CENTER FOR MEMORY AND RECORDING RESEARCH

University of California San Diego

CMRR Fall 2026 Research Review

and Chairs Celebration

Program and Abstracts

Thursday and Friday, November 19 and 20, 2026

Talks: Jack Keil Wolf Auditorium, CMRR building. Posters: Jacobs Hall Lobby and Qualcomm room.

Program as of November 18, 2026.

Program at a Glance

Thursday, November 19: CMRR Review and Chairs Celebration

Time	Program / Talk Title	Speaker / Participants
8:30–8:45 am	Welcome and CMRR overview	Vitaliy Lomakin
8:45–9:05 am	**Enabling Next Generation In Memory Computing Systems, through Ferroelectric Materials Based Devices**	Prab Bandaru
9:05–9:25 am	**Engineering Light for Optical Information Processing and Magnetic Switching**	Abdoulaye Ndao
9:25–9:45 am	**X-ray Nanovision of Ionic Dynamics**	Oleg Shpyrko
9:45–10:00 am	Coffee break	
10:00–10:20 am	**Micromagnetic and Multiphysics Simulation as a Design Tool for Magnetic Materials and Devices**	Vitaliy Lomakin
10:20–10:40 am	**Magnetic Thin Films and Nanostructures**	Eric Fullerton
10:40–11:00 am	**Hybrid Graphene and Quantum Dot Devices for Multispectral and Non-Linear Infrared Optoelectronic Devices**	Oscar Vazquez Mena
11:00–11:30 am	Extended break	
11:30–11:50 am	**Progress on Solid-State Lithium-Sulfur Batteries**	Ping Liu
11:50 am–12:10 pm	**Memcomputing: When Memory Becomes a Computing Tool**	Max Di Ventra
12:10–1:00 pm	Lunch	
1:00–3:00 pm	Student and postdoc poster session *Location: Jacobs Hall Lobby & Qualcomm room.*	CMRR students, postdocs, and sponsor-connected affiliates
3:00–3:30 pm	Break and guest arrival	Guests, leadership, and honorees
3:30–4:45 pm	Celebration honoring CMRR Endowed Chairs, Fellows, and Directors	University leadership, new and current Endowed Chairs, CMRR Fellows, and new and former Directors
4:45–6:45 pm	Reception with substantial food, wine, and beer	CMRR community and guests

Friday, November 20: CMRR Review and Sponsor Advisory Meeting

Time	Program / Talk Title	Speaker / Participants
8:05–8:15 am	Welcome and Thursday recap	Vitaliy Lomakin
8:15–8:35 am	**Oxide Thin-Film Transistor Technology for Next-Generation Sustainable Electronics**	Kenji Nomura
8:35–8:45 am	**Coding Theory, Memory, and AI** *Prerecorded talk*	Paul Siegel
8:45–9:00 am	**Research highlights: Schuller and Kummel groups**	Presented by Vitaliy Lomakin
9:00–9:20 am	**An Overview of the Advanced Material Processing and Synthesis Laboratory (AMPS Lab)**	Javier Garay
9:20–9:40 am	**High-Heat-Flux Evaporation Cooling for Computing and Power Electronics**	Renkun Chen
9:40–9:55 am	Coffee break	
9:55–10:25 am	**Probing and Manipulating Ferroic States with Twisted Photons** *IEEE SD Magnetics Chapter talk*	Edwin Fohtung, Rensselaer Polytechnic Institute
10:25–10:45 am	**Research in Medical Device Technology and Magnetic Recording**	Frank Talke
10:45–11:05 am	**Recycling of Lithium-Ion Batteries and Magnets**	Zheng Chen
11:05–11:25 am	**Metamaterials, Plasmonics and Related Applications**	Zhaowei Liu
11:25–11:45 am	**Imaging Magnetic Domains: Fundamentals to Applications**	Sergio Montoya
11:45 am–12:05 pm	**From Helimagnetism to Altermagnetism: Computational Discovery of Emerging Magnetic Materials**	Kesong Yang
12:05–12:25 pm	**Advanced Magnetometry and Cryogenic Measurement Platforms for Magnetic and Quantum Materials Research**	Randy Dumas, Quantum Design
12:25–12:45 pm	**Magnetic Skyrmions and Chiral Spin Textures in Nanostructured Materials**	Dustin Gilbert, University of Tennessee, Knoxville
12:45–12:55 pm	Schultz Prize announcement	Prize presenter and recipient
12:55–1:05 pm	Best Poster Awards	Poster judges and award recipients
1:05–1:15 pm	Review wrap-up and closing thanks	CMRR leadership and attendees
1:15–2:35 pm	Sponsor advisory meeting with working lunch	CMRR leadership and sponsors
1:15–2:05 pm	Lunch for all other attendees	Students, postdocs, faculty, and guests

Talk Abstracts

Thursday, November 19

8:45–9:05 am

Enabling Next Generation In Memory Computing Systems, through Ferroelectric Materials Based Devices

Prab Bandaru

Ferroelectric (FE) materials can be integrated into non-volatile RAM as well as field effect transistors (FETs)/tunnel junctions (TJ) - with the advantages of fast switching speeds (< 100 ns) and CMOS compatibility. Such aspect is relevant for in-memory computing (IMC) related to AI applications, involving multi-level storage coupled with high performance in situ computing for future advanced technology nodes.

The basis for IMC is the polarization of a FE, which (a) may be set to an up (/down) state from an applied electric field for memory, and (b) which can also modulate the electrical current in a channel, as is done in transistor logic. While FE based memory devices have been utilized as FERAMs (FE random access memory), FE transistors are not as well known. A major reason is that voltages, and power, is larger than that presently used for silicon based technology.

It has then been indicated that the path forward for the widespread usage of FE materials would be considerably facilitated through the reduction of programming voltages to on-chip logic-compatible values of <1 Volt. Obstacles involve issues related to the scaling of the FEs to lower thickness as well as the presence of an interfacial layer (IL) between the high-permittivity FE and the substrate - resulting in wasted voltage across the IL.

We have shown that lower operating voltages along with a higher tunneling electroresistance (TER) could be achieved through IL engineering. Consequently, it was demonstrated that ultrathin FE films deposited on single-layer graphene/Si can exhibit polarization switching at reduced voltages ~0.8 Volt, with significant TER.

9:05–9:25 am

Engineering Light for Optical Information Processing and Magnetic Switching

Abdoulaye Ndao

9:25–9:45 am

X-ray Nanovision of Ionic Dynamics

Oleg Shpyrko

Ionic motion at the nanoscale remains poorly understood, largely because operando tools capable of resolving ions moving through a crystalline lattice have not existed until very recently. I will present several studies that use Coherent X-ray scattering techniques to directly image and probe ionic transport inside operating energy storage devices and the structural response of the underlying atomic lattice to that transport.

10:00–10:20 am

Micromagnetic and Multiphysics Simulation as a Design Tool for Magnetic Materials and Devices

Vitaliy Lomakin

Simulation has become a practical design tool for magnetic materials and devices, allowing ideas to be tested and optimized before fabrication. I will give an overview of our group's work on micromagnetic and multiphysics modeling, which couples magnetization dynamics with electromagnetic, thermal, elastic, and

spin transport effects. The talk will introduce our high-performance simulation tools, including the FastMag micromagnetic solver, and show how they are used to predict and design the behavior of realistic structures. Examples will include magnetic recording media and heads, spin-torque oscillators and their synchronization for sensing and neuromorphic computing, soft magnetic materials, and the reconstruction of magnetic textures from X-ray scattering data. I will conclude with opportunities for collaboration with CMRR sponsors.

10:20–10:40 am

Magnetic Thin Films and Nanostructures

Eric Fullerton

My group's research continues to be centered on the engineering of nano-structured materials and devices and the characterization of their structural, magnetic, optical and transport properties. The particular focus of my research is on magnetic materials and devices, but my research more broadly explores optical, thermal, superconducting, and ionic responses of nanomaterials. I will highlight recent research results in all-oxide spintronics, antiferromagnetic spintronics, topological magnetism and all optical switching of magnetic materials.

10:40–11:00 am

Hybrid Graphene and Quantum Dot Devices for Multispectral and Non-Linear Infrared Optoelectronic Devices

Oscar Vazquez Mena

Data-intensive technologies, from data centers and storage to semiconductor manufacturing and defense systems, increasingly depend on infrared light for sensing, metrology, and optical interconnects. Yet today’s short-wave infrared detectors rely on costly, complex materials such as InGaAs that are difficult to integrate with silicon platforms. This talk presents our work on low-cost, solution-processed infrared optoelectronics, fabricated at low temperature and in air for compatibility with large-area, back-end-of-line-style integration. We show tellurium films and nanocrystals that detect light beyond the range of silicon and germanium, and hybrid graphene–quantum dot stacks that resolve multiple spectral bands within a single compact device, with no gratings, filters, or beam splitters. These approaches point toward compact spectral sensors for process monitoring and optical data links, and toward infrared imaging for defense. Finally, we discuss integrating nonlinear materials, plasmonics, and photonics to enhance sensitivity at target wavelengths, and outline the path forward.

11:30–11:50 am

Progress on Solid-State Lithium-Sulfur Batteries

Ping Liu

Solid-state lithium-sulfur (Li-S) batteries promise high energy density, long cycle life, and low cost. However, realizing long cycle life and high utilization for the sulfur cathode is extremely challenging due to low conductivity, low reactivity, and volume change induced microstructural failure. On the other hand, enabling a stable lithium metal anode is a difficult task in its own right. We will discuss our progress on tackling challenges of both electrodes. On the cathode side, we have focused on improving sulfur-based and lithium sulfide-based cathodes by introducing dopants into these insulating compounds to enhance conductivity and reactivity. The challenges of the lithium anode are related to its reactivity with the sulfide electrolytes. We have focused on understanding the selection rules for the carbon interlayer material that provides a low cost solution. Collectively, these advancements promise to push the energy density and cycle life of solid state Li-S batteries towards practical utility.

11:50 am–12:10 pm

Memcomputing: When Memory Becomes a Computing Tool

Max Di Ventra

Friday, November 20

8:15–8:35 am

Oxide Thin-Film Transistor Technology for Next-Generation Sustainable Electronics

Kenji Nomura

The rapidly growing demand for energy-efficient, high-performance, and environmentally sustainable electronic systems is driving the exploration of next-generation semiconductor technologies beyond conventional silicon-based platforms. Metal-Oxide semiconductor technologies, particularly oxide thin-film transistors (TFTs), have emerged as promising candidates for enabling sustainable and advanced electronic applications. Their low-temperature processability, scalable and cost-effective manufacturing potential, diverse material compositions, and compatibility with large-area fabrication and back-end-of-line (BEOL) processing provide significant advantages for next-generation electronic integration.

Toward the development of energy-efficient, high-performance, and sustainable electronics, we are exploring advanced oxide semiconductor device technologies through comprehensive materials and device engineering, encompassing the development of novel oxide semiconductor materials, defect and interface engineering, contact optimization, and innovative device architecture. In this talk, we will present our recent research advances, with a particular focus on emerging areas of oxide semiconductor technology, BEOL-compatible three-dimensional complementary field-effect transistors (CFETs) enabled by the integration of n-type amorphous-IGZO and p-type-Te TFT. This research directions highlight their potential to enable energy-efficient, highly integrated, and multifunctional electronic systems for next-generation sustainable electronics.

8:35–8:45 am

Coding Theory, Memory, and AI

Paul Siegel Prerecorded talk

This talk will highlight several recent projects in the Signal Transmission and Recording (STAR) group. Topics include error-correcting codes for DNA-based storage, a spatio-temporal generative-AI model for flash memory, and analog codes for in-memory computing.

8:45–9:00 am

Research highlights: Schuller and Kummel groups

Presented by Vitaliy Lomakin

9:00–9:20 am

An Overview of the Advanced Material Processing and Synthesis Laboratory (AMPS Lab)

Javier Garay

We provide an overview of the research in and capabilities of the Advanced Material Processing and Synthesis Laboratory (AMPS Lab) at UC San Diego. The research focuses on materials processing, property measurements and the integration of materials in devices. The application spaces are in lasers/optical devices, magnetic devices, thermal management and fusion energy. We will present work on: 1) thin film deposition for spintronic devices. 2) Powder consolidation for nanocomposite and bulk magnet fabrication. 3) Pulsed laser material processing for dissimilar material welding including microelectronic packaging.

9:20–9:40 am

High-Heat-Flux Evaporation Cooling for Computing and Power Electronics

Renkun Chen

Our group investigates micro- and nanoscale heat transfer and its applications in energy, electronics, and bio-systems. In this overview I will focus on our recent work on high-heat-flux evaporation cooling for computing and power electronic chips: stable thin-film evaporation from fiber membranes with interconnected pores, capillary-fed liquid delivery for continuous high-flux operation, and the translation from wick-level transport physics to cold-plate packaging relevant to AI data-center cooling.

9:55–10:25 am

Probing and Manipulating Ferroic States with Twisted Photons

Edwin Fohtung, Rensselaer Polytechnic Institute IEEE SD Magnetics Chapter talk

Light carrying orbital angular momentum (OAM) provides a new degree of freedom for probing and controlling the collective behavior of matter. Unlike conventional illumination, twisted photons possess spatially structured wavefronts and angular momentum that can couple to the lattice, charge, orbital, and spin degrees of freedom in quantum materials. These interactions offer opportunities to investigate and manipulate ferroic order, symmetry breaking, and topological textures beyond conventional optical excitation.

In this talk, I will discuss our recent advances in using twisted optical and X-ray photons to probe and manipulate ferroic states across multiple length scales. Combining orbital-angular-momentum-dependent optical spectroscopy with coherent X-ray diffraction imaging, we investigate how structured light influences lattice distortions, polarization configurations, and nanoscale strain fields in ferroic materials. I will highlight experimental observations of light-induced modifications of ferroelectric topological structures, including polarization vortices and related strain responses, and discuss how the handedness and spatial structure of the incident light can provide additional sensitivity to symmetry and ferroic order. I will also introduce emerging approaches based on twisted hard X-rays for accessing structural and electronic information encoded in coherent diffraction patterns.

These developments establish structured photons as versatile probes of coupled ferroic degrees of freedom and suggest new pathways toward light-controlled functional states. More broadly, they open opportunities for investigating topological ferroic phenomena and developing reconfigurable materials for future information storage, sensing, and quantum technologies.

10:25–10:45 am

Research in Medical Device Technology and Magnetic Recording

Frank Talke

Recent activities in medical device technology and tribology of magnetic recording will be reviewed. The development of an intraocular pressure sensor for implantation in the eye for patients with glaucoma will be discussed, followed by modelling of human tissue using composite materials. The use of Augmented Reality and MRI as potential alternatives to fluoroscopy in the treatment of back pain will be presented.

10:45–11:05 am

Recycling of Lithium-Ion Batteries and Magnets

Zheng Chen

There is a growing need of critical materials (e.g., Co, Ni, Li, Nd) due to their strong demand in lithium-ion batteries (LIBs) and magnets. Recycling of critical materials can help mitigate the supply chain shortage and offer sustainable solution. In this talk, I will discuss on our recent progress in innovating materials and processing technologies for more sustainable LIBs. I will first discuss our recent work on the next generation direct recycling methods, aiming to produce new electrode materials capable of matching the performance

of native materials. By leveraging advanced characterizations, we study the microstructure and compositional evolution of battery materials during cycling, which are compared with the recycled materials. We demonstrate successful recycling of various battery materials to high performance active materials. Scaling up challenges will also be discussed. Then, I will also briefly talk about our recent work on solid-state battery materials, with focus on addressing materials challenges in chemical and mechano-chemical instability. Sulfide-based electrolyte systems will be used as the example to demonstrate our approaches in cell design and fabrication.

11:05–11:25 am

Metamaterials, Plasmonics and Related Applications

Zhaowei Liu

Metamaterials and plasmonics have been proved to be promising approaches for various applications in nanoscale. In this talk, I will summarize some of our work in the field including quantum metamaterials, metamaterials enhanced sensing, plasmonics enhanced light emission and plasmonics at sub-10nm scales.

11:25–11:45 am

Imaging Magnetic Domains: Fundamentals to Applications

Sergio Montoya

The ability to directly image magnetic domains and their boundaries is crucial from a technological standpoint, as a material's macroscopic magnetic behavior is directly related to its microscopic domain structure. Domain imaging enables a deeper understanding of magnetization reversal processes and drives the development of next-generation devices that exploit unique properties of novel domains, such as chiral spin textures and skyrmions. Furthermore, it provides the foundation for read/write operations in magnetic information devices, guides the optimization of soft and hard magnets, and offers direct methods to verify data sanitization in magnetic storage devices. In this talk, I will discuss a selection of imaging techniques we are collaboratively developing and highlight the new insights these methods provide regarding the spin structure of magnetic domains and their potential applications.

11:45 am–12:05 pm

From Helimagnetism to Altermagnetism: Computational Discovery of Emerging Magnetic Materials

Kesong Yang

Magnetic materials with unconventional spin arrangements offer exciting opportunities for next-generation information technologies, including spintronics and magnetic memory. In this talk, I will highlight our recent progress in the computational discovery and understanding of emerging magnetic materials, with a particular focus on intercalated transition-metal dichalcogenides. Using first-principles calculations and atomistic spin modeling, we investigate how chemical composition, crystal structure, and spin–orbit coupling govern magnetic interactions and stabilize competing magnetic orders, ranging from conventional ferromagnetism and antiferromagnetism to helimagnetism and altermagnetism. These studies provide microscopic insights into the origins of complex magnetic states and establish computational strategies for identifying and controlling magnetic properties in layered materials.

12:05–12:25 pm

Advanced Magnetometry and Cryogenic Measurement Platforms for Magnetic and Quantum Materials Research

Randy Dumas, Quantum Design

Since the inception of the SQUID-based Magnetic Property Measurement System (MPMS) in the 1980s, Quantum Design has continued to provide equipment for the characterization of novel magnetic materials.

This talk will first provide a short historical overview of our capabilities that have helped enable many of the most significant advances in magnetic recording over the past several decades. Finally, and looking more towards the future, recent advances in quantum sensing using nitrogen-vacancy (NV) centers for nanoscale magnetic imaging will be discussed.

12:25–12:45 pm

Magnetic Skyrmions and Chiral Spin Textures in Nanostructured Materials

Dustin Gilbert, University of Tennessee, Knoxville

Poster Abstracts

Student and postdoc poster session: Thursday, November 19, 1:00–3:00 pm, Jacobs Hall Lobby and Qualcomm room.

Poster 1

Mutual Synchronization of Spin-Torque Oscillators through Superconducting Triplet Correlations

Presenter: Egor Savostin
Advisor: Vitaliy Lomakin

We investigate mutual synchronization of two spin-torque oscillators through the spin response of a conventional superconducting film. Magnetic proximity induces spin-triplet correlations in the singlet superconducting background, providing a microscopic mechanism for nonlocal coupling between the oscillators.

Our numerical framework combines the full nonlinear, spatially resolved Landau-Lifshitz-Gilbert equation with a reciprocal superconducting spin response calculated from self-consistent, spatially nonuniform Usadel solutions. The superconducting response is treated adiabatically about a fixed gap background.

For two yttrium iron garnet (YIG) nanomagnets coupled through niobium (Nb), we identify a regime in which superconducting coupling produces antiphase synchronization near 2.69 GHz despite unequal driving currents. Matched simulations with the superconducting response disabled retain sustained oscillations but exhibit continuing relative-phase drift.

Analytical mode projection guides the choice of magnetic bias and geometry to suppress resonant dipolar coupling. Additional controls show that locking survives removal of dynamic mutual dipolar fields and disappears when the inter-island superconducting interaction is removed. These results demonstrate superconductivity-mediated synchronization within the stated effective model and identify geometry, magnetic orientation, and current detuning as controls for distinguishing triplet-mediated coupling from magnetostatic synchronization.

Poster 2

Dual Axis Coherent X-Ray Diffraction Imaging: CPRA and Diffraction Slice Selection

Presenter: Andrew Parsons
Advisors: Vitaliy Lomakin and Sergio Montoya

Dual-axis coherent X-ray diffraction imaging improves the distribution of measurements in three-dimensional Fourier space but can increase the number of diffraction views requiring phase retrieval. This work investigates whether Fourier-informed view selection can preserve reconstruction quality while reducing computation. Simulated diffraction data from a three-dimensional branched dendrite were collected about one or two perpendicular rotation axes. At matched projection counts of 80–180, exact-projection tests showed that dual-axis sampling produced lower volumetric errors and higher correlation with the ground truth than single-axis sampling. A selection algorithm then reduced a dense dual-axis dataset from 160 to 100 views by prioritizing diffraction patterns that contributed information not represented by nearby angles while maintaining angular coverage. The selected views were reconstructed using RAAR and the Carousel Phase Retrieval Algorithm, aligned across both scan axes, and assembled into a three-dimensional volume using GENFIRE. The reduced dataset preserved the dendrite's principal morphology and decreased measured end-to-end reconstruction time from approximately 10.6 to 8.3 minutes, a 21.5% reduction. These results demonstrate that dual-axis acquisition combined with Fourier-informed selection can reduce reconstruction time while retaining major structural information. Further work will evaluate fine surface-detail preservation and improve truth-free screening of poorly converged projections.

Poster 3

Recovering the Magnetic Structure from Reflection Geometry Soft X-ray Scattering

Presenter: Bill Murray

Advisors: Vitaliy Lomakin and Sergio Montoya

We aim to reconstruct magnetic spin textures, including spin orientation, from soft X-ray scattering measured in reflection geometry, which does not require transmission through the sample. The problem is difficult because the detector records intensity without phase, and because different magnetization fields can produce similar scattering. In one test, a reconstruction matched the total intensity to within 0.06% while assigning 40% of the magnetic signs incorrectly. We present two strategies. The first identifies the magnetic components that the measurements support most reliably, using singular value decomposition and a commutator (Lie-bracket) analysis to locate rotational textures, and then uses the FastMag micromagnetic solver to complete the unconstrained regions. The second uses features of the reflection pattern to search a library of micromagnetically solved structures. In controlled simulations, an improved hybrid input-output algorithm reduced the median relative object error from about 34% to 0.1%, and analytical refinement improved the average magnetization direction across 96 simulated textures. Building the library and demonstrating a complete reconstruction are the next steps.

Poster 4

Schuller Nanoscience Group

Presenter: Javier Rodriguez-Alvarez

Advisor: Ivan Schuller

Contributors: Javier Rodriguez-Alvarez, Erbin Qiu, Juan Andres Hofer, Tianxing D. Wang, Ivan K Schuller

Nanoscience and nanotechnology are disciplines that seek to understand the processes that govern a material's behavior by understanding its microscopic properties. In this poster, we present our main lines of research: nanostructured magnetic materials, thermal effects at the micro- and nanoscale, and complex oxides for neuromorphic computing. We also present our capabilities for fabrication and characterization of new materials and nanostructures that form the backbone of our research efforts.

Poster 5

From Thermal Dynamics to Neuromorphic Computing in Quantum Materials

Presenter: Erbin "Ben" Qiu

Advisor: Ivan Schuller

Contributors: Erbin Qiu, Yuan-Hang Zhang, Juan Andres Hofer, Max Di Ventra, Ivan K Schuller

Heat is conventionally regarded as a source of energy dissipation in electronic devices. Here, we demonstrate how electrothermal feedback and thermal coupling in phase-transition quantum materials can be harnessed for neuromorphic computing. Using operando infrared thermography, we visualize spatiotemporal thermal dynamics in VO2 device arrays. We further demonstrate how electrothermal interactions enable neuronal spiking, synchronization, and stochasticity, supporting functionalities including random-number generation and reservoir computing. These results establish thermal dynamics as a computational resource and highlight the potential of quantum materials for energy-efficient neuromorphic hardware.

Poster 6

Thermal Imaging Reveals Geometry-Controlled Filament Guiding in VO_2 Networks

Presenter: Jonathan Shvartzberg
Advisor: Ivan Schuller
Contributors: Jonathan Shvartzberg, Ivan K Schuller

Controlling conductive filament formation in insulator-to-metal transition materials offers a route to reconfigurable electronic networks. Here, we use near-infrared thermal microscopy to investigate filament formation and guiding in VO_2 films etched into network geometries. Applied voltage and localized heating are used to control filament formation, while thermal imaging maps the associated temperature distributions. We examine how network geometry and local thermal excitation influence filament pathways, revealing the interplay between structural confinement, heating, and the insulator-to-metal transition. This work explores geometry and localized heating as complementary tools for directing conductive paths in VO_2 networks.

Poster 7

Current-Controlled Exchange Bias Using the Morin Transition

Presenter: Tianxing D. Wang
Advisor: Ivan Schuller
Contributors: Tianxing D Wang, Juan Andrés Hofer, Javier Rodriguez-Alvarez, Ivan K Schuller

Exchange bias (EB), the pinning of ferromagnetic spins by an adjacent antiferromagnet is often regarded as a passive effect in spintronics because antiferromagnets are insensitive to external magnetic fields. To add a new functionality, we control EB in microdevices by exploiting the Morin transition, a reorientation of the Néel vector in antiferromagnetic hematite. To enable room temperature operation, we use growth-induced strain in hematite to raise the Morin transition from the bulk value (260 K) to 360 K below the Neel temperature. We demonstrate that Joule heating can be harnessed to enable magnetic functionality of a device operating in selected temperature range well below the Néel transition. Our study combines sputtering deposition, reciprocal space mapping using X-ray diffraction, magneto optic Kerr effect measurements, and thermal microscopy.

Poster 8

Exploring Perpendicular Exchange Bias in α-Fe_2O_3/[Co/Pt] Systems Mediated by Morin Transition

Presenter: Daniel Domenech
Advisor: Ivan Schuller
Contributors: Daniel Domenech, Javier Rodriguez-Alvarez, Tianxing D. Wang, Juan Andrés Hofer, Jose Maria Porro, Rafael Morales, Ivan K Schuller

Exchange bias arises from interfacial exchange coupling between ferromagnetic and antiferromagnetic layers, typically resulting in a horizontal shift of the ferromagnetic hysteresis loop. While extensively studied in different systems, its implementation in perpendicular magnetic configurations involving antiferromagnetic hematite (α-Fe_2O_3) remains comparatively unexplored. The Morin transition in α-Fe_2O_3 offers an additional degree of freedom to modify interfacial coupling through the temperature-dependent reorientation of the antiferromagnetic Néel vector. The central question of this work is whether this spin reorientation can influence the magnitude and character of perpendicular exchange bias in α-Fe_2O_3/[Co/Pt] heterostructures, and how this behavior depends on sputtering growth conditions such as thickness or temperature growth of Fe_2O_3 or number of repetitions of [Co/Pt] stack. We investigate this question using structural characterization and polar magneto-optical Kerr effect measurements, examining the interplay between exchange bias, perpendicular magnetic anisotropy, and interfacial coupling. This work aims to establish hematite as a potential platform for tunable magnetic pinning centers in perpendicular magnetic nanostructures.

Poster 9

Multispectral Devices Based on Stacked Graphene/Quantum Dot Devices

Presenter: Freddy Garcia
Advisor: Oscar Vazquez Mena

Poster 10

Tellurium-Based Photodetectors Based on Cost-Efficient Wet Processing

Presenter: Suraj Patel
Advisor: Oscar Vazquez Mena

Poster 11

Hands-On Microfabrication at CMRR: Training the Next Generation of Semiconductor Engineers

Presenter: John Navarro
Advisor: Oscar Vazquez Mena

Poster 12

The Use of Augmented Reality and Magnetic Resonance Imaging (MRI) in Computer-Navigated Back Surgery

Presenter: Songyuan Lu
Advisor: Frank Talke

Chronic back pain is a growing global health concern, necessitating frequent interventions like Radiofrequency Ablation (RFA) and Epidural Steroid Injections (ESI). However, standard procedures currently rely on fluoroscopy, exposing patients and medical staff to harmful ionizing radiation. Our project addresses this challenge by developing a radiation-free Augmented Reality (AR) navigation system tailored for spinal pain management. By integrating high-resolution MRI data with fiducial marker tracking, our system overlays a personalized 3D spine model (constructed from the patient's MRI image) onto the patient's back in real time. Preclinical needle-insertion trials on a 3D-printed lumbar phantom demonstrate that our AR system achieves accuracy within 2mm. This approach not only eliminates radiation risks but also offers a cost-effective solution to advanced surgical navigation, ensuring precise, safe, and accessible care for smaller healthcare facilities.

Poster 13

Development of Strain-Hardening Composite Materials for the Simulation of Human Tissue

Presenters: Brian Li and Po-Han Chan
Advisor: Frank Talke
Authors: Brian Li, Po-Han Chan, Summer Lindauer, Jyoti Mayadev, Vlado A. Lubarda, and Frank E. Talke

Our research group developed a soft composite that mimics the nonlinear mechanics of human soft tissue. It consists of a 3D-printed thermoplastic polyurethane (TPU) scaffold sheet with sinusoidal corrugation, embedded in a silicone matrix. The goal is a tunable metamaterial for soft-tissue models used in medical device calibration, bench testing, and clinical training. We characterized the composite in uniaxial tension up to a stretch ratio of 2, using digital image correlation (DIC) to measure strain. We then compared its true stress–stretch response with that of porcine vaginal tissue. The composite showed tissue-like strain stiffening: a compliant initial toe region followed by a stiffer heel region. Heel-region stiffness scaled with scaffold thickness. Toe-region stiffness depended on both thickness and the corrugation's wavelength-to-amplitude ratio. Using these relationships, we tuned the composite to match the nonlinear response of porcine vaginal tissue and made vaginal phantoms from it with anatomy-informed geometry. We are now

using these phantoms to test an in-lab medical dilator for treating vaginal stenosis and to train machine-learning diagnostic models for the dilator. We are also using them in an ongoing collaboration with the medical school on physician training.

Poster 14

Cu Impurity Removal During Battery Recycling

Presenter: Wenlin Yan
Advisor: Ping Liu

Poster 15

Development of High-Energy-Density Lithium-Sulfur Batteries

Presenter: Qiushi Miao
Advisor: Ping Liu

Poster 16

Thin-Film Evaporation-Enabled Cold Plates for High-Performance Cooling of AI Chips and Power Electronics

Presenter: Kwangsoo Cho
Advisor: Renkun Chen

The rapidly increasing power density of artificial intelligence (AI) processors and power electronic devices presents significant challenges for thermal management. Conventional single-phase liquid cooling technologies face limitations in heat transfer performance, particularly under extreme heat fluxes and rapidly varying thermal loads. This work investigates a novel two-phase cooling approach that integrates capillary-driven thin-film evaporation with advanced cold-plate architectures to enable high-performance thermal management.

We demonstrate that porous glass-fiber membranes can sustain highly efficient thin-film evaporation, achieving heat fluxes exceeding 1 kW/cm² with rapid thermal response. The interconnected pores provide strong capillary liquid replenishment, while evaporation within microscale liquid films enables high heat transfer coefficients. Building on these results, we are developing integrated cold plates that combine thin-film evaporation membranes with thermally conductive copper porous structures and engineered liquid-flow channels. This architecture aims to simultaneously enhance capillary-driven liquid supply, reduce thermal resistance, and facilitate vapor removal while maintaining compatibility with practical cooling systems.

Poster 17

Analog Error Correcting Codes and Their Frame-Theoretic Constructions

Presenter: Ziyuan Zhu
Advisor: Paul Siegel

Poster 18

1 µm Chiplet Underfill Using ALD ZnO Converted to MOF

Presenter: Amy Ross
Advisor: Andrew Kummel

Poster 19

Optical Beam Shaping Induced Reconfigurable Magnetic Domains

Presenter: To be announced
Advisor: Abdoulaye Ndao