIA Fe-BASED MELT SPUN PRECURSORS

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Abstract: The search for high-performance permanent magnets without reliance on critical rare-earth elements has intensified in recent years. Among the promising candidates, α'' $Fe_{16}N_2$ has gained attention owing to its giant saturation magnetization (1.39 T), large theoretical maximum energy product (BH_{max} ~130 MGOe), and composition from earth-abundant elements Fe and N. However, bulk synthesis of this metastable phase remains difficult due to its narrow compositional and thermal stability window, coupled with the challenge of nitrogen incorporation via surface diffusion. In the present study, we designed a series of binary and quaternary alloys with carefully selected alloying elements to expand the γ-region and accommodate up to 2.9 wt% N. The alloys were processed into ribbons by melt spinning and subsequently subjected to austenitic ammonia nitriding followed by rapid gas quenching in a specially designed furnace. X-ray diffraction studies revealed a clear transformation from the initial BCC structure of the melt-spun alloys to FCC after nitriding, and the subsequent formation of α″-$Fe_{16}N_2$ upon tempering. Microstructural evolution of the nitrided phases and iron–nitrogen martensite was confirmed through transmission electron microscopy and electron probe microanalysis (EPMA). Magnetic hysteresis loops of the various alloys were correlated with the phase fraction and the presence of α''$Fe_{16}N_2$, demonstrating enhanced hard magnetic behaviour. This study represents one of the first attempts to employ alloying strategies to stabilize the metastable α'' $Fe_{16}N_2$ phase, providing a promising pathway toward the bulk synthesis of rare-earth-free permanent magnets.

Keywords: Iron nitride, Hard Magnet, Ammonia Nitriding, Melt-Spinning, Microstructure.

Abstract ID: 475

QUANTUM INFORMATION ENTROPIES OF A GAUSSIAN QUANTUM DOT UNDER SPIN-ORBIT AND MAGNETIC INFLUENCES

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Abstract: This study explores how Rashba and Dresselhaus spin-orbit interactions and confinement potential strength affect the quantum information of a two-electron system confined within a two-dimensional GaAs quantum dot with Gaussian confinement potential. In this work, we study the quantum information entropies for a two-electron system GaAs quantum dot using a variational approach based on a Chandrasekhar-type wave function with three adjustable parameters and a modified Jastrow correlation factor [1]. We have observed that the Shannon entropy (Fisher entropy), which tells about the delocalization (localization) of electrons in the quantum dot, increases (decreases) with increasing quantum dot size. Further, we have investigated the effects of Rashba and Dresselhaus spin-orbit interactions and different confinement potential strengths on von-Neumann entropy to investigate the entanglement of two interacting electrons confined in a quantum dot. These findings provide a deeper understanding of spin-orbit-driven electron correlations and the tunability of quantum dot systems for quantum computing and quantum communication applications.

Keywords: Quantum Dot, Shanon Entropy, Fisher Entropy, Entanglement Entropy, Spin-orbit intercation.

References:

[1] Anusha Kachu, Thara Angoth, Narasimha Raju Chebrolu & Aalu Boda, Scientific Reports **15**, 40219 (2025).

Abstract ID: 477

HYSTERESIS MODELING USING BOUC-WEN MODEL APPLIED TO MAGNETORHEOLOGICAL DAMPER

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Abstract: For most static and dynamic functioning applications, a thorough understanding and research of vibrations is necessary to achieve longer-lasting performance that is comfortable, dependable, and useful. When creating varied systems, vibration is an extremely important consideration. Numerous physical systems are impacted by the phenomena of hysteresis. Because it offers a problematic nonlinear multi-valued behaviour, it is commonly observed in plants where controllers are being constructed. Growing interest in managing hysteretic plants is a result of ongoing study into nonlinear systems. The hysteresis of the magnetorheological damper is examined in a semi-active vibration system. Bouc-Wen model of hysteresis has been used to tap the hysteresis while loading and unloading in the magnetorheological damper. MATLAB has been used to further model and simulate the Bouc-Wen's hysteresis equations for an MR damper, which are presented in this paper. The model is mathematically tractable for control design and may describe a broad variety of hysteretic and non-hysteretic behaviours of any semi-active or active suspension system. This paper presents the results of force versus velocity and displacement obtained using simulation of the Bouc-Wen model equations for a magnetorheological damper. The graph of force versus displacement indicates what should be the value of force applied to a suspension system so as to obtain a certain level of damping and hence a ride comfort is obtained. These results would be useful when it is applied to a controller-controlled suspension system when magnetorheological damper is used. The novelty of the research is the generation of MATLAB code using the Modified Bouc-Wen model equations to generate graphs of the data from an MR damper experimental setup.

Keywords: Bouc-Wen model, Magnetorheological (MR) fluid, magnetorheological damper, hysteresis, suspension system, vibration control.

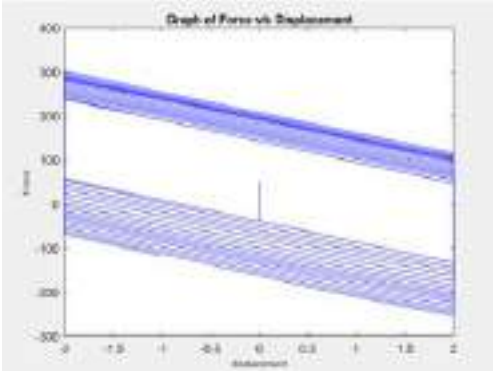


Fig. 1: Plot of Force versus Displacement [1].

References:

[1] Xinchun, G., Yonghu, H., Yi, R., Hui, L., & Jinping, O. (2015). A novel self-powered MR damper: theoretical and experimental analysis. Smart Materials and Structures, 24(10), 105033.

Abstract ID: 478

SPINTRONICS AND CHIRALITY: SPIN SELECTIVE ELECTRON TRANSPORT THROUGH CHIRAL MATERIALS

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Abstract: Recent experiments have demonstrated that the electron transfer through chiral molecules depends on the electron spin orientation. This phenomenon has been termed the chiral-induced spin selectivity (CISS) effect [1], and it provides a challenge to theory and promise for organic/inorganic molecule-based spintronic devices. Recently an efficient method to organic spintronic based on CISS effect has been suggested. In the CISS effect, the chirality of the molecular system itself acts as a spin-filter, thus avoiding the use of magnets for spin injection. Techniques for measuring spin-selective electron transport through molecules and some examples of recent experiments will be discussed [2-6]. By studying spin-dependent electron transport through various supramolecular structures, and inorganic chiral molecules, we can able to describe the possible application of the CISS effect for developing new kinds of memory devices. Such memory would be based on spintronics, the use of the electrons' spin, rather than charge. Furthermore, the CISS effect is a multidisciplinary phenomenon with implications in chemistry, physics and biology; therefore, this field has many-fold directions and will open new avenues for scientific and technological exploration.

Keywords: Molecular Spintronics; Chiral-Induced Spin Selectivity (CISS) Effect; Spin Filters; Spin-Selective Electron Transport; Spin Based Devices.



Fig. 1: Demonstrating spin selectivity in electron transfer process through chiral molecules.

References:

[1] R. Gupta, A. Balo, R. Garg, A. K. Mondal*, K. B. Ghosh, P. C. Mondal, Chem. Sci. 15 (2024) 18751-18771.
[2] M. Yasmin, R. Garg, A. Balo, A. K. Mondal*, K. B. Ghosh, J. Phys. Chem. Lett. 17 (2026) 1630–1639.
[3] R. Garg, P. S. Bisht, N. Bhatt, N. Nakka, A. K. Mondal*, Chem. Mater. 37 (2025) 6293–6301.
[4] R. Garg, P. S. Bisht, S. C. Sahoo, A. K. Mondal*, Angew. Chem. Int. Ed. 64 (2025) e202418222.
[5] N. Nakka, R. Garg, P. S. Bisht, A. K. Mondal*, Small 20 (2024) 2405691.
[6] P. S. Bisht, R. Garg, N. Nakka, A. K. Mondal*, J. Phys. Chem. Lett. 15 (2024) 6605-6610.

Abstract ID: 480

DESIGN OF FERROMAGNETIC MATERIAL-BASED PHOTOTHERMAL LAYER FOR HYBRID BROADBAND SOLAR ABSORPTION SYSTEM

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Abstract: Solar energy in the form of electromagnetic radiation provides a vast and sustainable source for the power generation. Photovoltaic systems convert the visible (~400-700 nm) portion into electricity, while a significant fraction is lost as heat in the infrared region (>700 nm). This unusual thermal energy can be recovered using thermoelectric modules, improving overall energy utilization. However, challenges in integration limits the efficiency of the system and life span. The output voltage of the device was significantly enhanced to 4.08 V as compared to the standalone PV which shows 3.18 V. TEG modules generally achieve efficiency in the range of about 5-8%, which means only a small portion of the available thermal energy is converted into useful electrical power. To tackle this here integrating photothermal layer between the two systems as insulating material coated with ferromagnetic nickel target from a RF sputtering. This study measured the surface temperature properties of the ferromagnetic Ni fabrics. Ni exhibits high thermal conductivity which can influence heat conduction mechanisms and promote efficient heat transfer across the hybrid interface. Also, it acts as an efficient photothermal layer by combining broadband solar absorption with tunable magnetic field. The spontaneous polarization in the system also influences the charge separation in the photovoltaic layer, allowing simultaneous electrical and thermal energy excitation. Based on the research gaps, the present work investigates a novel interface engineering approach using conducting fabric as a photo thermal layer with a ferromagnetic metal coating for more efficient and long-lasting hybrid integration.

Keywords: Ferromagnetic material, Photovoltaics, Thermoelectric generator, Photothermal layer, RF Sputtering.

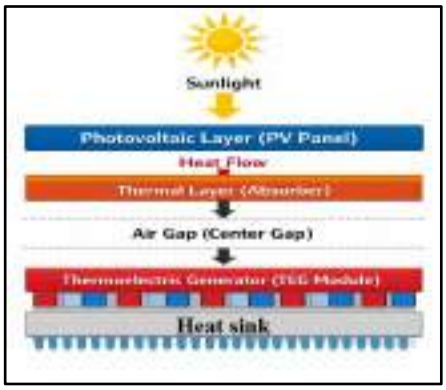


Fig. 1: Integrated hybrid PV-TEG system.

References:

[1] Hachim, Dhafer Manea, Ahmed Al-Manea, Raed Al-Rbaihat, Qahtan A. Abed, Mohammed Sadiq, Raad Z. Homod, and Ali Alahmer, *J. Sol. Energy Eng.* 147 (2025) 021011.
[2] P Kumar, R Kumar, V Sharma, M K Khanna, and B K Kuanr, *J. Electron. Mater.* 54 (2025) 164-171.

Abstract ID: 481

MAGNETIC COMPENSATION AND TUNABLE FERRIMAGNETISM IN TWO-PHASE CO_3O_4–CO_2TIO_4 SPINEL SYSTEM

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Abstract: We systematically investigated the compositional dependence of magnetic behavior of the two-phase oxide spinel system $(1-x)Co_3O_4 + xCo_2TiO_4$ over the range $0 \leq x \leq 1$ (wt.%). A clear variation in the ferrimagnetic Néel temperature (T_N) was observed, decreasing from 53.5 K to 47.4 K as the composition was varied from x = 0.23 to x = 1.0. For temperatures below T_N, the temperature-dependent dc magnetic susceptibility [$\chi_{dc}(T)$] measured under both zero-field-cooled (ZFC) and field-cooled (FC) conditions exhibits a distinct magnetic compensation temperature (T_{COMP}), arising from the complete cancellation of magnetization between the tetrahedral (A) and octahedral (B) sublattices. Notably, T_{COMP} decreases systematically from 37.71 K to 31.74 K with increasing Co_2TiO_4 content. Furthermore, a significantly large coercivity ($H_C \approx 19$ kOe for x = 0.23) and a pronounced exchange bias field ($H_{EB} \approx 887$ Oe for x = 1.0) were observed below T_N, both of which are strongly tunable with composition. The origin of the enhanced H_C and H_{EB} is attributed to the complex interplay of interfacial exchange coupling, magnetic anisotropy, and competing interactions between the constituent spinel phases.

Keywords: ferrimagnetic, Magnetic Compensation, Exchange bias, spinel.

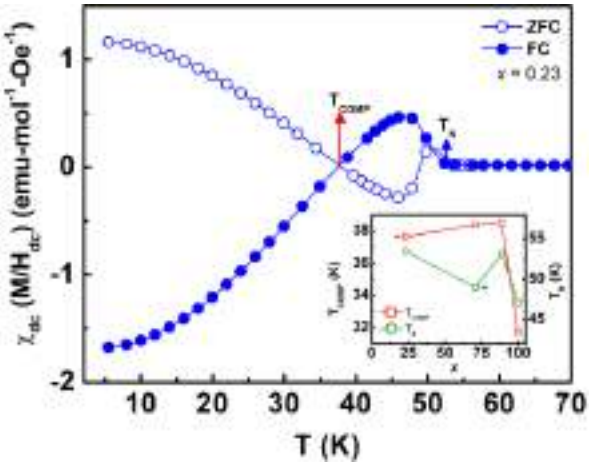


Fig. 1: Temperature dependent dc-magnetic susceptibility for $(1-x)Co_3O_4 + xCo_2TiO_4$ (x =0.23) recorded under ZFC and FC condition. Inset of the figure shows the variatio of T_{COMP} and T_N as a function of x.

References:

[1] J. Hubsch et. al. Phys. Rev. B **26** (1982) 3815 - 3823. [2] S. Nayak et. al., Phys. Rev. B **92** (2015) 214434 – 214443. [3] S. Nayak et. al. Physica B: Condensed Matter 695 (2024) 416560 - 416570.

Abstract ID: 483

PEAK EFFECT AND VORTEX PHASE DIAGRAM IN THE NONCENTROSYMMETRIC SUPERCONDUCTOR $Nb_{0.18}Re_{0.82}$

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Abstract: Noncentrosymmetric superconductors (NCSs) exhibiting time-reversal symmetry breaking (TRSB) have attracted considerable attention due to their unconventional superconducting properties [1]. $Nb_{0.18}Re_{0.82}$is a notable member of this class, with Tc ≈ 8.19 K, reported multigap superconductivity [2], and signatures of TRSB [3]. Although its superconducting gap structure and thermodynamic properties have been investigated extensively, the vortex physics of $Nb_{0.18}Re_{0.82}$ remains largely unexplored. In this work, we present comprehensive dc magnetization, ac susceptibility, and transport measurements performed on platelet-shaped single crystals of $Nb_{0.18}Re_{0.82}$. Despite the highly disordered nature of the system (RRR ≈ 1.13), ac susceptibility measurements reveal a pronounced peak effect, indicative of an order disorder transition of the vortex lattice (Fig. 1). The evolution of the peak effect with temperature and magnetic field suggests softening of the vortex lattice and enhanced pinning near the upper critical field. From these measurements, we systematically extract the vortex phase boundaries and construct a detailed H-T vortex phase diagram for $Nb_{0.18}Re_{0.82}$. The observed features highlight the interplay between disorder, broken inversion symmetry, and vortex dynamics in this NCS system. Furthermore, real-space imaging techniques could directly visualize flux compression and vortex disorder, offering deeper insight into the pinning mechanisms underlying the emergence of the peak effect in $Nb_{0.18}Re_{0.82}$

Keywords: Superconductivity, Non centrosymmetric, Peak effect, Vortex Phase Diagram.

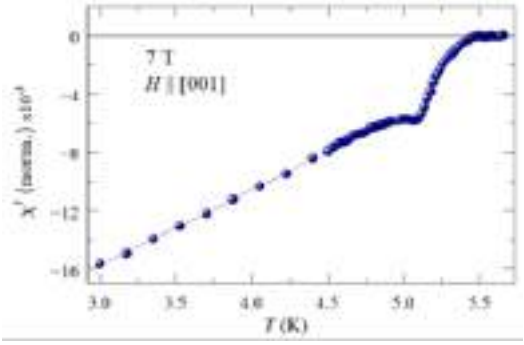


Fig. 1: Observation of peak effect for H || [001] at 7 T field.

References:

[1] Manfred Sigrist, *AIP Conf. Proc*. 55–96, 1162, (2009).
[2] Cirillo, C *et al*, *Physical Review B*, 91(13), 134508, (2015).
[3] Shang, T, *et al*, *Physical Review Letters*, 121(25), 257002, (2018).

Abstract ID: 484

INDIGENOUS DEVELOPMENT OF GAS ATOMIZED Fe-Ni POWDERS FOR ADDITIVE MANUFACTURING

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Abstract: The Fe-Ni alloys with 25-36 wt% Ni contents have wide applications for aerospace tooling, telescopic components, precision measuring device, semiconductor packaging, magnetic shielding, precision electronics etc. These alloys are difficult to machine for its highly ductile nature. However, these alloys can be processed as the powders, which subsequently prepare the intricate components through additive manufacturing (AM). The aim of this research is to produce good quality Fe-Ni alloy powders indigenously by the gas atomization technique, which could be directly utilized for AM. The ingot of $Fe_{73}Ni_{27}$ alloy is prepared by an air induction furnace and followed by a powder production by a close coupled gas atomizer with the optimization of its process parameters. The yielding of atomized powders is about about 97-99% for a size range of 1-300 µm. Sieve analysis is done to separate the powders for its utilization in different additive manufacturing techniques. After sieve analysis, the D_{50}, and D_{90} of the powders are found about 24 and 93 µm. size range respectively. The flowability of the powders is found to be 13.4, 13.5, 14.7 and 16.6 second per 50 gm of the powders for the 20-50, 50-71, 71-100 and 100-200 µm size ranged powders respectively. Tap density of fine powders (< 50 µm) is obtained more than coarser powders. The SEM images reveal high sphericity and satellite free outer surface. The XRD analysis revealed FCC crystallinity. Due to good shape, size distribution and flowability, the developed powders are highly promising for additive manufacturing.

Keywords: Invar Alloys, Gas Atomization, Additive Manufacturing, Powder processing.

Abstract ID: 485

A SIMPLE, LOW-COST RASPBERRY PI PICO-BASED DIGITAL B-H LOOP TRACER

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Abstract: Magnetic hysteresis is a fundamental phenomenon exhibited by ferromagnetic and ferrimagnetic materials, wherein the magnetic induction (B) lags behind the applied magnetic field (H) during cyclic magnetization. The resulting B-H hysteresis loop encodes critical material parameters — coercivity, retentivity, saturation magnetization, and hysteresis loss — that are indispensable for characterizing magnetic materials used in transformers, inductors, permanent magnets, and biomedical applications such as magnetic hyperthermia [1, 2]. Accurate and affordable measurement of these parameters remains essential for both material research and quality control. This work presents the design of a low-cost digital hysteresis loop tracer built around the Raspberry Pi Pico microcontroller. A sinusoidal excitation signal is synthesized using the Pico's Programmable I/O (PIO) peripheral, driving a DAC0800 digital-to-analog converter with precise frequency and amplitude control. The analog sine wave is amplified by a push-pull power amplifier operating as a constant-current source to energize a magnetizing solenoid, producing a uniform alternating magnetic field [3]. The sample — solid or liquid — is enclosed in a glass ampule and placed inside a search coil wound coaxially within the solenoid's homogeneous field region. The induced pick-up voltage, proportional to dB/dt, and the field-proportional voltage across a series standard resistance are simultaneously acquired by the Pico's onboard 12-bit ADC. Numerical integration yields B, enabling real-time B-H loop reconstruction and extraction of key magnetic parameters [3, 4]. The proposed platform offers a portable, cost-effective alternative to conventional tracers, suitable for characterizing soft ferromagnetic alloys, nanocrystalline ribbons, and magnetic nanoparticle suspensions [1, 4].

Keywords: Magnetic hysteresis loop tracer, Raspberry Pi Pico, B-H curve characterization, coercivity, saturation magnetization.

References:

[1] P. Lenox, L.K. Plummer, P. Paul, J.E. Hutchison, A. Jander, P. Dhagat, IEEE Magn. Lett. 9 (2018) 6500405.
[2] S. Chikazumi, Physics of Magnetism, Krieger, Malabar, Florida, 1978, p. 21.
[3] S.N. Kane, Zs. Gercsi, N. Ghodke, S.S. Khinchi, A. Gupta, DAE-SSPS (2005) P287.
[4] J.C. Barrière, B-H Loop Tracer, Project Report, 2015.

Abstract ID: 486

APPROACHING FERRITE-BASED EXCHANGE-COUPLED NANOCOMPOSITES SYNTHESISED VIA ONE POT SOL GEL AUTO COMBUSTION METHOD FOR PERMANENT MAGNET APPLICATIONS

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Abstract: Permanent magnets are essential in contemporary technologies, underpinning various applications that contribute to a sustainable future, including wind turbines and electric vehicles. While magnets derived from rare-earth elements (REE) exhibit exceptional magnetic performance, the detrimental environmental consequences of extracting these resources, and geopolitical tensions present significant challenges. As an alternate for the REE the Ferrite-based permanent magnet have been developed because of their advantageous characteristics, including cost-effectiveness and a reliable supply chain. This work focused on synthesizing exchange-coupled nanocomposites with controlled ratios of hard and soft ferrites to achieve superior performance and a higher energy product compared to hexaferrites. The $(Ba_{0.5}Sr_{0.5}Fe_{12}O_{19})1\text{-}X/(Ni_{0.3}Co_{0.7}Fe_2O_4)_X$ composites were synthesized using the sol-gel auto combustion technique. Subsequently, the samples were subjected to annealing at a temperature of 1100 °C for a duration of 4 hours to facilitate phase formation within the material. The structural analysis was conducted using X-Ray diffraction (XRD), confirming the sample as M-type hexaferrite and spinel ferrite based on the lattice parameters. The structural morphology of the sample was analyzed using the Field Emission Scanning Electron Microscope (FE-SEM) to verify the existence of both hard and soft ferrite materials. The magnetic parameters of the sample, including saturation magnetism Ms, remanent magnetism M_R, squareness ratio M_r/M_s, and coercivity H_c, were confirmed by the Vibrating Sample Magnetometry (VSM). Based on the characterization results, we can optimize the novel material for PM's applications.

Keywords: Permanent magnets, Exchange coupling, Energy Product, Hexaferrites, Spinel ferrites.

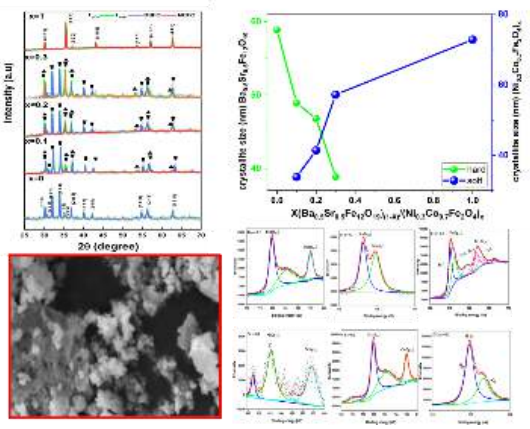


Fig. 1: Magnetic nanocomposites for permanent magnets.

References:

[1] Granados-Miralles C, Saura-Múzquiz M, et al. ACS Appl Nano Mater 2018;1:3693–704.
[2] Maltoni P, Sarkar T, Barucca G, Varvaro G, Locardi F, et al. J Phys Chem C 2021;125:5927–36.

Abstract ID: 488

DYNAMICS OF FERROMAGNETIC AND SYNTHETIC ANTIFERROMAGNETIC SKYRMIONIUM IN GRANULAR NANOTRACK

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Abstract: Magnetic skyrmioniums with zero net topological charge hold promise for nextgeneration spintronic devices. Using micromagnetic simulations, we study current-driven dynamics of ferromagnetic (FM) and synthetic antiferromagnetic (SAF) skyrmioniums in granular nanotracks. Variations in interfacial Dzyaloshinskii–Moriya interaction, anisotropy, and saturation magnetization strongly influence their mobility and stability. FM skyrmioniums show high sensitivity to disorder, exhibiting pinning at low currents and Magnus force–induced deformation at high currents, with mobility dependent on grain size. External magnetic fields enhance their stability by reducing distortions. In contrast, SAF skyrmioniums remain stable across wide disorder and current ranges due to Magnus force cancellation, maintaining higher velocities. The dynamics is well explained by Thiele equation in the presence of stochastic forces arising due to inhomogeneities in material parameter. Disorder-induced pinning reduces motion in both systems, however SAF skyrmioniums experiences much weaker suppression, making them robust candidate for racetrack memory and spintronic logic applications.

Keywords: Skyrmionium, Granular Nanotrack, Magnus Force, Pinning

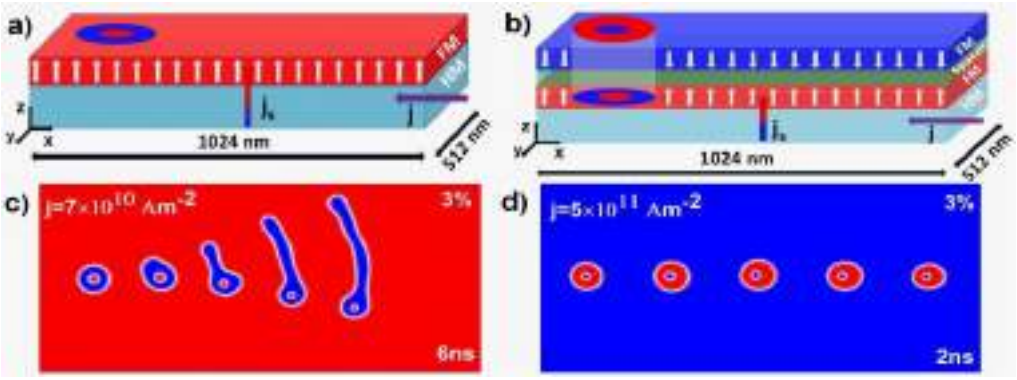


Fig. 1: (a) Schematics of FM and (b) SAF nanotracks hosting a skyrmionium. (c) Dynamics of FM skyrmionium showing deformation (d) SAF skyrmionium motion without deformation.

References:

[1] Kern, L. M., Kuchkin, V. M., Deinhart, V., Klose, C., Sidiropoulos, T., Auer, M., ... & Pfau, B. (2025). Controlled Formation of Skyrmion Bags. *Advanced Materials*, 2501250.

[2] Zhang, X., Xia, J., Zhou, Y., Wang, D., Liu, X., Zhao, W., & Ezawa, M. (2016). Control and manipulation of a magnetic skyrmionium in nanostructures. *Physical Review B*, *94*(9), 094420.

[3] Jing, K. Y., Wang, C., & Wang, X. R. (2021). Random walk of antiferromagnetic skyrmions in granular films. *Physical Review B*, *103*(17), 174430.

Abstract ID: 489

SPIN TRANSPORT IN HM/HEXAGONAL FERRITE MAGNETIC INSULATOR BILAYERS

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Abstract: Heavy metal (HM)/magnetic insulator (MI) heterostructures are promising for efficient spin transport and low-power spintronic applications due to their low damping and reduced energy dissipation [1]. In this work, we report on HM/hexagonal ferrite MI bilayers grown using sputtering, exhibiting low ferromagnetic resonance (FMR) linewidth indicative of high crystalline quality [2]. We systematically investigate spin pumping and spin Hall magnetoresistance (SMR) in these structures. The spin current injected into the heavy metal layer is electrically detected via the inverse spin Hall Effect (ISHE), confirming effective spin–charge conversion. These results highlight the potential of sputtered HM/hexagonal ferrite bilayers as a reliable platform for studying interfacial spin dynamics and for developing next-generation energy-efficient spintronic devices [1].

Keywords: Magnetic Insulator, Inverse Spin Hall Effect (ISHE), Ferromagnetic Resonance (FMR), Spin Pumping.

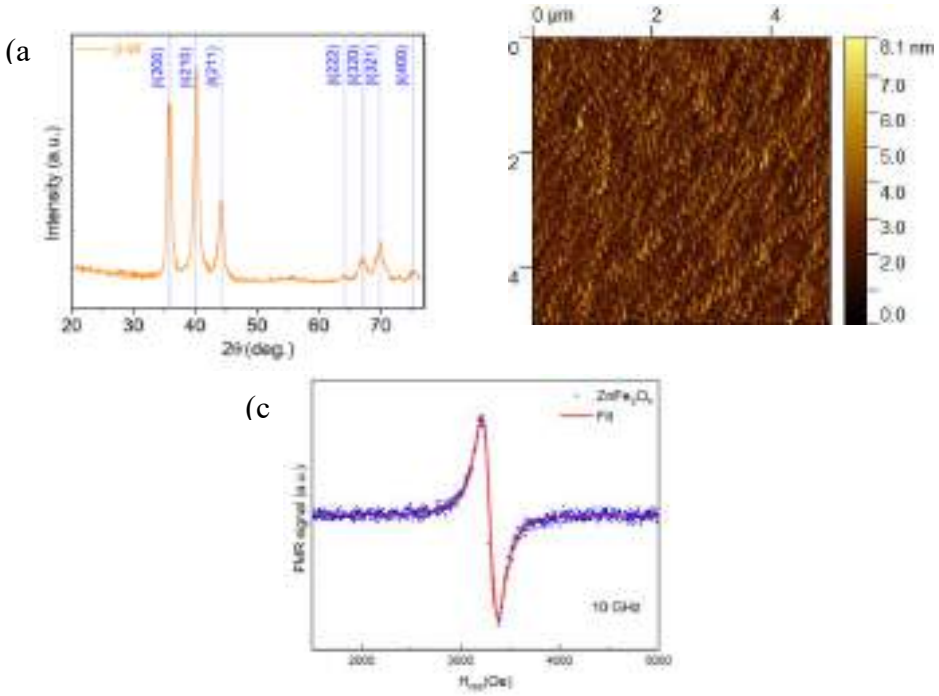


Fig. 1: (a) GIXRD of β-W (15 nm); (b) AFM of $ZnFe_2O_4$ (~0.8 nm roughness); (c) FMR of $ZnFe_2O_4$ at 10 GHz ($\Delta H_0 \approx 240$ Oe), indicating low magnetic inhomogeneity.

References:

[1] M. T. Gray, J. T. Brangham, F. Yang, P. C. Hammel, Phys. Rev. Appl. 9 (2018) 064039.
[2] S. Emori, T. Nan, A. M. Belkessam, X. Wang, S. X. Wang, Nano Lett. 18 (2018) 4273–4278.

Abstract ID: 492

INFLUENCE OF OUT-OF-PLANE STRAIN AND ITS GRADIENT ON STABILITY AND DYNAMICS OF TOPOLOGICAL TEXTURES

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Abstract: Magnetic skyrmions and skyrmion bags are topologically protected spin textures that have garnered significant attention for their potential applications in next-generation spintronic devices, such as high-density memory, logic gates, and neuromorphic computing [1]. Their stability, small size, and low current-driven mobility make them promising candidates for energy-efficient data storage and processing technologies [2]. In this work, we demonstrate the stabilization of skyrmions and skyrmion bags in magnetic thin films under out-of-plane strain. Furthermore, we investigate the current-induced dynamics of these topological textures under the influence of an out-of-plane strain gradient. By applying the strain gradient both parallel and perpendicular to the electron flow, we show that strain engineering offers an energy-efficient mechanism to control skyrmion motion. Notably, we observe that an appropriately tuned strain gradient can suppress the skyrmion Hall effect [3], enabling straight-line motion of the topological textures a crucial feature for device applications. Our micromagnetic simulation results are in excellent agreement with theoretical predictions (Thiele equation)

$$G\times(V_e-V)+D(\beta V_e-\alpha V)+F_{strain}=0 \quad (1)$$

Where, $F_{strain} = -\nabla W_{strain}$, $W_{strain} = -3/2\ \varepsilon_{zz}\, k\lambda(m\cdot z)^2$ reinforcing the viability of strain mediated control for skyrmion-based technologies.

Keywords: Skyrmion, Theile Equation, Strain Gradient, Current-induced Dynamics, Skyrmion Hall Effect.

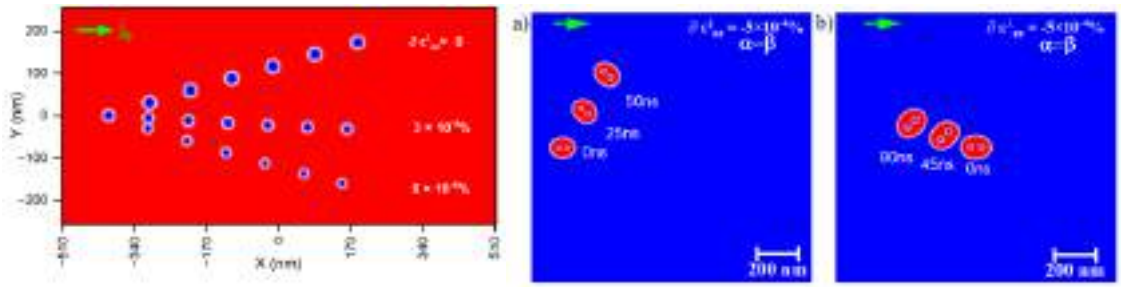


Fig. 1: (1) Suppression of Skyrmion Hall Effect via out-of-plane strain gradient. (2a-b) Trajectory of skyrmion bag under negative strain gradient applied parallel and perpendicular to electron flow.

References:

[1] Fert et al., Nat. Rev. Mater. 2, 17031 (2017).
[2] Parkin & Yang, Nat. Nanotechnol. 10, 195–198 (2015).
[3] Ahmad et al., J. Magn. Magn. Mater. 2025, 172945.

Abstract ID: 493

MAGNETOTRANSPORT RESPONSE IN THE ALTERMAGNETIC CrSb SINGLE CRYSTAL

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Abstract: Altermagnets are collinear antiferromagnets with alternating local structures around opposite-spin sublattices that enable a spin-split Fermi surface without net magnetization, giving rise to spin-dependent phenomena absent in typical antiferromagnets. Among altermagnetic candidates, CrSb exhibits g-type altermagnetism with a multi-pocket Fermi surface. Here, we synthesize a single crystal of CrSb and present a detailed characterization of its magnetization, electrical transport, and magnetotransport properties in conjunction with first-principles calculations. CrSb shows metallic behavior with a spin-split Fermi surface in the antiferromagnetic state with an ordering temperature $T_N \sim 707$ K. It exhibits a large nonsaturating magnetoresistance with sixfold symmetry at low temperature in accord with the crystal structure and Fermi surface. Analysis of carrier concentrations and mobilities indicates exceptionally high carrier mobility at 2 K. These results suggest that CrSb is a unique altermagnetic system with high carrier mobilities and anomalous transport properties, promising for applications.

Keywords: Altermagnets, collinear antiferromagnets, magnetization, spin-split Fermi surface.

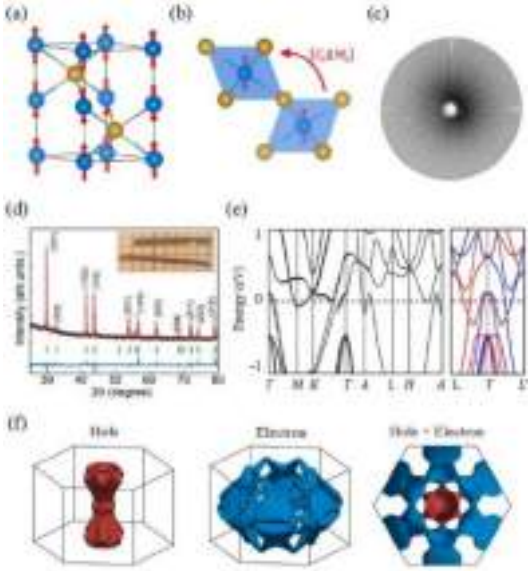


Fig. 1: (a-b) Spin and crystal structure of altermagnetic CrSb. Blue and brown spheres show Cr and Sb atoms, and arrows indicate magnetic moments. The two sublattices are related by {C2∥Mz} or {C2∥C̃6z} symmetry. (c) Laue diffraction pattern of the (0001) plane at room temperature. (d) Powder XRD pattern with Rietveld refinement; inset shows single crystals. (e) Calculated band structure with spin-orbit coupling along high-symmetry directions. (f) Spin-polarized Fermi surface showing hole and electron pockets.

References:

[1] L. Smejkal, R. Gonz´alez-Hern´andez, T. Jungwirth, and J. Sinova, Sci. Adv. 6, eaaz8809 (2020).

Abstract ID: 495

INTRINSIC GYROTROPIC MAGNETIC CURRENT OF ORBITAL ORIGIN

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Abstract: Gyrotropic magnetic current (GMC) refers to the generation of an electrical current by a time-dependent magnetic field $\boldsymbol{B}(t)$ in gyrotropic crystals. Its conventional origin is attributed to the magnetic field induced band energy corrections and the associated Fermi-surface oscillations [1]. More recently, a spin-driven magnetic displacement contribution was identified [2], revealing an intrinsic component to the effect. However, the corresponding orbital contribution has remained unexplored. In this work, using a density-matrix formulation that incorporates both minimal coupling and spin–Zeeman interactions, we derive the electronic equations of motion in the presence of an oscillating magnetic field. Our formulation uncovers a previously unexplored orbital contribution to the wavepacket velocity arising from a magnetic field induced correction to the Berry connection. We characterize this correction through a band-geometric quantity, the orbital magnetic Berry connection polarizability (MBCP). Physically, this orbital contribution arises from the time variation of the magnetic field induced charge polarization. In the low-frequency transport regime, this mechanism becomes purely intrinsic ($j^{\mathrm{IGMC}}(t)$). Unlike the conventional Fermi-surface contribution, this response is a Fermi-sea effect and remains finite in both metals and insulators. Importantly, it survives in inversion-broken systems that preserve combined parity–time reversal symmetry, where conventional gyrotropic responses vanishes. As a concrete realization, we demonstrate the effect in the parity–time reversal ($\mathcal{PT}$) symmetric antiferromagnet CuMnAs. We find that the orbital contribution dominates over its spin counterpart by nearly an order of magnitude. Moreover, the intrinsic GMC is odd under time reversal and reverses sign upon Néel-vector reversal, establishing it as a direct and experimentally accessible probe of antiferromagnetic order.

Keywords: Gyrotropic current, Berry connection polarizability.

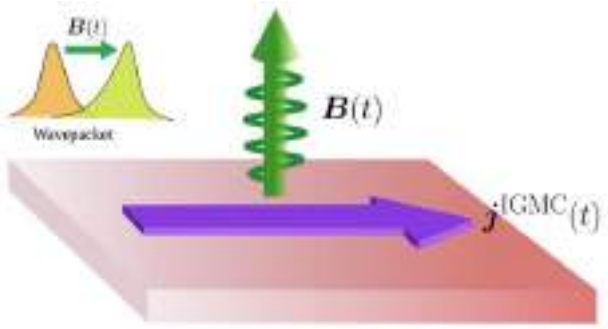


Fig. 1: Schematic of the intrinsic gyrotropic magnetic current.

References:

[1] Shudan Zhong, Joel E. Moore, and Ivo Souza, "*Gyrotropic magnetic effect and the magnetic moment on the fermi surface*," Phys. Rev. Lett. 116, 077201 (2016).

[2] Longjun Xiang, Jinxiong Jia, Fuming Xu, Zhenhua Qiao, and Jian Wang, "*Intrinsic gyrotropic magnetic current from zeeman quantum geometry*," Phys. Rev. Lett. 134, 116301 (2025)

Abstract ID: 496

INTERFACE ENGINEERING OF ANOMALOUS HALL EFFECT IN NICKEL THIN FILM HETEROSTRUCTURES

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Abstract: Through a collaborative theoretical and experimental investigation, we demonstrate the effects of interface engineering of the anomalous Hall effect in nickel thin film heterostructures. Experimentally, ferromagnetic Ni, grown on different single-crystal substrates, $LaAlO_3$, $SrTiO_3$, and MgO, with different biaxial tensile strain,viz.,0.28%, 0.57% and 0.87%, respectively, is found to exhibit decrease in anomalous Hall conductivity, which is further tuneable by an external electric field. To explain the experimentally observed characteristics of the anomalous Hall effect in various Ni heterostructures, we conduct first-principles calculations utilising density functional theory. Our calculations on bulk Ni under strain indicate a consistent rise in anomalous Hall conductivity with increasing strain up to a certain value, implying that strain alone fails to account for the behaviour observed in the experiments. Inversion symmetry is broken at the interfaces, resulting in Rashba interaction due to spin-orbit coupling, which subsequently alters the anomalous Hall conductivity at various interfaces. Our explicit calculations show that Ni/MgO, Ni/$SrTiO_3$, and Ni/$LaAlO_3$ exhibit increasing magnitude of Rashba coupling, leading to correspondingly increasing anomalous Hall conductivity, consistent with the measurements. Furthermore, using Ni/$SrTiO_3$ as an example, we show that Rashba coupling, and hence the anomalous Hall conductivity can be tuned using an external electric field. Our research underscores the pivotal influence of substrate and interfacial factors in regulating the anomalous Hall effect in heterostructures.

Keywords: Interface Heterostructures, Ni-thin films, Anomalous Hall Effects, Density Functional Theory, Rashba Interaction.

Abstract ID: 497

MAGNETIC AND NEUTRON DIFFRACTION STUDY OF $La_2Ni_{1-x}Fe_xMnO_6$ (x = 0.00, 0.05, 0.10, and 0.15) DOUBLE PEROVSKITES

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Abstract: The double perovskite compound, La_2NiMnO_6 (LNMO), has garnered considerable scientific attention in contemporary research due to its wide range of applications as sensors, memory devices, spintronic devices, and solar cells [1]. In recent years, the consequences of B-site substitution on the B and B' cationic ordering has been studied for LNMO samples, which shows structural stability and variation in magnetic properties [1,2]. A comprehensive structural and magnetic study of $La_2Ni_{1-x}Fe_xMnO_6$ (x = 0.00, 0.05, 0.10, and 0.15) was carried out using combined Rietveld refinement of XRD and ND data at room temperature. All samples predominantly crystallize in the monoclinic $P2_1/n$ phase, while the undoped sample (x = 0.00) also exhibits a secondary rhombohedral phase that disappears with Fe doping. Magnetic measurements revealed two ferromagnetic transitions (T_{c1} and T_{c2}), and Tc1 increases from 264 K for x = 0.0 to 274 K for x = 0.15. Temperature-dependent ND refinement revealed that the Fe-substituted samples exhibit smoother thermal evolution of lattice parameters and bond lengths, indicating enhanced structural integrity. The ⟨Ni/Mn–O⟩ bond length increased with Fe content, suggesting a relaxation of octahedral distortions. Low-temperature ND confirmed that the magnetic moments of Ni^{2+}, Fe^{2+}, and Mn^{4+} ions are aligned along the *b*-axis, consistent with long-range ferromagnetic ordering as shown in Figure 1. Overall, Fe doping in $La_2Ni_{1-x}Fe_xMnO_6$ effectively tunes both the structural and magnetic properties, promoting enhanced ferromagnetic behavior and phase stability.

Keywords: Double Perovskites, structural properties, Magnetic structure, Neutron diffraction

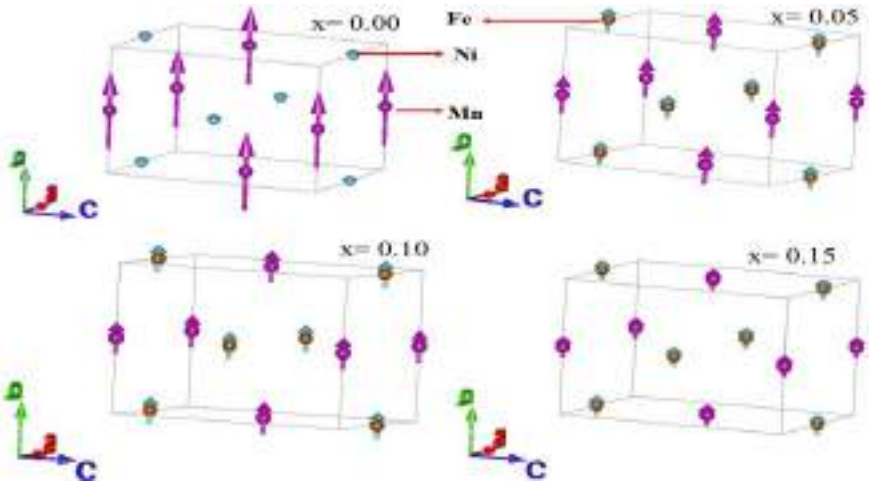


Fig. 1: Magnetic structure of $La_2Ni_{1-x}Fe_xMnO_6$ (x= 0.00, 0.05, 0.10, and 0.15) samples at a temperature of 10 K.

References:

[1] Shah Aarif Ul Islam and Mohd Ikram, Rare Met. 38(9) (2019) 805–813.
[2] Raju Kumar, R.N. Bhowmik, A.K. Sinha, J. Alloy. Compd. 920 (2022) 165917.

Abstract ID: 498

MAGNETIZATION AND SPIN DYNAMICS STUDY OF $Mn_5Ge_{(3-x)}Ga_x$ (x = 0.0, 0.1, 0.3, 0.5 and 0.9) ALLOY BY FERROMAGNETIC RESONANCE

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Abstract: The Mn-based intermetallics Mn_5Ge_3 [1]with hexagonal Mn_5Si_3 type structure (space group $P6_3/mcm$) have been receiving considerable attention over the last few decades due to their itinerant ferromagnetism and Curie temperature (T_c = 297 K) near room temperature [2, 3]. Chemical substitution of Ga, which is non-magnetic at the Ge site, offers an effective means to manipulate electronic structure, magnetic exchange interactions, and spin-relaxation processes. However, a comprehensive understanding of how non-magnetic (Ga) substitution affects the spin dynamics in Mn_5Ge_3 remains unexplored. In this work, we present a systematic study of Ga-doped Mn_5Ge_3 ($Mn_5Ge_{(3-x)}Ga_x$, x = 0.0, 0.1, 0.3, 0.5 and 0.9) synthesized via vacuum induction melting. Room-temperature XRD confirms single-phase hexagonal $P6_3/mcm$ structure for pure Mn_5Ge_3 (a = 7.18839 Å, c = 5.03273 Å). Rietveld refinement shows Mn1 (6g), Mn2 (4d), and Ge1 (6g) sites. Ga doping at Ge causes peak shifts, bond lengths (~2.49–2.60 Å), angles (~55°–121°) changes, indicating distortion affecting exchange. M(T) data show T_c decreases from 297 K to 294 K with Ga doping, due to weakened magnetic exchange interactions. Curie-Weiss fits, $\chi(T) = C/(T-\theta_{cw})$, yield C = 13.9 emu-K/Oe and 11.3 emu-Oe/K, a positive value of $\theta_{cw,}$ i.e. 296 K (pure) and 294 K (x=0.5) indicates ferromagnetic order. M(H) loops show M_s decreases from 126 emu/g to 84 emu/g, μ_{eff} from $2.1\mu_{B/Mn}$ to 1.9 $\mu_{B/Mn}$, H_c from 9 Oe to 3 Oe, indicating low hysteresis loss [3]. From temperature-dependent ferromagnetic resonance (FMR) (120–300 K) data, we have seen that resonance field (H_{res}) and linewidth (ΔH) decrease with increasing temperature, which indicates an increase in exchange interactions between Mn-Mn ions. The spin–spin relaxation time (τ_2) increases up to 0.3 Ga doping due to improved magnetic homogeneity, then decreases due to enhanced disorder and spin scattering. While the spin–lattice relaxation time (τ_1) initially decreases because of stronger spin–phonon coupling. At higher doping, τ_1 increases as lattice disorder hinders efficient energy transfer.

Keywords: Spintronics, Magnetic exchange interactions, Ferromagnetic Resonance (FMR), Spin relaxation.

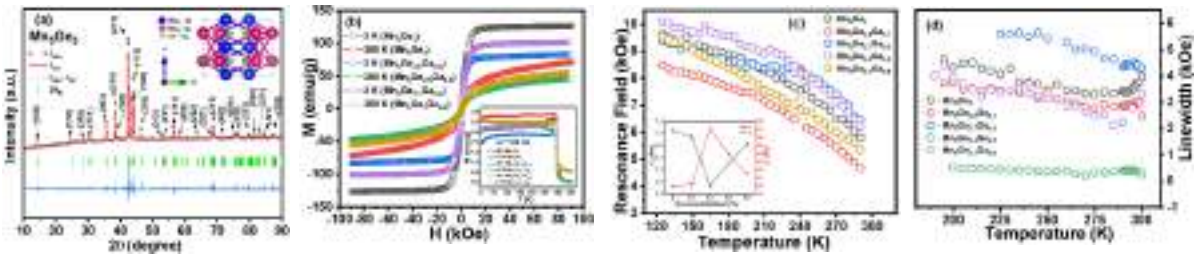


Fig. 1: (a) XRD pattern of Mn_5Ge_3. (b) MT and MH curves of $Mn_5Ge_{3-x}Ga_x$ (x = 0.0, 0.1, 0.3, 0.5 and 0.9) (c-d) Variation of resonance field and linewidth with temperature.

References:

[1] G. Kappel et al., Phys. Status Solidi A **34**, 691 (1976).
[2] T. Toliński et al., Intermetallics **47**, 1 (2014).
[3] Lalita et al., J. Alloys Compd. **876**, 159908 (2021).

Abstract ID: 499

QUANTUM METRIC INDUCED NONLINEAR THERMAL NOISE IN PT SYMMETRIC ANTIFERROMAGNET

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Abstract: Electrical current fluctuations provide a powerful probe of band geometry in quantum materials, complementing conventional transport measurements. In particular, intrinsic noise components that are insensitive to the relaxation time encode universal band-geometric properties of Bloch electrons. Here [1], we predict a second-order intrinsic contribution to the thermal noise of charge current that persists even in parity and time reversal symmetric systems. This noise is governed by the quantum metric via the Berry Connection Polarizability (BCP), a gauge independent quantity that captures band geometry beyond Berry curvature. Importantly, unlike intrinsic Berry curvature induced noise [2] which are restricted to transverse responses, the BCP generates a finite longitudinal noise component, in addition to a transverse component. This effect arises from field-induced modifications in the Bloch wavefunctions and band energies, and it dominates in PT-symmetric antiferromagnets where Berry curvature based contributions are suppressed by symmetry. Applying our theory to CuMnAs, we demonstrate that thermal current noise exhibits clear signature of quantum metric near the band edges. Our results establish nonlinear current noise as a direct and robust probe of quantum metric in PT-symmetric antiferromagnets.

Keywords: Current noise, Band Geometry, PT symmetry, Antiferromagnets, Intrinsic response.

References:

[1] Dibyanandan Bhowmick, Amit Agarwal, arXiV:2509.20647.
[2] Miaomiao Wei, Luyang Wang, Bin Wang, Longjun Xiang, et al., Phys. Rev. Lett. 130, 036202.

Abstract ID: 504

ENGINEERED HYBRID $Mg_xMn_{1-x}Fe_2O_4$/OXIDIZED-MWCNT NANOFLUIDS EXHIBITING CONTROLLABLE MAGNETIC AND CYCLIC-VISCOELASTICITY FOR HYPERTHERMIA APPLICATION

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Abstract: Conventional ferrofluid requires repeated dosage to maintain the therapeutic window of 42–45 °C in magnetic fluid hyperthermia (MFH). To reduce the dosage, we introduce a novel one-pot sonochemical-assisted hydrothermal method to synthesize superparamagnetic PEGylated $Mg_xMn_{1-x}Fe_2O_4$ magnetic nanoparticles (12-20 nm) uniformly anchored onto oxidized multiwalled carbon nanotubes (MWCNTs). Controlled surface oxidation introduces –OH, $–NH_2$, and –COOH functional groups, enhancing electrostatic stabilization and enabling excellent cyclic colloidal stability, evidenced by a zeta potential of –44 mV. Magnetorheological studies confirm robust cyclic performance, with viscosity retained at ~9 Pa·s under 0.8 T even after shear deformation (0–500 s^{-1}) across five cycles. The magnetic nanofluids (MNFs) exhibit shear-thinning behavior following the power-law model ($\eta = c\gamma^n + \eta_\infty$), with flow indices ranging from –0.69 to –0.94, indicating viscoelastic characteristics. Among compositions, MWCNT@$Mg_{0.2}Mn_{0.8}Fe_2O_4$ shows superior properties, including narrow hydrodynamic size (~92 nm) and enhanced saturation magnetization (47 emu/g). For MFH applications, MNFs at 5 and 10 mg/mL were evaluated under alternating magnetic fields (12 mT; 264–586 kHz) within Hergt's safety limits. The CNTMg0.2 nanofluid achieved maximum SAR of 168.4 W/g and ILP of 3.179 nHm^2/kg, matching or exceeding clinically approved ferrofluids (0.15–3.1 nHm^2/kg) [1-2]. Additionally, the system maintains performance under varying shear rates and magnetic fields. The hydrophilic MWCNT framework and sp^2 carbon backbone of PEG–$Mg_xMn_{1-x}Fe_2O_4$ MNFs provide a stable, efficient, and reusable platform for non-invasive cancer hyperthermia.

Keywords: Magnetic hyperthermia, magnetic nanofluid, specific adsorption rate, viscoelastic fluid

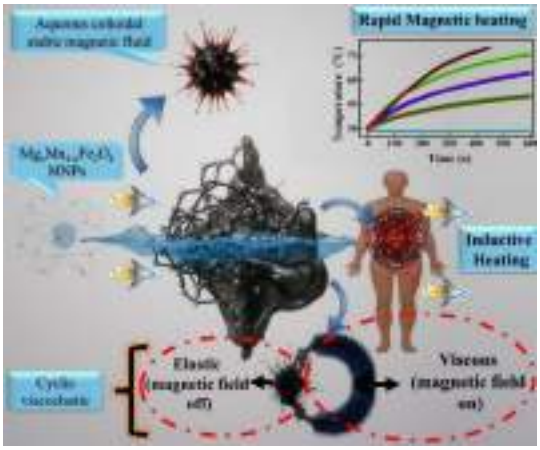


Fig. 1: The cycloviscoelastic $Mg_xMn_{1-x}Fe_2O_4$ MNFs used a repeatable magnetic fluid hyperthermia for rapid magnetic heating.

References:

[1] Ansari, S. R.; Suarez-Lopez, Y. D. C.; Thersleff, T.; et al., ACS Nano 2024, 18 (23), 15284–15302.
[2] Somvanshi, S. B., Jadhav, S. A., Gawali, S. S., Zakde, K., et al., J. Alloys Compd., 2023 *947*, 169574.

Abstract ID: 505

SPIN BAND GEOMETRY DRIVES THERMAL SPIN MAGNETIZATION AND CURRENT

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Abstract: Generating spin magnetization and spin currents without magnetic or electric fields is a key frontier in spin caloritronics. Spin responses driven by thermal gradients offer a promising route, though the band geometric origin of intrinsic mechanisms, especially in non-magnetic materials, remains poorly understood. Here we develop a unified quantum theory of thermal spin magnetization and spin currents (including both the spin Seebeck and Nernst effects) in itinerant electrons, rooted in spin-band geometry and encompassing both Fermi-surface and Fermi-sea contributions. We identify two key geometric quantities: the spin-velocity metric tensor, which governs thermal spin magnetization, and the spin geometric tensor, combining spin Berry curvature and spin quantum metric, which generates thermal spin currents. Numerical calculations for chiral metal RhGe, antiferromagnet CuMnAs, and monolayer semiconductor MoS_2 demonstrate sizable thermal spin responses. Our results establish the band geometric origin of thermal spin transport and provide guiding principles for discovering and engineering next-generation spin caloritronic materials.[1]

Keywords: Thermal spin magnetization, Thermal spin current, Spin band geometry, Spin Berry curvature, Spin Caloritronics.

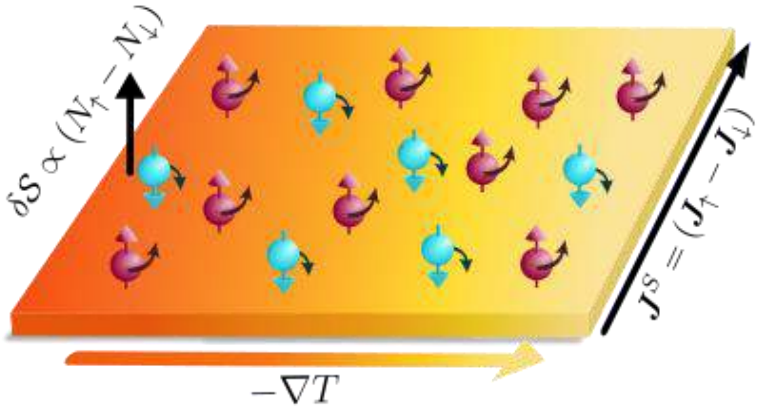


Fig. 1: Schematic of thermally driven spin responses: A temperature gradient generates an imbalance between up and down spins of itinerant electrons due to spin-orbit coupling, leading to spin magnetization (δS) and current (J^S).

References:

[1] S. Sarkar, H. Varshney, S. Sarkar, A. Agarwal, Materials Today Quantum, 10, 100062 (2026).

Abstract ID: 506

EFFECT OF Cr DOPING ON THE CRYSTALLOGRAPHIC AND MAGNETIC PROPERTIES OF THE TETRAGONALLY DISTORTED Mn_3Ga HEUSLER ALLOY

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Abstract: Among the Mn-based Heusler alloys, ferrimagnetically ordered $D0_{22}$ type-Mn_3Ga[1-2] has particularly drawn attention towards spin-transfer torque devices due to its high Curie temperature (~ 770 K), large spin-polarisation (~ 88 %) and strong magneto-crystalline anisotropy (K_u ~10^7) arising from the tetragonal lattice distortion along c- axis. As theoretically suggested[3] substituting Cr atoms at Y site could lead to a lowering of magnetisation if $D0_{22}$ crystalline phase is experimentally stabilised. On the contrary, Mn_2CrGa[4] is reported to crystallise in a cubic structure, which was emerged as a half-metallic ferrimagnet with high Curie temperature (~ 800 K). To stabilise this phase in $D0_{22}$ symmetry, many doping studies[3,5] (such as Pt, Fe, Co, Ni) have been reported in the full Heusler alloy Mn_2YGa at the Y-site. In this work, we present a systematic study of the effect of Cr substitution on $Mn_3Ga(X_2YZ)$ or $Mn_{3-\delta}Cr_\delta Ga$ ($0 \leq \delta \leq 2$) at Y and X sites leading to crystallographic disordering. A transformation from $D0_{22}$ (tetragonal, $\delta = 0.5$) to B2 (cubic, $\delta = 2$) [see (a)-(d) of Fig1] was observed contributing to hard and soft magnetic phases in these alloys which is explored over wide temperature range (3 K to 900 K) [see (e) and (f) of Fig 1]. The coercivity mechanism was explored using the Stoner-Wohlfarth model and minor loop analysis ($H \leq 2T$) [not shown], which further confirms the domain wall motion with low impedance via nucleation. The phase reformation of these alloys is studied through temperature-dependent Raman spectroscopy [not shown].

Keywords: spin-polarisation, magneto-crystalline anisotropy, Stoner-Wohlfarth model.

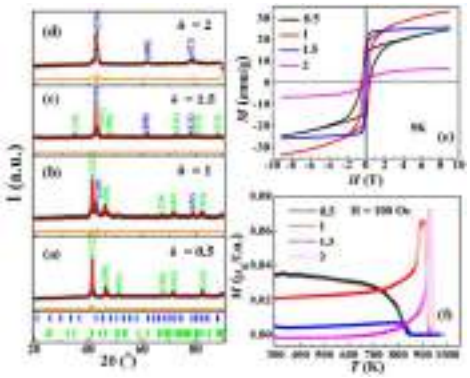


Fig. 1: The Rietveld fit of room temperature X-ray diffraction pattern of $Mn_{3-\delta}Cr_\delta Ga$ alloys (a)-(d). The field (e) and temperature (f) dependent magnetisation of $Mn_{3-\delta}Cr_\delta Ga$ alloys.

References:

[1] M.J. Winterlik et.al., Physical Review B, 77,054406 (2008).
[2] S. Perween et. al., Journal of Physics and Chemistry of Solids, 154, 110050(2021).
[3] H. G. Zhang et.al., Intermetallics, **106**, 71(2019).
[4] W. Zhang et. al., AIP Advances **6**, 056218 (2016).
[5] X.-Z. Li et. al., Acta Materialia **140**, 188 (2017).

Abstract ID: 507

BAND GEOMETRY INDUCED THIRD-HARMONIC GENERATION IN ALTERMAGNET

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Abstract: Third-harmonic generation (THG) is a key nonlinear optical process for ultrafast imaging, terahertz (THz) signal generation, and symmetry-sensitive probes, often dominating in centrosymmetric materials where lower-order responses vanish. Yet, the role of band geometry, Fermi surface effects, and disorder in enabling large and tunable THG remains poorly understood. Here, we develop a finite-frequency quantum kinetic theory of THG based on the density matrix formalism, deriving the third-harmonic conductivity tensor. Our framework isolates five distinct band-geometric contributions to interband and intraband processes, separates Fermi sea from Fermi surface terms, and incorporates disorder effects phenomenologically. We further provide a complete symmetry classification of THG for all 122 magnetic point groups. Applying the theory to graphene and the spin-split altermagnet RuO_2, we trace its THG response to specific geometric terms. These results establish a predictive foundation for designing materials with enhanced and tunable THG in the finite-frequency regime [1].

Keywords: THG, Band geometry, Symmetry, Altermagnet.

References:

[1] S. Sarkar, D. Mandal, A. Agarwal, Phys. Rev. B **112**, 245425.

Abstract ID: 509

THICKNESS-DRIVEN MAGNETIC ORDERING AND LOW-TEMPERATURE SPIN DYNAMICS IN BETA-Mn TYPE $Co_8Zn_8Mn_4$ MAGNETIC THIN FILMS

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Abstract: We report the thickness- and temperature-dependent static magnetization and ferromagnetic resonance (FMR) properties of nanocrystalline β-Mn structured $Co_8Zn_8Mn_4$ thin films in the thickness range of 100-410 nm. Temperature-dependent magnetization (M vs T) measurements reveal a slight decrease in Curie temperature (T_C) from 357 K to 350 K with increasing thickness, indicating nearly unchanged stoichiometry and robust ferromagnetic ordering across all samples. The hysteresis (M vs H) measurements show that the M_S increases with both thickness and decreasing temperature. The 220 nm and 410 nm films exhibit M_S values of 206 (323) emu/cc and 396 (568) emu/cc at 300 (5) K, respectively, in agreement with the reported bulk values. To investigate the spin dynamic properties, temperature-dependent FMR measurements were performed using a coplanar waveguide (CPW)-based CryoFMR-40 spectrometer. The resonance field (H_{res}) of the 220 nm film decreases continuously from ~ 2.16 kOe at 300 K to ~ 0.87 kOe at 5 K, reflecting the increase in spontaneous magnetization and internal exchange field at lower temperatures. The linewidth (ΔH) decreases from 300 K to 100 K due to reduced thermally activated magnon scattering and spin relaxation losses; however, the sharp broadening at 5 K is attributed to enhanced low-temperature magnetic inhomogeneity arising from Mn-spin freezing, local anisotropy fluctuations, and defect-induced two-magnon scattering. Thickness-dependent FMR analysis further shows a reduction in $4\pi M_{\mathrm{eff}}$ and an increase in effective damping ($\alpha_{\mathrm{eff}} \sim 10^{-2}$) with increasing thickness. These results demonstrate tunable static and dynamic magnetic properties of $Co_8Zn_8Mn_4$ thin films for spintronic applications.

Keywords: Chiral Magnetic Thin Films, Curie Temperature, Broadband Coplanar Waveguide Ferromagnetic Resonance, Two-Magnon Scattering, Effective Gilbert Damping.

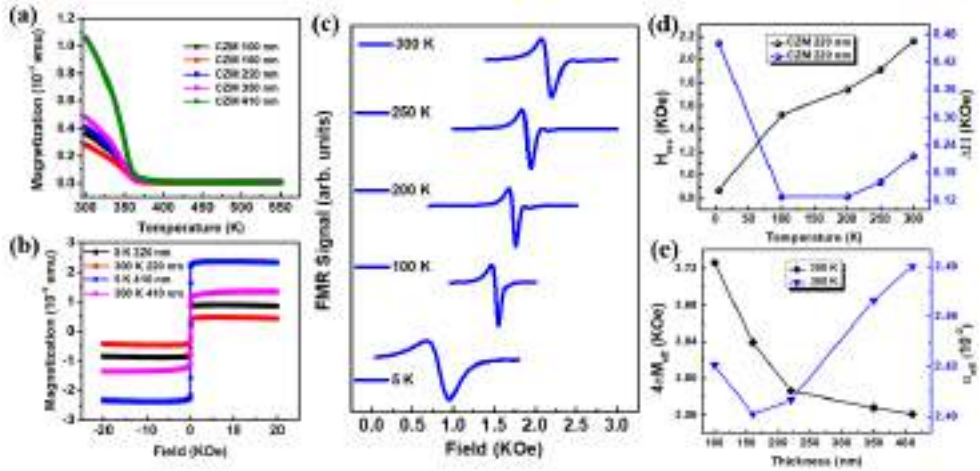


Fig. 1: (a) M vs T for $Co_8Zn_8Mn_4$ thin films of 100-410 nm. (b) M vs H curves of 220 nm and 410 nm films at 5 K and 300 K. (c) FMR spectra of 220 nm film at temp. from 300 K to 5 K at 10 GHz. (d) H_{res} and ΔH as a function of temp. (e) $4\pi M_{\mathrm{eff}}$ and α_{eff} as a function of thickness.

Abstract ID: 511

AN OVERVIEW OF THIN FILM COATING LIKE CrN, DLC, TiN AND AlCrN

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Dronacharya Group of Institutions Greater Noida

Abstract: Initially piston rings were made of simple cast iron ,which had a rough surface due to which there was an increasing behaviour of COF (Coefficient of Friction) and Wear due to metal to metal contact. In the present work we are using Chromium Nitride (CrN) coated piston rings and analysing under different load conditions to examine the behaviour of COF (Coefficient of Friction) and Wear with a constant sliding distance. From the study it is observed that, coefficient of friction and wear are increasing with the increasing load at a constant sliding distance.

Abstract ID: 514

IMPACT OF Lu^{3+} SUBSTITUTION ON CATION DISTRIBUTION, MAGNETOCRYSTALLINE ANISOTROPY, AND CHARGE TRANSPORT MECHANISMS IN $NiFe_{2-x}Lu_xO_4$ (x@ 0, 5, and 7.5%) SPINEL FERRITES

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Abstract: This study presents a comprehensive investigation into the structural, magnetic, and electrical properties of $NiFe_{2-x}Lu_xO_4$ (x@ 0, 5, and 7.5%) samples spinel ferrites synthesized via the solid-state reaction method. X-ray diffraction and Rietveld refinement confirmed the formation of a cubic inverse spinel phase (space group $O_h^7(Fd\bar{3}m)$, showing a lattice expansion with increasing rare-earth substitution. Cation distribution and onsite magnetic moments were analyzed through Mössbauer spectroscopy, revealing that Lu^{3+} occupancy at the B-site leads to a decrease in hyperfine fields and net magnetic moments, maintaining a Néel-type collinear ferrimagnetic structure. The magnetocrystalline anisotropy constants (K_1), derived using the law of approach to saturation (LAS) model, show significant temperature dependence influenced by the rare-earth ions. In parallel, the complex impedance and dielectric properties were examined to elucidate the electrical dynamics. Dielectric dispersion was modeled using Koops' phenomenological theory and a modified Debye function that accounts for multiple ion relaxation processes. Impedance spectroscopy distinguished the contributions of bulk grains and grain boundaries to the overall resistivity. Temperature-dependent AC conductivity revealed an Overlapping Large Polaron Tunneling (OLPT) mechanism, while DC conductivity studies confirmed thermally activated charge carrier mobility. This work establishes a direct correlation between rare-earth-induced structural modifications and the resulting modulation of magnetic anisotropy and conduction mechanisms, providing critical insights for the application of these ferrites in high-frequency and magnetic sensing devices.

Keywords: Ferrites, cation distribution, hyperfine fields, Impedance, Relaxation time, Overlapping Large Polaron.

References:

[1] Kodam Ugendar, Shanigaram Mallesh, Sudireddy Swathi, Naini Pavan Kumar, M.N.V. Ramesh, G. Markandeyulu, Soo-Yong Lee, Young-Woo Nam, Materials Science and Engineering B 323 (2026) 118835.

[2] Kodam Ugendar, Kamala Bharathi K, Raghavendra Reddy V, Sudhindra Rayaprol, Vasudeva Siruguri, and Markandeyulu Garimalle, Journal Of Applied Physics 121, 055101 (2017).

Abstract ID: 515

INFLUENCE OF MULTI-STAGE SPARK PLASMA SINTERING STRATEGY ON DENSIFICATION AND MICROSTRUCTURE OF NdFeB SINTERED MAGNETS

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Abstract: Neodymium-iron-boron (NdFeB) materials are widely used permanent magnetic materials for critical applications in electric vehicles, wind turbines, and medical equipments. Yet, conventional sintering of NdFeB necessitates relatively higher sintering temperatures for full densification. Therefore, advanced sintering techniques such as spark plasma sintering are preferred for improved densification at a lower sintering temperature. The present research proposes a multi-stage sintering strategy to significantly lower the sintering temperature in SPS. Experimental results confirm the multi-stage sintering with a pre-heating step (see Figure) facilitated enhanced densification. A higher sintering temperature is required for large sized NdFeB powders. Moreover, dominant (α-Fe) phase is observed for materials sintered at higher temperatures. Overall, careful optimization of SPS parameters with respect to initial powder size and composition is necessasary to avoid α-Fe formation.

Keywords: Permanent Magnets, NdFeB, Spark Plasma Sintering, Densification

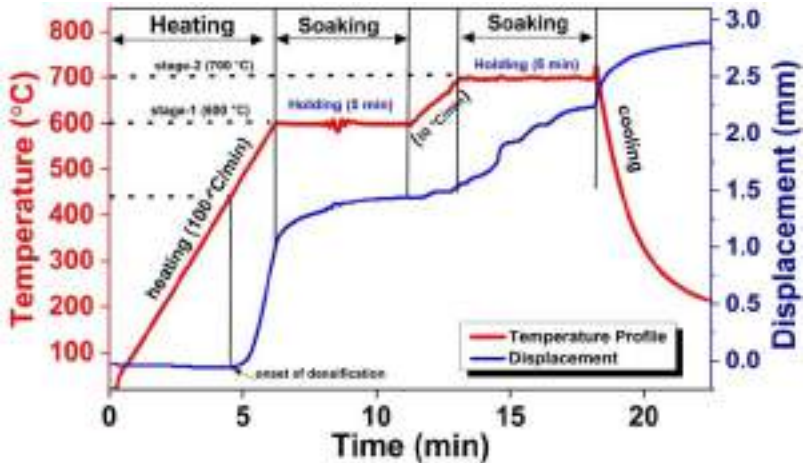


Fig. 1: Linear shrinkage - time - sintering temperature profiles of multi-stage SPS process.

Abstract ID: 516

LARGE COERCIVITY AND TUNABLE EXCHANGE BIAS IN Eu_2NiIro_6 DOUBLE PEROVSKITE

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Abstract: Double perovskites are a highly versatile class of materials that exhibit a wide spectrum of intriguing physical properties. In this work, we report a comprehensive experimental and theoretical study of polycrystalline Eu_2NiIrO_6, synthesized by the conventional solid-state reaction method. Rietveld refinement of the X-ray diffraction data confirms that the compound crystallizes in a monoclinic structure with the $P2_1/n$ space group, while scanning electron microscopy reveals an average grain size of approximately 0.83 µm. Optical measurements indicate a band gap of 1.71 eV, placing Eu_2NiIrO_6 within the visible-light region. Magnetic investigations reveal two magnetic transitions at 163 K and 143 K. At 3 K, the material exhibits a ferromagnetic hysteresis loop characterized by a large coercive field of 3.66 T and a remanent magnetization of 0.638 emu/g. Under zero-field-cooled conditions at 3 K, the hysteresis loops display a spontaneous exchange bias of 1.9 kOe and a magnetization asymmetry of 0.32 emu/g. Upon field cooling, conventional exchange bias behaviour is observed for cooling fields up to ±9 T, while notably, pronounced exchange bias effects persist even for very small field-cooling fields, highlighting the tunable nature of the exchange bias in this system.

Keywords: X-ray diffraction, Double perovskite, Exchange bias, Spin-pinning/vertical shift.

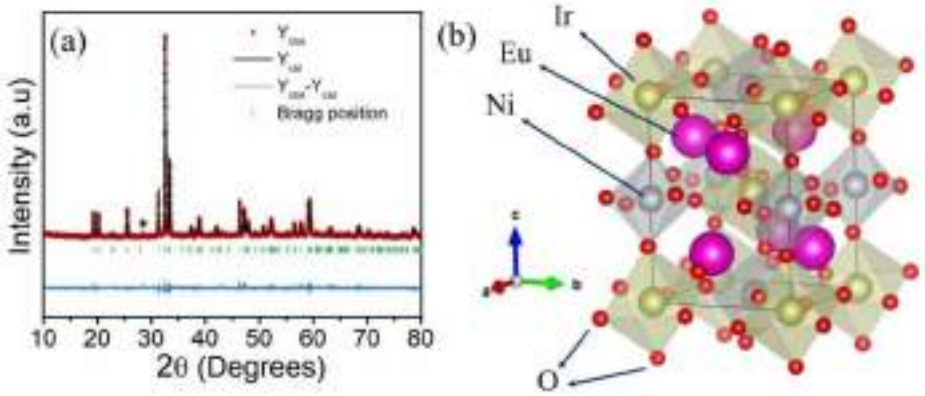


Fig. 1: Room temperature Rietveld refined X-ray diffraction pattern of ENIO compound, (b) the crystal structure of the ENIO compound.

References:

[1] M.T. Anderson, K.B. Greenwood, G.A. Taylor, K.R. Poeppelmeier, Prog. Solid State Chem. 22 (1993) 197–233.
[2] D.M. Cussen, Chem. Mater. 18 (2006) 2855–2866; H. Aharen, Phys. Rev. B 81 (2010) 224409.
[3] R. Morrow, J. Am. Chem. Soc. 135 (2013) 18824–18830.
[4] K.-I. Kobayashi, T. Kimura, H. Sawada, K. Terakura, Y. Tokura, Nature 395 (1998) 677–680.

Abstract ID: 520

A FIRST-PRINCIPLES STUDY OF MAGNETIC ANISOTROPY AND SPIN SELECTIVITY IN MSe_2/WTe_2 (M= 3d TRANSITION METAL ATOM) VDW HETROBILAYER

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Abstract: The ability to tailor the electronic and magnetic properties of two-dimensional (2D) materials opens new avenues for designing spintronics devices. In this study, first principles calculations have been performed for investigating the structural, electronic and magnetic properties of TMDs and their hetrobilayer. Among the two different stacking configurations considered (AA and AA′) for bilayer WSe_2/WTe_2, the AA′ stacking configuration has been identified as energetically favorable and dynamically stable. Doping one layer of the bilayer system MSe_2/WTe_2 (M = Sc, Ti, V, Cr, Mn, Fe, Co, Ni and Cu), significantly alter the electronic structures and induce finite magnet ordering in the structures. The $FeSe_2/WTe_2$ structure attains maximum magnetic moment of 3.99 μ_B and exhibit ferromagnetic ordering with curie temperature 80.11 K. Among all the structures VSe_2/WTe_2 exhibit antiferromagnetic ordering with Neels's temperature 139.89 K. findings of this work establish a strong theoretical foundation to designing 2D materials with tunable magnetic properties, paving the way for further experimental exploration and next generation spintronics device application.

Keywords: Transition Metal Dichalcogenides (TMDs), Density Functional Theory, Monte Carlo Simulation, Magnetic 2D Material, Spintronics.

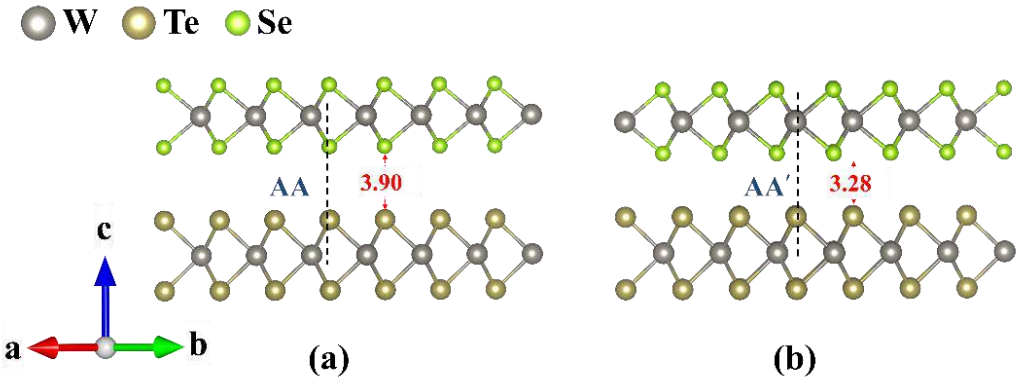


Fig. 1: Stacking sequences of WSe_2/WTe_2 hetrobilayer (a) AA configuration, (b) AA′ configuration.

Abstract ID: 523

MAGNETIC ZnO–$MnFe_2O_4$/POLYPYRROLE POROUS PHOTOTHERMAL NANOCOMPOSITE FOR HIGH-EFFICIENCY SOLAR DOUBLE SLOPE DESALINATION

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Abstract: Water scarcity and the increasing demand for sustainable freshwater production have accelerated the development of advanced Solar Double Slope Desalination (SDSD) systems with enhanced photothermal efficiency. A novel magnetic ZnO–$MnFe_2O_4$/Polypyrrole (PPy) porous photothermal nanocomposite was synthesized and experimentally evaluated for high-efficiency SDSD under real outdoor conditions. The hybrid material combines the excellent visible-light absorption capability of PPy, the thermal stability and photocatalytic characteristics of ZnO, and the magnetic photothermal properties of $MnFe_2O_4$ to achieve enhanced solar energy harvesting and interfacial evaporation performance. The porous interconnected structure promoted rapid water transport, efficient heat localization, and continuous vapor generation under solar irradiation. The nanocomposite was synthesized using a chemical oxidative polymerization-assisted hydrothermal method and characterized using XRD, FESEM, EDS, FTIR, and UV–Vis DRS analyses. FESEM images revealed a highly porous interconnected morphology with particle sizes of approximately 60 nm. UV–Vis DRS analysis showed strong broadband solar absorption with absorptivity reaching nearly 97%, Experimental SDSD studies were conducted from 06:00 to 18:00 h under outdoor solar conditions with peak solar radiation varying between 850 and 1050 W/m² at 12:00–13:00 h. The ZnO–$MnFe_2O_4$/PPy absorber achieved rapid surface heating with peak temperatures of approximately 74°C, significantly enhancing photothermal conversion compared with the conventional solar still (CSS). The optimized nanocomposite produced a freshwater yield of approximately 7.4 $L \cdot m^{-2} \cdot day^{-1}$ with an overall thermal efficiency of nearly 58%, whereas the CSS achieved only ~3.9 $L \cdot m^{-2} \cdot day^{-1}$ and ~38% efficiency. Furthermore, $MnFe_2O_4$ improved thermal energy confinement and sustained evaporation during late-afternoon operation.

Keywords: Solar Desalination; Photothermal Nanocomposite; ZnO–$MnFe_2O_4$/Polypyrrole Interfacial Solar Evaporation; Magnetic Porous Absorber



Fig. 1: Nanocompostites used DUSS performance

Abstract ID: 524

BIOCHAR-ASSISTED Fe_3O_4/Chitosan/TiO_2 POROUS PHOTOTHERMAL MATERIAL FOR SUSTAINABLE SOLAR SINGLE SLOPE DESALINATION

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Abstract: Freshwater scarcity and increasing global energy demand have accelerated the development of sustainable solar-driven desalination technologies with improved photothermal conversion and thermal management capabilities. In this study, a novel biochar-assisted Fe_3O_4/Chitosan/TiO_2 porous photothermal nanocomposite was synthesized and experimentally investigated as an efficient solar absorber for sustainable single-slope solar still (SSS) desalination under real outdoor conditions at the Solar Energy Laboratory, Koneru Lakshmaiah Education Foundation (KLEF), India. The hybrid nanocomposite combines Fe_3O_4 nanoparticles for magnetic-assisted photothermal heating and rapid solar absorption, TiO_2 nanoparticles for enhanced thermal stability and photocatalytic activity, chitosan as a hydrophilic polymer matrix for improved water transport, and porous biochar as a heat-localization and adsorption support. The material was synthesized using a hydrothermal-assisted sol–gel method and characterized through XRD, FESEM, EDS, FTIR, BET, and UV–Vis DRS analyses. FESEM analysis revealed a highly porous interconnected morphology with particle sizes around 45 nm, while BET analysis showed a mesoporous structure with a surface area of 96.4 m^2/g and an average pore diameter of 8.7 nm. UV–Vis DRS confirmed broad UV–visible solar absorption with a reduced band gap of 2.68 eV. The modified SSS operated under peak solar radiation of 920–1050 W/m^2 and achieved a maximum basin water temperature of 71.3°C with a peak evaporative heat transfer coefficient of 34.8 $W \cdot m^{-2} \cdot K^{-1}$. The freshwater productivity reached 6.82 $L \cdot m^{-2} \cdot day^{-1}$, representing a 61.2% improvement over CSS, with thermal and exergy efficiencies of 67.8% and 7.1%, respectively.

Keywords: Photothermal Solar Desalination; Porous Nanocomposite; Interfacial Solar Evaporation; Solar Single-Slope Still; Photothermal Conversion Efficiency

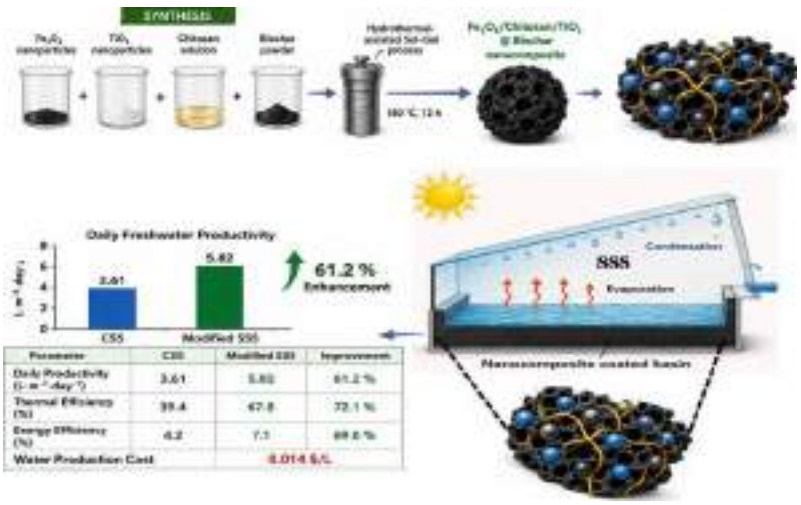


Fig. 1: Graphical Abstract

Abstract ID: 525

SMART FLUORESCENT Fe_3O_4/ZnO NANOSTRUCTURES FOR MAGNETICALLY TARGETED HYPERTHERMIA

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Abstract: The strategic integration of two materials with complementary functionalities has recently gained significant momentum in biomedical research. Fluorescence-enabled nanoparticles with optimized thermal responses have been demonstrated to enhance the efficiency of magnetic fluid hyperthermia (MFH) systems. In the present work, multifunctional Fe_3O_4/ZnO magnetic nanocomposites were successfully synthesized via a facile hydrothermal route with an equal weight ratio of 1:1. Structural characterization distinctly reveals the coexistence of the hexagonal wurtzite phase of ZnO alongside the cubic spinel phase of Fe_3O_4. Notably, detailed optical, magnetic, and induction heating investigations demonstrate the presence of quantum size effects, tunable magnetic behavior, and appreciable self-heating performance. Furthermore, the experimental outcomes offer valuable insight into the physicochemical properties of the Fe_3O_4/ZnO system, highlighting its strong potential as a promising candidate for fluorescence-guided imaging and magnetic hyperthermia applications.

Keywords: Fluorescent Magnetic Nanocomposite, Coercivity, Magnetic Hyperthermia, Heating Efficiency.



Fig. 1: Schematic representation of the preparation of the engineered nanocomposite.

References:

[1] Rakesh S and Patel M K 2026 A Review of Applications of Eco-Engineered Magnetic Nanoparticles in Agricultural Systems
[2] Hazarika K P and Borah J P 2024 Study of biopolymer encapsulated Eu doped F - e 3 O 4 nanoparticles for magnetic hyperthermia application *Sci. Rep.* 1–13
[3] Hazarika K P and Borah J P 2022 Biocompatible Tb doped Fe3O4 nanoparticles with enhanced heating efficiency for magnetic hyperthermia application *J. Magn. Magn. Mater.* **560** 251–6
[4] Mondal D K, Borgohain C, Paul N and Borah J P 2019 Tuning hyperthermia efficiency of MnFe2O4/ZnS nanocomposites by controlled ZnS concentration *J. Mater. Res. Technol.* **8** 5659–70

Abstract ID: 527

MAGNETIC $CoFe_2O_4$/ZnO–BIOCHAR POROUS PHOTOTHERMAL NANOCOMPOSITE FOR HIGH-EFFICIENCY SOLAR BOX COOKING APPLICATIONS

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[1]Department of Computer Science, Jerusalem College of Engineering, Chennai, Tamil Nadu, India.
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Abstract: The increasing demand for sustainable, fuel-independent, and environmentally friendly cooking technologies has stimulated the development of advanced photothermal materials for efficient solar thermal energy conversion. In this study, a novel $CoFe_2O_4$/ZnO–Biochar was synthesized and experimentally evaluated as a high-performance solar absorber for solar box cooker applications under real outdoor conditions at the Solar Energy Laboratory, Koneru Lakshmaiah Education Foundation (KLEF), India. The nanocomposite was prepared using a hydrothermal-assisted co-precipitation method employing $Co(NO_3)_2 \cdot 6H_2O$, $Fe(NO_3)_3 \cdot 9H_2O$, $Zn(NO_3)_2 \cdot 6H_2O$, NaOH, and porous biochar. Structural and surface characterization was performed using XRD, FESEM, EDS mapping, FTIR, UV–Vis DRS, and BET analyses. XRD results confirmed the successful formation of crystalline $CoFe_2O_4$ and hexagonal ZnO phases, while FESEM images revealed uniformly distributed nanoparticles with particle sizes of approximately 25–45 nm embedded within the porous biochar matrix. BET analysis showed a high surface area of132 m^2/g and an average pore diameter of 7.8 nm, indicating enhanced mesoporosity and heat confinement capability. UV–Vis DRS analysis demonstrated broadband solar absorption exceeding 93%, while the nanocomposite achieved a thermal conductivity of 0.68 $W \cdot m^{-1} \cdot K^{-1}$. Experimental investigations revealed that the modified solar box cooker attained a peak absorber plate temperature of 135 °C under solar radiation of 980 W/m^2, compared to 102 °C for the conventional cooker. Cooking efficiency improved significantly from 28% to 46%, while evening thermal retention increased by 35%, demonstrating the strong potential of the developed magnetic photothermal nanocomposite for efficient, low-cost, and sustainable solar cooking applications.

Keywords: Photothermal Conversion; $CoFe_2O_4$/ZnO–Biochar; Solar Thermal Cooking; Magnetic Nanocomposites; Thermal Energy Storage.

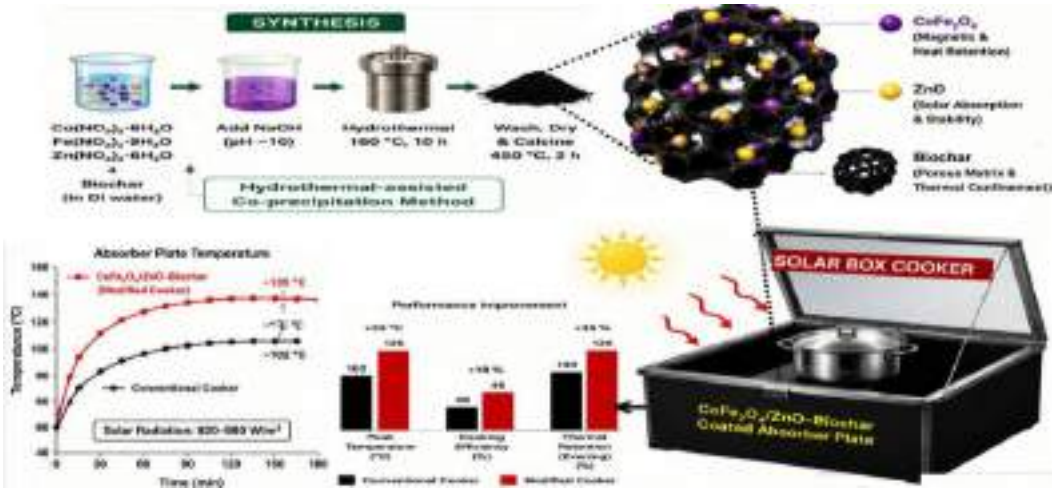


Fig. 1: Perfomance of Solar Cooker using $CoFe_2O_4$/ZnO–Biochar.

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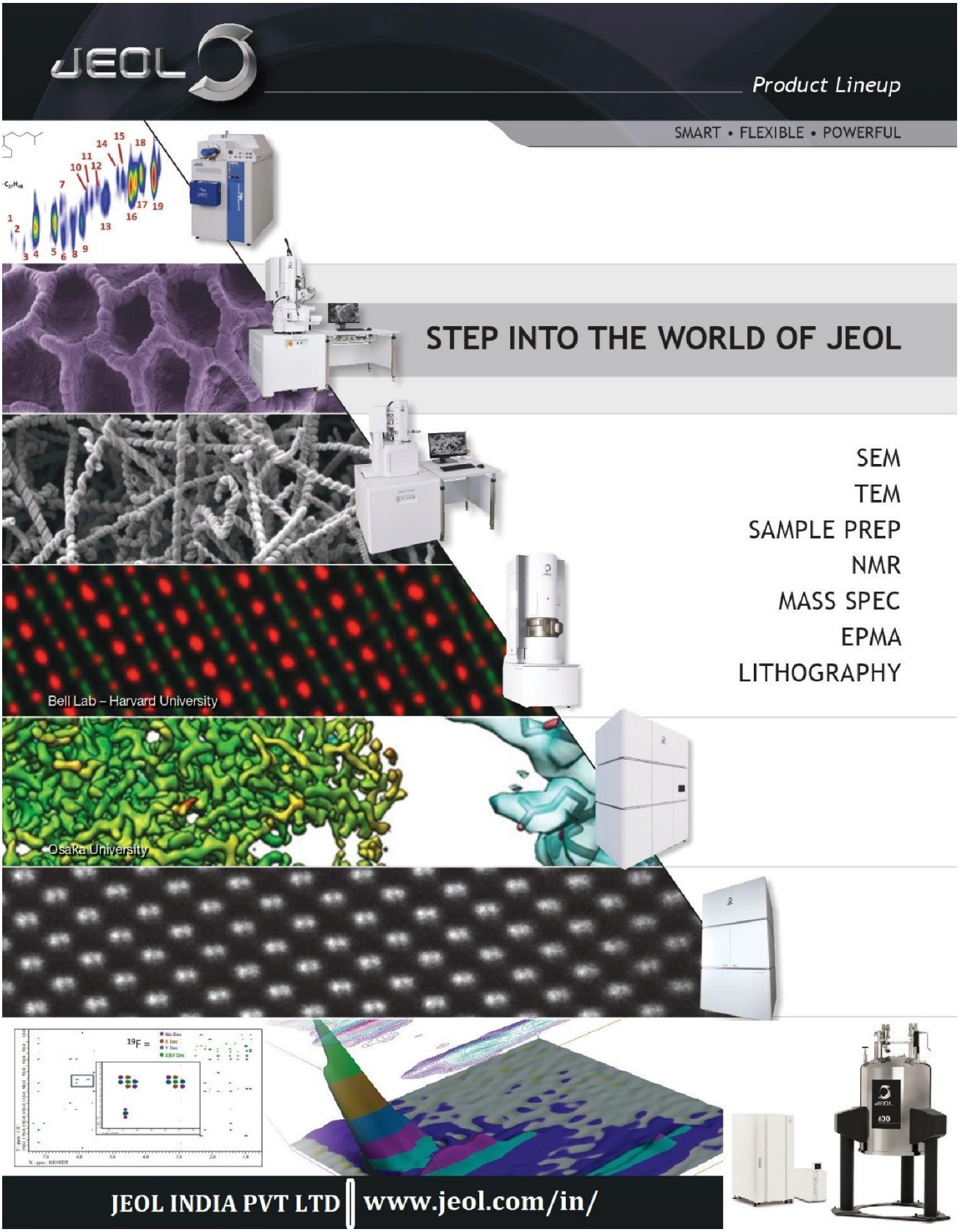

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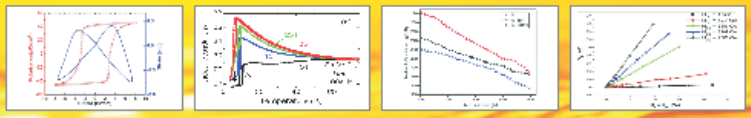
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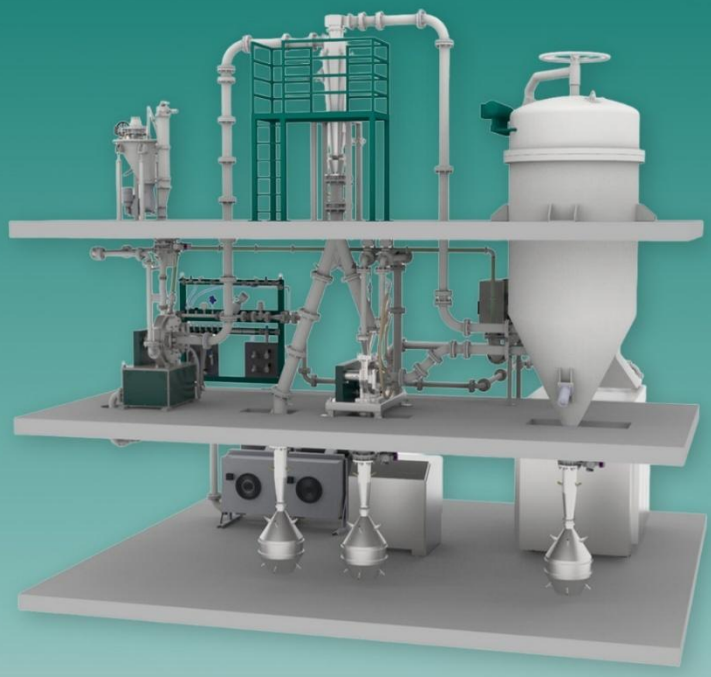


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