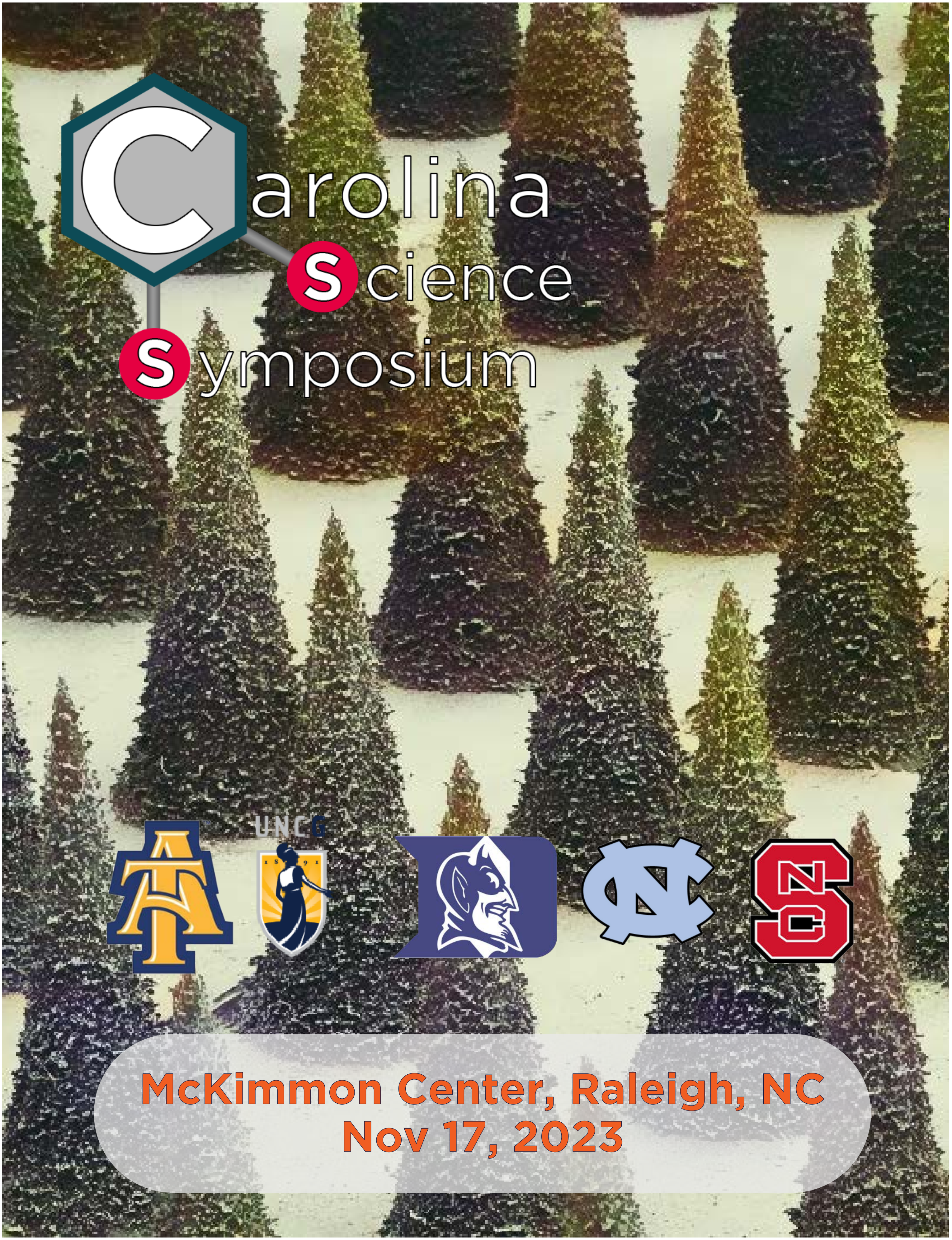

Carolina Science Symposium

McKimmon Center, Raleigh, NC
Nov 17, 2023

Contents

Cover: Microneedle Forest Array of polymer microneedles used for plant sensing by Lydia Nicole Skolrood Parks

Carolina Science Symposium

2023

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Awards

Description	Prize
AIF Best Paper Awards 2 awards for the best paper published during the year that acknowledges the use of the Analytical Instrumentation Facility sponsored by ***AIF***	**$200/ea**
Student Oral Prize 2 awards for the best student oral presentation sponsored by ***RTNN*** *and* ***Micross***	**$200/ea**
Student Poster 1st Prize Sponsored by ***AVS Mid-Atlantic***	**$500**
Student Poster 2nd Prize Sponsored by ***Protochips***	**$300**
Student Poster 3rd Prize Sponsored by ***Tescan***	**$150**
Poster Vendor Prizes 2 Sponsored by ***ThermoFisher*** and others sponsored by ***Smart Materials Solutions, All Scientific***	**$100/ea**
NNF Student Poster Prize Best Student poster uses the NNF facilities and acknowledges them on the poster sponsored by ***NNF***	**$250**
ASM Hans Stadelmaier Award 2 Best posters that shows X-ray Diffraction techniques Sponsored by ***Rigaku***	**$150** **$100**
Mike Rigsbee Photo Contest Best pictures as voted by judges sponsored by ***Hitachi***	**$100**
Asylum Photo Contest Best pictures as voted by judges sponsored by ***Oxford/Asylum***	**$100**
Vendor Raffle 2 Drawing for Gift cards for students that have visited and had their raffle ticket signed by three vendors.	**$50/ea**
CSS Raffle 1 Drawing randomly from attendees that have filled out the online survey after the meeting.	**$50**

Agenda

Time	Name	Presentation	
8:00 - 9:00 AM		**Registration and Coffee (Poster & Vendor Setup)**	
Chairperson		Phillip Strader	RTNN
8:45 - 9:15	Kirtley Amos	Data Science in Ag – Accelerating Translational Agriculture Research	Invited, NCSU
9:15 – 9:30	Ben Sekely	Modeling to Understand Surface Recombination and its Effects on Surface Quantum Wells	NCSU
9:30 -9:45	Akash Singh	Glass formation in Metal Halide Perovskite using Ultrafast Calorimetry	Duke
9:45 -10:00	Ndepana Andrew	Study of Capacitive Charge injection at bacteria interface	UNC
10:00 – 11:00		**Break**	
11:00 -11:15	Sam Bottum	Monte Carlo Simulations of Mie Scattering in Multijunction Silicon Nanowire Suspensions	UNC
11:15 -11:30	Mohammad Javad Zarei	Parylene CVD Coating Processes and Test Methods for Evaluating Coating Properties and Performance	NCSU
11:30 -11:45	Alicia Bryan	Metal-Organic Chemical Vapor Deposition of Hybrid Perovskites	UNC
11:45 -12:00	Ashrit Verma	Progress Towards A Three-Node Ion-Trap Quantum Network	Duke
12:00 – 2:00 PM		**Lunch – Poster Session & Vendor Exhibits**	
Chairperson		Chuck Mooney	NCSU
2:00-2:30	Shyam Aravamudhan	Building a Semiconductor Workforce	Invited, JSNN

2:30-2:45	Hirandeep Reddy Kuchoor	Comparison of GaAsSb nanowire axial and core-shell based p-i-n photodetectors for near-infrared applications	NCA&T
2:45 – 3:00	Kacie Wells	Thermoplastic Elastomers with Inherent Antimicrobial Properties	NCSU
3:00 - 4:00		**Poster Session Final Judging Vendor Exhibits**	
4:00 - 4:30		**Presentation of Prizes**	

Speakers

Data Science in Ag – Accelerating Translational Agriculture Research

Kirtley Amos

The complex challenges our global community is facing transcend the scope of a single discipline, requiring integrative and collaborative approaches to identify technological solutions. As technology advances at a rapid pace, unprecedented amounts of data are being collected across the life sciences. However, currently very few can use this data to its maximum potential. Harnessing big data is essential to our ability to make real-time, informed decisions that lead to practical solutions.

Through interdisciplinary plant science and agriculture data analytics, the EnBiSys (**En**gineering Computational Methodologies for Multi-hierarchical **Bi**ological **Sys**tems) Lab translates research findings to real-world results through the development of targeted computational and analytical solutions for modeling and controlling biological systems. We use multiscale systems modeling to advance the comprehensive understanding of emergent properties in biological and agricultural systems.

Within this presentation I will highlight some of the projects that we as a lab have been a part of and contributed too. They include but are not limited to: (1) applying big data practices to improve processes within sweet potato commercialization pipelines, (2) development and implementation of effective modeling techniques to understand the plant microbiome, and (3) multiscale modeling of the lignin biosynthesis pathway for bioenergy trait improvement within poplar. These are but a few examples of how engineering practice can be applied within agricultural domains to address pertinent questions across biological scale.

Modeling to Understand Surface Recombination and its Effects on Surface Quantum Wells

B. J. Sekely, J. F. Muth - Electrical and Computer Engineering; North Carolina State University

H. O. Everitt, C. T. Kuhs - US Army DEVCOM Army Research Laboratory

Surface passivation is known to produce large effects on the recombination efficiency of III-V materials, including strongly enhanced emission behavior of surface quantum wells. Surface quantum wells are structures where a thin GaN capping layer is confined on one side by the vacuum and on the other side by an AlGaN barrier layer. In this talk, modeling of III-N surface quantum well structures is discussed, examining how the surface modifies the vacuum potential and how piezoelectric and polarization effects influence optical emission. The structures were simulated using several 1D Poisson and Schrodinger equation solvers. The model was compared with experimental data from AlGaN/GaN HEMT structures that have a GaN cap.

Glass formation in Metal Halide Perovskite using Ultrafast Calorimetry

Akash Singh, Yongshin Kim, Reece Henry, Harald Ade, and David B. Mitzi

While the existence of a glassy state has been established in numerous materials families, including chalcogenide semiconductors, metal halide perovskites (MHPs), currently one of the most exciting and extensively studied classes of semiconductors, have primarily been known to exist only in crystalline states. However, our recent discovery of reversible crystal-glass switching in MHPs challenged this notion by employing structural engineering techniques in an exemplary [S-(âˆ’)-1-(1-naphthyl)ethylammonium]2PbBr4 (SNPB) perovskite, achieving slow melt ordering kinetics that resulted in a stable melt-quenched glassy state.[1] Nevertheless, it is challenging to vitrify and conduct kinetic studies on the broader MHP family, particularly members with flexible and non-bulky aliphatic organic cations, thereby limiting the glass forming compositional space. In this study, we expand the range of MHP glass formation across a broader range of organic (fused ring to branched aliphatic) and halide (bromide to iodide) compositions by employing an unconventional technique called ultrafast calorimetry that enables rapid cooling and heating of samples (4-5 order higher than achievable through conventional calorimetry). For the exemplary case of the 1-MeHa2PbI4 (1-MeHa = 1-methyl-hexylammonium) perovskite, a low melting MHP with Tm ~170 Â°C, we demonstrate the ability to obtain a glass by melt-quenching at a rate of 6000Â°C/s, assisted with a partial mass loss of ~15%. The obtained glass shows a glass transition temperature of ~16 Â°C and faster crystallization kinetics compared to SNPB.[2] Furthermore, through iterative calorimetric and viscosity measurements, and a combination of kinetic, thermodynamic, and rheological modeling techniques, we construct an Angell plot and determine important glass-forming kinetic parameters, such as the activation energy of glass crystallization (EA = 124 to 50 kJ/mol for 45 to 97 Â°C), fragility index (m = 72), and crystal growth rates (Umax = 0.21 m/s), providing a deeper understanding of the system's behavior.[3] Ultrafast calorimetry can thus have immense potential to expand the compositional range of glass-forming MHPs, offering a greater range of glass-forming abilities. The results and techniques employed in this study also contribute to establishing a framework for selecting suitable MHP candidates for applications beyond conventional photovoltaics, emitters, and sensors, opening possibilities in areas such as cost-effective memory, computing, metamaterials, and reconfigurable photonic devices.

[1] A. Singh, M. K. Jana, D. B. Mitzi, Adv. Mater. 2021, 33, 2005868.

[2] A. Singh, D. B. Mitzi, ACS Mater. Lett. 2022, 4, 1840.

[3] A. Singh, Y. Kim, R. Henry, H. Ade, D. B. Mitzi, J. Am. Chem. Soc. 2023, 145, 18623.

Study of Capacitive Charge injection at bacteria interface

Ndepana Andrew and Hemali Rathnayake

Among a wide range of biotic interfaces research, the interactions of a variety of microorganisms with biocompatible polymers and composites, and nanostructures have been well-studied, offering their adaptation to broaden research direction for developing a variety of biosensing platforms, drug delivery systems, and wearable, implant and biobased charge storage devices, with either improved or new capabilities and performance.

However, adapting these biotic systems to develop aforementioned systems and devices with good performance requires clear scientific knowledge and understanding of how chemical, physical, and intrinsic properties of a â€œsubstrateâ€ affect its interaction with cells and microbes to yield predictable outcomes and programmable characteristics. Of most of the metabolic electron transfer phenomena from a microbe to an extracellular substrate and vice versa in a variety of exoelectrogenic and non-exoelectrogenic microbes that have been studied, only a few have been investigated in-depth to deduce the physiological responses of microbes, study their electron transfer processes, and elucidate surface chemistries at their respective biotic interfaces with a variety of organic, inorganic, and hybrid substrates.

By introducing a new concept of using a metal-organic framework (MOF) as an abiotic substrate, we grow E.coli on MIL-MOF to create a biobased charge capacitive bio interface from live E.coli and functional MIL-MOF. The preliminary result from our study shows that there are some interactions between the E.coli and the functional MIL-88B translating to electron transfer processes taking place at the bio interface in which the functional abiotic MOF substrate stimulates the E.coliâ€™s metabolic electron transfer process by modulating charge injection at the microbe/MOF interface generating better capacitive signatures.

These findings suggest that by combining the functionalities of living systems such as bacteria and non-living biocompatible systems such as metal-organic frameworks, it is possible to design smart interfacial biosystems for charge storage purposes with programmable characteristics.

Monte Carlo Simulations of Mie Scattering in Multijunction Silicon Nanowire Suspensions

Samuel R. Bottum, Corban G. E. Murphey, Samantha R. Litvin, Jin-Sung Park, James F. Cahoon

An alternate paradigm to the commonly investigated planar photoelectrode is the particle suspension reactor (PSR), which couples light-absorbing semiconductor nanoparticles with reaction tailored cocatalysts. PSRs present advantages over their planar counterparts by offering significant cost advantages and mitigating issues related to reactant diffusion to the electrode surface. One promising type of low-dimensional semiconductor material for PSRs is the silicon nanowire (SiNW). SiNWs grown via the vapor-liquid-solid mechanism can be doped during growth to encode a superlattice of p-i-n junctions to form a multijunction nanowire (MJNW) structure. Dopant transitions are sufficiently abrupt to allow n-p units between each p-i-n junction to act as a tunnel junction, thus allowing voltage summation across the length of a single wire. This allows exceptional photovoltaic characteristics, including a photovoltage that is directly proportional to the number of junctions, generating upwards of 10 V for a single 40-junction NW. This photovoltage is well in excess of what is needed to drive useful chemical reactions, such as CO2 reduction and solar-driven water splitting, as recently reported. While promising, initial solar-to-hydrogen (STH) efficiencies of the MJNW PSR must be improved, which will require the rational design of several different aspects of the system. Light management by engineered scattering is a well-known technique to increase absorption in planar solar energy systems. It is also well known that SiNWs with different sizes and cross-section morphologies can support a series of optical resonances that give rise to high scattering efficiencies and are directly correlated with enhanced light absorption. While photonic resonances are well described at the single NW level, often described using Mie theory, the influence of these resonances on the optical properties of a PSR consisting of a suspension of randomly oriented NWs is unknown. Here, we analyze the absorption and scattering properties of PSRs and demonstrate photonic engineering of Mie scattering resonances of NWs within a PSR to increase absorption across the solar spectrum. A Monte Carlo model integrating Mie theory is used to simulate the optical properties and compared to experimental measurements. The results highlight the direct connection between single-NW photonic properties and the optical properties of NW suspensions, providing an avenue for photon managements in PSRs.

Parylene CVD Coating Processes and Test Methods for Evaluating Coating Properties and Performance

Mohammad Javad Zarei, Sean Clancy

Parylenes (poly-para-xylylene polymers) are deposited through a chemical vapor deposition (CVD) process performed under vacuum and yields coatings with high purity, superior conformality, and excellent chemical barrier, dielectric, and optical properties. Confirmation of the thin film polymer coating properties and performance are determined via a variety of metrology techniques, including thickness measurements, contact angle, FTIR spectroscopy, nanoindentation, pencil hardness, and more.

Comparison of GaAsSb nanowire axial and core-shell based p-i-n photodetectors for near-infrared applications

Hirandeep Reddy Kuchoor, Priyanka Ramaswamy, Shisir Devkota, Jia Li, and Shanthi Iyer

In recent years, III-V nanowires (NWs) have been extensively used in photodetector (PD) applications such as optical communications, night vision, and military surveillance in the near-infrared (NIR) range. In this work, we present the systematic designs of self-catalyzed molecular beam epitaxially (MBE) grown GaAsSb heterostructure axial and core-shell (C−S) p-i-n structured ensemble NW PD on Si substrate, as well as extending the C-S structure growth on monolayer graphene substrate. A systematic study has been performed to realize a high-quality p-i-n heterostructure by exploring several growth methods for better insight to mitigate the growth challenges, which impacts on the NW electrical and optical properties. Also, a novel hybrid axial C−S p-i-n GaAsSb NW structure was designed with an axial n/i core as opposed to the conventional n-core structure. The PD fabricated utilizing the optimized GaAsSb axial p-i-n NWs exhibited the longer wavelength cutoff at ~ 1.1 μm with a significantly higher responsivity of ~ 120 A/W (@-3 V bias) and a detectivity of 1.1 ×1013 Jones operating at room temperature (RT). Whereas in the hybrid axial and C−S structure, the photogenerated current, together with the high-band-gap axial i-region, aids to suppress the trap-assisted tunneling mechanism, which is found to be favorable over traditional C−S NW architecture. A high rectification ratio from current−voltage measurements, suppression of low-frequency noise, the absence of 1/f noise, a low corner frequency of ~2.5 Hz beyond which only frequency-independent white noise is present from low-frequency noise measurements, and bias- and frequency-dependent capacitance−voltage measurements all point to the formation of a high-quality C−S junction in the hybrid structure. The hybrid axial C−S n-i-p GaAsSb has been band-gap-engineered for wavelengths up to 1.5 μm, exhibiting responsivity of 225 A/W@-3 V and detectivity of 1.1 × 1013 Jones operating at RT. Moreover, the hybrid axial C−S structure grown on monolayer graphene surface had boosted the figure of merits with higher responsivity > 1000 A/W and detectivity, indicating the potential of p-i-n GaAsSb NWs PD for spectroscopic, imaging, and sensing applications.

Metal-Organic Chemical Vapor Deposition of Hybrid Perovskites

Alicia C. Bryan, Jonathan K. Meyers, Lorenzo Y. Serafin, and James F. Cahoon

Hybrid perovskites (HPs) have become widely recognized in the chemistry and materials science communities as a promising candidate for the next generation of efficient optoelectronic and photovoltaic devices. Their unique hybrid organic-inorganic nature affords HPs an exciting blend of electronic and structural properties, and yields both advantages and challenges in fabrication. The vast majority of HP fabrication methods to date have focused on simple solution processing, while comparatively few vapor-phase HP deposition methods have been developed, and these broadly rely on single-source evaporation of solid HP crystals or dual-source coevaporation of precursor salts. However, these methods suffer from limited control over reactant vapor pressures and temperatures that in turn lead to limited control over final film composition and morphology. In light of this, we have developed a metal-organic chemical vapor deposition (MOCVD) method for HP fabrication to enable precise control of composition, stoichiometry, and film morphology. Using our custom-built reactor equipped with vapor precursors including methylamine, tetraethyllead, and hydrogen halide gasses, we have successfully deposited continuous thin films of phase-pure CH3NH3PbI3 perovskites as confirmed using X-ray diffraction, UV-visible and photoluminescence spectroscopy, and scanning electron microscopy. We further probed deposition on a variety of substrates including FTO-glass, silicon oxide, and organic-functionalized materials to investigate the vital relationship between substrate identity and film nucleation and growth dynamics.

Progress Towards A Three-Node Ion-Trap Quantum Network

Ashrit Verma, Jameson O'Reilly, George Toh, Sagnik Saha, Mikhail Shalaev, Isabella Goetting, Christopher R Monroe

Trapped ions are one of the leading platforms for quantum technologies including simulations, computing, sensing, metrology, and networking. Long chains of trapped ions are a leading platform for quantum information processing, but their control suffers from spectral crowding and excess motional heating when chains grow too long. One proposal to access larger Hilbert spaces and thus more computational power is to entangle ions in separate traps via photonic interconnects. Here we report our progress towards a quantum network consisting of three multispecies ion traps in separate vacuum chambers. Each node of the network contains barium ions for remote entanglement generation and nearby ytterbium ions for quantum memory. Using different species avoids crosstalk between communication and memory qubits and allows us to benefit from individual strengths of each ion species. Barium is well-suited for communications since it emits single photons in the visible range of the electromagnetic spectrum. Ytterbium features long coherence times allowing for long-lasting quantum memory. This approach offers potential for the creation of larger quantum networks for quantum computing scaling, quantum communications and other applications of quantum technologies.

Building a Semiconductor Workforce

Shyam Aravamudhan

Semiconductors are the backbone of all technology, particularly digitization — enabling everything from consumer goods, medical devices, and transportation to communications, and energy infrastructure — and they play an active part in almost every aspect of our lives. However, to sustain and advance this dynamic industry a well-prepared and adaptable workforce is of utmost importance. As per the U.S. National Strategy on Microelectronics Research report, "A semiconductor industry economic analysis forecasts that an additional $50 billion Federal investment to incentivize domestic manufacturing would create nearly 100,000 direct jobs associated with the manufacturing expansion, including at least 40,000 new, long-term jobs." In this talk, we will explore the semiconductor industry's current state, challenges, and opportunities towards building a skilled workforce. We will also educational pathways and other strategies that will empower people to enter and succeed in this industry.

Thermoplastic Elastomers with Inherent Antimicrobial Properties

Kacie Wells, Dr.Richard Spontak

The global Covid-19 pandemic shed new light on the true dangers of viruses and how reducing the spread of microbes is crucial for our health. While great strides have been made to mitigate the virus and prevent future outbreaks, there are still major threats such as antimicrobial resistant pathogens that are a growing concern. Antimicrobial resistant bacteria and viruses are microbes which are able to evolve and adapt to resist medical treatments, such as antibiotics. These microbes are responsible for millions of deaths globally, outnumbering those related to the HIV/AIDS or Malaria Crises. Current methodologies for inactivating microbes include chemical disinfectants, such as bleach, and UV light exposure as point-in time solutions. These solutions are not able to completely inactivate infectious microbes unless used exactly right, often needing frequent reapplication. Infectious microbes are capable of remaining on surfaces for days to weeks, they have the ability to easily transfer from host to host. High traffic areas such as schools, public transit stations, and hospitals are major contributors to the spread, with 5% of all patients in hospitals acquiring an infection. Due to various microbes' ability to survive in harsh environments, self-sterilizing materials are becoming critical for reducing the impact of their spread. Methods using metals and metal oxides or photodynamic light therapy have proven to be effective as self-sterilizing surfaces, but have drawbacks such as health concerns and pathogen specific inactivation. Our approach is the use of inherently self-disinfecting anionic block copolymers which have been shown to kill over 99.9999% of multiple microbes in just minutes. The mid-block sulfonated block copolymer produces a water-activated pH-drop near its surface, inactivating gram-positive, gram-negative, and spore-forming bacteria (such as C. difficile), as well as viruses (including SARS-CoV-2). This method is not specific to any chemical moieties on a pathogen, so the chance of microbes developing antimicrobial resistance is low. The block copolymer film can self-assemble into highly ordered microstructures which have been found to have a large effect on antimicrobial properties. We employed various casting solvents (polar and nonpolar) to prepare the polymer films and form different microstructures from micelles to organized lamellae. We also implemented post treatment of the films, solvent-vapor annealing and hydrothermal annealing, to further change the microstructure, altering the tortuosity of the pathways for proton diffusion. With a more equilibrium microstructure sulfonate groups were accessible on the film surface (confirmed with high resolution SEM), swelling greatly upon hydration and creating an acidic environment. The film post treatments have been able to illustrate the elucidate time-dependent morphological responses of the block copolymer to Gram-positive (Staphylococcus aureus) and Gram-negative (Escherichia coli) bacteria. The film treatments resulted in changes to the bacterial inactivation kinetics, which we compared and analyzed using a model assuming a two-stage inactivation process. The anionic block copolymer's ability to inactivate a wide range of infectious microbes presents a new method for preventing the spread of infectious microbes and helping to slow the rise of antimicrobial resistant pathogens.

Posters

	Name	Title	
1	Renaissa Ghosh	Synthesis Methods for Graphene	NCSU
2	Brian Cole	Developing Direct-Printed On-skin Electrode Drug Delivery Technology	Duke
3	Shichen Guo	One-Pot Synthesis of Copper-based Microclubs with Asymmetric Scattering and Absorption	Duke
4	Devon Leimkuhl	Controlling Nucleation Sites for Metal Oxide Film Growth on Glassy Carbon via Electrochemical Pre-Oxidation	UNC
5	Aline Cristiane Kumpfer Nascimento	Evaluation of the use of residual rice husk ash in the treatment of recycled concrete aggregates	NCSU
6	Rashmita Baruah	Analysis of electric field and the energy band diagram from COMSOL simulation of GaAsSb nanowire based photodetectors	NCA&T
7	Omiya Ayoub	Nanostructured Surfaces Modulate the Candida albicans Biofilm Formation	UNCG
8	Panesun Tukur	Development of High Entropy Perovskite Oxide Electrocatalyst for the Oxygen Evolution Reaction: A Combined Experimental, Density Functional Theory and Machine Learning Approach to Predicting Oxygen Vacancy Formation Energies and Molecular Adsorption Energies	UNCG
9	Merna Melad	Efficient RNA Targeting by Cas7-11 CRISPR Effectors in Plant Systems	UNCG
10	Samantha Litvin	Designing Multijunction Silicon Nanowires for Solar-to-Hydrogen Conversion	UNC
11	Io Saito	Idealized model experiment for validation of AFM interphase characterization	Duke

12	Owen Courtney	Probing THz Response of Silicon Geometric Diodes Coupled to Microscale Antennas	UNC
13	Becca Radomsky	Design of Ionic Conductors for Solid-State Fluoride-Ion Batteries	UNC
14	Andrew Christy	Hybrid Magnonics for Coherent Information Processing	UNC
15	Oluwatoyin Atikekeresola	Raman Responses of Mechanically Activated Lead-Free BNKT	NCCU
16	Conner Slamowitz	Batteries without Redox: Layered Electrides as Fluoride-ion Battery Electrodes	UNC
17	Yugwini Deshmukh	COMPARISON OF NIP GaAsSb NANOWIRES BASED PHOTODETECTORS PERFORMANCE GROWN BY MBE ON SILICON AND GRAPHENE	NCA&T
18	Ayobami Taiwo	Raman and FTIR Spectroscopy Analysis of Polyurethane-Based Composites	NCCU
19	Robert Castaneda	Femtosecond microscopy imaging of charge carrier dynamics in electronically non-equilibrium semiconductor interfaces using low fluence spectroscopy	UNC
20	Swapna Kalkar	Extraction and Quantification of Antenna pigments to study Tailoring Photoresponse of Cyanobacteria	UNC
21	April Sharp	A gut feeling: investigating the role of pollen morphology in reducing gut parasite infections in bees	NCSU
22	Junjian Wang	Enhancing Fine-Mapping of Complex Traits in Farm Animals through Bayesian Mixed Model: A Case Study with Duroc Pigs	NCSU
23	Kelvin Adrah	Bioinspired Coordination Polymer Frameworks for Adsorption Desalination	UNCG
24	Dylan Peverall	Electron Interactions with Microstructures and Defects During Additive Manufacturing	NCSU

25	Farhan Ishrak	Magnetization of Al-based alloys by shear-assisted solid phase processing	NCSU
26	Sipan Liu	Scalable Green Manufacturing of Microstructured Surfaces Using Viscoelastic Interfacial Instability	NCSU
27	William McLain	Dual Stiffness Substrates for Excellent Microscopy	NCSU
28	Mohamed Ramadan Abd Allah Mohamed	Dyeing Cotton Sustainably for Enduring Color Fastness with Reactive Dyes	NCSU
29	Frederick Adrah	EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF TEMPERATURE VARIATIONS ON E. COLI GROWTH RATE	UNCG
30	Muhammed Ziauddin Ahmad Ebrahim	MOF-based hybrid aerogels for enhanced functionality	NCSU
31	Brayden Wilkins	A cost-effective method of identifying pollen and contaminants within honey based on an artificial neural network	NCSU
32	Raphael Ayivi	Molecularly Imprinted Polymers as Sensitive Nanosensors for Organophosphate Pesticide Detection	UNCG

Synthesis Methods for Graphene

Renaissa Ghosh

The 2-D structure of graphene, an allotrope of carbon with remarkable characteristics, is revolutionizing the technology world. This article provides a synopsis of three popular methods for graphene synthesis. The mechanical exfoliation method attempts to separate graphene layers from bulk graphite and is used for small-scale production. The next method is the chemical vapor deposition (CVD) synthesis, which uses a reaction between a gaseous hydrocarbon and a solid substrate to promote graphene growth. Finally, the modified Hummer's method involves the use of oxidizing and reducing agents to obtain graphene oxide (GO) from graphene flakes under low-temperature conditions from which graphene is synthesized as the final product.

Developing Direct-Printed On-skin Electrode Drug Delivery Technology

Brian Cole, Rowena Ge, Aaron Franklin

Iontophoresis is a non-invasive clinical technique for transdermal drug delivery (TDD). Advancements in iontophoresis (ITP) technology have catalyzed the development of transdermal patches characterized by gradual and prolonged drug liberation, thereby enhancing patient compliance with prescribed regimens. Nonetheless, its ubiquity remains constrained at present owing to documented instances of patient unease, deficiencies in precise dosage modulation, and incapability in dispensing large biomolecules, such as insulin. In preceding studies, it was demonstrated that conductive circuits could be printed onto living human skin with an aerosol jet printer (AJP) and an aqueous metallic silver nanowire (AgNW) colloidal suspension. It is proposed that a TDD system with direct printed electrodes might offer a lower contact resistance and improve controlled drug release, rather than transferring electrodes as is the case for commercial ITP patches. The overarching vision of this research is to improve therapy for patients by developing a Direct-printed On-Skin Electronic Drug-delivery (DOSED) technology.

In this work, AgNW inks were formulated, their printing process was optimized, and performance experiments were conducted to validate the DOSED model and to develop ITP prototypes. AgNW patterns were printed at room temperature onto glass and skin substrates at a 100% yield without any sintering process required. Increasing the platen temperature to 80 Â°C lowered sheet resistance to values below 1 Î©/sq. Preliminary work suggests that printed electrodes require less potential to operate in a Franz Cell at equivalent surface areas and current densities. Printed electrodes provided reproducible drug delivery at a sub-2V potential bias. The printed electrodes were subjected to 1x phosphate-buffered saline (PBS) for 24hr without encountering any reduction in sheet resistance. Additionally, a static bias of 2 volts was applied, resulting in currents surpassing the maximum safe current density (MSCD) threshold, yet the cathodes remained stable for 24 hours. These observations collectively indicate the viability of printed AgNW electrodes for cathodal iontophoresis.

One-Pot Synthesis of Copper-based Microclubs with Asymmetric Scattering and Absorption

Shichen Guo, Michael Boyarsky, S. Avery Vigil, Yifan Yu, Ivan A. Moreno-Hernandez, Michael E. Gehm, Benjamin J. Wiley

The synthesis and investigation of anisotropic micro- and nanostructures has emerged as a significant area of interest in colloidal science due to their unique structure-dependent properties and diverse applications. This study introduces a 20-min, one-pot synthesis for generating two-component microclubs consisting of a Cu2O head and Cu2O@Cu shaft. We analyzed 100,000+ particles in minutes with a FlowCam to elucidate the influential roles of sodium hydroxide (NaOH), hydrazine (N2H4), and ethylenediamine (EDA) in microclub production. This new synthesis process offers a simplified route to create two-component, anisotropic microstructures, while the use of a FlowCam illustrates its potential to rapidly accelerate microparticle analysis for colloidal synthesis. The microclub particle also demonstrates asymmetric scattering and absorption properties by simulation, which exhibits the potential of the aligned microclub structure for asymmetric imaging.

Controlling Nucleation Sites for Metal Oxide Film Growth on Glassy Carbon via Electrochemical Pre-Oxidation

Devon P. Leimkuhl, Carrie L. Donley, Megan N. Jackson

Coating electrode materials with metal oxide thin films can benefit the performance of electrocatalysts and charge storage materials. Atomic layer deposition enables the deposition of conformal, uniform films on a wide range of electrodes; however, an even film depends on the availability of nucleation sites directly on the electrode surface. Here we show that electrochemical oxidation of glassy carbon electrodes prior to deposition of alumina thin films by ALD leads to more uniform, electrochemically passivating films. Cyclic voltammetry (CV), X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM), and atomic force microscopy (AFM) demonstrate that film uniformity increases with increasing potential of pre-oxidation until 2.50 V vs. Ag/AgCl, at which point the films are fully passivating and appear continuous by SEM. Further increasing the potential of pre-oxidation leads to uniform, but less consistently passivating alumina films. These findings show that electrochemical pre-oxidation is a rapid and readily tunable strategy for controlling oxygenic nucleation sites and therefore the growth of thin metal oxide films on glassy carbon electrodes.

Evaluation of the use of residual rice husk ash in the treatment of recycled concrete aggregates

Aline Cristiane Kumpfer Nascimento

Jose Ilo Pereira Filho

The properties of recycled concrete aggregates - RCA are inferior to those of natural aggregates due to the residual mortar that negatively affects the properties of the produced concretes. In this context, the immersion treatment in pozzolanic mixtures proposes to provide a strengthening layer to the RCA. In view of this, the present research proposed to use the residual rice husk ash (RHA) from the grain processing as a pozzolanic material in this treatment. A group of RCA was treated in a mixture of RHA and Portland cement in proportions of 50-50, and its physical properties as well as the mechanical properties of the produced concrete were compared to a group of untreated RCA. It was observed that the treatment improved the characteristics of the aggregate and the new ITZ due to the densification of the aggregates surface, but without significant improvement to the mechanical properties of the produced concrete.

Analysis of electric field and the energy band diagram from COMSOL simulation of GaAsSb nanowire based photodetectors

Joshua White*, Rashmita Baruah*, Hakeem Menefee and Shanthi Iyer

In recent years, photodetectors based on III-V semiconductor materials have garnered significant attention due to their potential for superior performance in optoelectronic applications. This study focuses on PIN nanowire photodetectors constructed from GaAsSb, a promising material from the III-V semiconductor family. A comprehensive simulation using the COMSOL Multiphysics platform was undertaken to understand the internal electric field distribution and energy band diagram of the GaAsSb nanowire under illumination. Preliminary results indicate a distinct electric field profile, which is crucial for efficient carrier separation and collection, and a unique energy band structure that offers insights into the device's photoresponse behavior. This study paves the way for optimizing GaAsSb-based PIN nanowire photodetectors and understanding the underlying physics that govern their operation.

Nanostructured Surfaces Modulate the Candida albicans Biofilm Formation

Omiya Ayoub, Lakshmi Gayatri Chivukula, Dennis LaJeunesse

Over the course of the last century, a significant escalation in antifungal resistance among fungal species has accentuated the critical demand for innovative theranostic approaches. The innate antimicrobial attributes exhibited by insect cuticles at the nanoscale have emerged as a compelling subject of therapeutic investigation. Nanostructured surfaces emulating the intricate patterns of insect cuticles offer a promising strategy for combatting fungal infections. Candida albicans, an opportunistic pathogenic yeast, commonly inhabits various niches within the human body, including the oral, gastrointestinal, and genitourinary tracts. The establishment of Candida infections is contingent upon a finely tuned interplay between the host's immune responses, and it often manifests as an opportunistic infection in the presence of underlying conditions such as cancer and AIDS. The primary focus of this study lies in transcriptomic analysis, which elucidates the molecular responses of Candida albicans to nanostructured surfaces inspired by the intricate wing patterns of Tibicien spp. cicadas. Our findings reveal substantial alterations in gene expression profiles associated with pivotal processes such as biofilm formation, hyphal morphogenesis, and DNA damage response following a 24-hour exposure to these meticulously designed nanostructures. Particularly noteworthy are the attenuated pathways related to cytoskeletal organization and ergosterol biosynthesis, which offer substantial promise for combating Candida albicans infections. These results open a multitude of avenues for the development of innovative strategies to address fungal infections and modulate biofilm formation, which have significant implications for clinical therapeutics and antimicrobial research.

Development of High Entropy Perovskite Oxide Electrocatalyst for the Oxygen Evolution Reaction: A Combined Experimental, Density Functional Theory and Machine Learning Approach to Predicting Oxygen Vacancy Formation Energies and Molecular Adsorption Energies

Panesun Tukur, Jianjun Wei, Yirong Mo, Wei Yong, Hanning Chen, Yinning Zhang

This research explores the design and development of high entropy perovskite oxide electrocatalysts for the oxygen evolution reaction (OER) through a comprehensive approach that integrates experimental investigations, density functional theory (DFT) calculations, and machine learning techniques. By harnessing the potential of high entropy materials, we aim to enhance the catalytic activity of perovskite oxides for the critical OER process. We investigate the formation energies of oxygen vacancies and molecular adsorption energies on these catalyst surfaces using state-of-the-art DFT simulations. Additionally, machine learning models are employed to predict these critical properties, providing insights into catalyst performance across a wide compositional space. The synergistic combination of these methods promises to accelerate the discovery of advanced OER electrocatalysts with improved efficiency and sustainability, contributing to the advancement of renewable energy technologies.

Efficient RNA Targeting by Cas7-11 CRISPR Effectors in Plant Systems

Merna Magdy, Eric Josephs

CRISPR/Cas systems operate as a defense mechanism in prokaryotes against viruses. They utilize Cas effector proteins, mainly nucleases, accompanied by programmable guide RNAs (gRNAs) to precisely target specific sequences through complementary base pairing. While DNA-targeting CRISPR systems like Cas9 and Cas12 have been repurposed for genome and epigenome manipulation in research and therapy, RNA-targeting CRISPR systems such as Cas7-11 and Cas13 have also been identified and effectively utilized to interact with or cleave RNAs in eukaryotic cells. Cas13 can target RNA and activate an endoribonuclease function, which can cut both the targeted RNA and nearby non-targeted RNA in a process known as "collateral activity." This collateral activity can be problematic. However, CRISPR/Cas7-11 system is gaining popularity for its ability to target RNA with minimal collateral activity in eukaryotes. Interestingly, when applied to plants, the Cas7-11 system didn't exhibit collateral effects. Encouraged by this discovery, we tested its antiviral potential against the Tobacco mosaic virus (TMV) in Nicotiana benthamiana and successfully used it to target specific endogenous RNA sequences, like the phytoene desaturase (PDS) gene. These findings pave the way for future applications of RNA-targeting CRISPR tools in specific knockdown procedures in plants.

Designing Multijunction Silicon Nanowires for Solar-to-Hydrogen Conversion

Samantha Litvin, Taylor Teitsworth, Sarah Sutton, Samuel Bottum, James Cahoon

Solar-driven hydrogen generation has been demonstrated with particulate multijunction silicon nanowires (MJ SiNWs) in suspension. As photocatalysts, MJ SiNWs have tunable photovoltages ranging from 0.2 to over 10 V and produce measurable water splitting activity at infrared wavelengths up to ~1050 nm. Utilizing a simple bottom-up synthesis, MJ NWs enable next generation photoelectrochemistry-based fuel production. However, significant improvements in the solar-to-hydrogen (STH) conversion efficiency must be achieved for this technology to be capable of meeting consumer energy demands. Here, we investigate electronic properties of the SiNWs that dictate the STH efficiency, with a particular focus on the effects of the dopant profile and the spatially-dependent surface charge recombination velocities. Single-NW photovoltaic measurements coupled with finite-element modeling allow an analysis of the effect of various surface passivation treatments and dopant profiles on key metrics including open-circuit voltage and short-circuit current density. The results highlight trade-offs between metrics and reveal the challenges to identifying strategies that improve the performance of individual p-i-n junctions while maintaining compatibility with co-catalyst deposition and performance of tunnel junctions. Improvements to STH efficiency via rational design of MJ SiNW structures will help to bring the cost and environmental advantages of silicon to the suspension design, providing a new approach for water-splitting reactors.

Idealized model experiment for validation of AFM interphase characterization

Io Saito, Dr. Richard Sheridan, Prof. Stefan Zauscher , Prof. Cate Brinson

Understanding the mechanical properties of polymer nanocomposite materials is essential for industrial use. Particularly, characterizing the local modulus near the filler has both practical and scientific significance in optimizing structure-property relationships and understanding polymer behavior near the interphase.

Nanoindentation via Atomic Force Microscopy (AFM) is a robust technique for characterizing the local modulus of soft materials due to its nanoscale spatial resolution. However, indentation into heterogeneous materials presents an issue called the "substrate effect" – the structural stress field caused by the rigid body is convoluted into the raw data.

Finite element analysis-based methods have been reported to deconvolute the interphase modulus from the obtained data. Nevertheless, experimental calibration is still needed. In this study, we simulate ideal AFM indentation using an "artificial interphase model," which consists of three layers with different moduli. By varying the thickness of the interphase layer and tip radius, we examined a wide range of indentation conditions.

We found an empirical master curve associated with the pure substrate effect, without any arbitrary interphase, as reported before. The presence of an interphase led to deviations from the master curve, correlating solely with the relative interphase thickness normalized to the far-field contact radius.

Our findings are broadly applicable to extract interphase properties from multiphase 2D materials, regardless of the specific interphase thickness.

Probing THz Response of Silicon Geometric Diodes Coupled to Microscale Antennas

Owen Courtney, Kelly White, James Custer, James Cahoon

Electrical diodes for direct current and alternating current applications are typically fabricated from semiconductor p-n junctions or metal-semiconductor Schottky junctions. Each technology presents advantages and limitations in terms of the frequency of rectification, reliability of fabrication, and integration on diverse or flexible substrates. We recently reported an alternate strategy—two terminal geometric diodes—to produce zero-bias silicon diodes capable of high-frequency rectification. The geometric diodes are spatially asymmetric, two-terminal majority carrier devices operating via a ballistic mechanism, which causes the ratcheting of electrons and generation of a DC bias upon application of an AC signal. The structures are grown from the bottom-up by a vapor-liquid-solid growth process, producing single-crystalline nanowire structures with precisely controlled asymmetric geometry and doping levels. As a result, we hypothesize that with appropriate design the devices can rectify above 1 THz, and our current proof-of-concept experimental results have demonstrated rectification through at least 40 GHz. We are currently working toward understanding the design principles (synthesis conditions, surfaces, doping levels, geometry, etc) that dictate geometric diode performance and evaluating THz operation by directly coupling geometric diodes to antennas, creating rectennas that can be integrated on diverse substrates for THz detection.

Design of Ionic Conductors for Solid-State Fluoride-Ion Batteries

Rebecca Radomsky, Lauren McRae, Jack Sundberg, Connor Slamowitz, Matthew Lanetti, Scott Warren

Our society's transition to renewable energy has drastically increased the need for energy storage systems beyond Lithium-ion batteries (LIBs). Fluoride-ion batteries (FIBs) are a promising alternative with higher theoretical energy densities and larger electrochemical operating windows. However, FIBs are yet to be fully realized due to the lack of materials that can reversibly intercalate fluoride ions. In particular, anodes with high capacities and energy densities remain a challenge. We have recently predicted that electrides, or materials with bare electrons present in well-defined lattice sites, exhibit a fundamentally new mechanism for anion diffusion that shows promise for FIB anodes. The mechanism for fluoride insertion into electrides—which we have named Electron-Anion Exchange (EAX)—allows for the one-to-one swap of anions and electrons as the anion hops between "vacant" electride sites. Because the participating anionic electrons are not associated with any atomic nuclei, the surrounding atoms do not experience any reduction or oxidation throughout the insertion process. The consequences of redox-free EAX are substantial. Due to the similar size and charge of anionic electrons and simple anions, the host lattice experiences virtually no electrostatic change during ion insertion and the reorganization energy becomes negligible. In order to fully exploit the effects of EAX for FIBs, including little to no lattice expansion upon intercalation and exceptionally low activation energies for fluoride diffusion, we have designed and synthesized a novel electride material, Y6S4. Similar to previously known electrides such as Y2C, Y6S4 has a layered structure with alternating layers of anionic electrons and host material. However, Y6S4 contains S pillars throughout the anionic electron layer that increase the interlayer spacing, causing the overlap with neighboring cations to be small. We predict the "pillared layered" structure of Y6S4 to have not only a larger capacity, but also a significantly higher fluoride ion conductivity than its layered electride analogs. We therefore predict Y6S4 to be one of the most efficient fluoride intercalation materials to date—with natural applications as an anode in FIBs or electrochemical capacitors.

Hybrid Magnonics for Coherent Information Processing

Andrew Christy, Wei Zhang, Yuzan Xiong

The vast majority of systems use electric currents to transmit signals, which have inherent drawbacks such as dissipation of energy as heat due to Ohmic processes. In contrast, magnons – the quanta of spin waves: the excitation of electron spins in a crystal lattice – can be harnessed as an information carrier in wave-based computing technologies. Similar to electromagnetic and acoustic waves, spin waves can propagate and interfere, which means they can deliver phase information for coherent information processing. Not only do magnonic circuits not experience dissipative heating like electronic circuits do, but their high frequencies could lead to faster and smaller computing elements. However, magnons suffer from their finite lifetimes. Hybrid phonon-magnon and photon-magnon systems can retain the inherent information processing capabilities of both quasiparticles, while also demonstrating emergent properties such as high Q-factors and nonreciprocal quantum information flow.

Raman Responses of Mechanically Activated Lead-Free BNKT

Oluwatoyin R. Atikekeresola, Vladimir B. Pavlovic, Marko Perić, Aleksandra Janicijevic, Branislav Vlahovic, Joseph O. Nduka

Lead-free Barium Sodium Potassium Titanate (BNKT) perovskite powder was synthesized via the Conventional Solid-State Reaction (CSSR) method, with a focus on observing the influence of various activation times on its crystal structure. Raman analysis of mechanically activated BNKT revealed the presence of a tetragonal phase with C4v symmetry (belonging to the P 4bm space group), and this was in agreement with the XRD patterns. Notably, the intensity of Raman signals exhibited a diminishing trend with increasing activation times (0, 5, and 10 minutes), likely attributed to reduced particle sizes and heightened mechanical strain, but the intensity increased for a 20-minute activation time. This study highlights the role of mechanical activation in fostering the development of nanocrystalline BNKT.

Batteries without Redox: Layered Electrides as Fluoride-ion Battery Electrodes

Connor Slamowitz, Tommi Aalto, Matthew Lanetti, Becca Radomsky, Samuel Weaver, Don McTaggart, Oliver Clemens, Scott Warren

The transition to a more sustainable society relies on innovations in energy production and storage. Rechargeable lithium-ion batteries have revolutionized energy utilization, laying a critical foundation for grid-scale energy storage and powering electric vehicles. The high demand for lithium, however, has caused environmental and human strain due to the need to mine resources in developing countries. Fluoride is among the most promising alternatives to lithium due to its lightweight and high electronegativity, leading to high-capacity batteries operating at a high voltage. In our path to creating rechargeable batteries based on fluoride anions, we have discovered the practical use of exotic materials known as electrides as fluoride-ion battery electrodes. Electrides are interesting inorganic materials that have high-energy electrons that localize to unique crystallographic lattice sites rather than sitting in a molecular orbital. In electrides that crystallize in a layered morphology, we predict that we can exchange an electride electron directly for a fluoride anion. In this work, we convert the layered electride, Y2C2+[2e-], to the fluorinated analog, Y2CF2, under an electrochemical bias. The electronic state of the analogs was measured using synchrotron x-ray absorption spectroscopy (XAS). By fitting the XAS measurements to high-quality DFT, a model of the electronic structure for each system was experimentally resolved. Using the BadELF algorithm on our model, the yttrium cation in Y2C2+[2e-] and Y2CF2 remained in the 2+ oxidation state. Altogether, the evidence suggests that the electrochemical fluorination of Y2C2+[2e-] electride does not involve oxidation or reduction of the host lattice – a unique mechanism that has never been observed in batteries and would have vast implications on the battery longevity, voltage, and capacity.

COMPARISON OF NIP GaAsSb NANOWIRES BASED PHOTODETECTORS PERFORMANCE GROWN BY MBE ON SILICON AND GRAPHENE

Yugwini Deshmukh, Hirandeep Reddy Kuchoor, Rashmita Baruah, Joshua White, Jia Li and Shanthi Iyer

Semiconductor nanowires have made a profound impact on materials science-related research. They are being explored for applications in several disciplines, such as remote sensors, photodetectors (PDs), solar cells, and medicines. In these nanostructures, composition control is essential because it allows for bandgap engineering. GaAsSb is found to have tunable narrow bandgaps in the near-infrared (IR) spectral region and exhibit emission wavelengths in the telecommunication wavelength region of 1300–1550 nm, making them particularly well suited for IRPD applications. The GaAsSb nanowires are produced on silicon and graphene substrates. Graphene's superior thermal and electrical conductivity, low surface energy, and weak van der Waals bonding make it an excellent substrate for growing high-performance nanowires. This presentation will compare the I-V characteristics obtained using conductive atomic force microscopy (CAFM) of nip GaAsSb nanowires-based photodetectors performance grown by molecular beam epitaxy (MBE) on silicon and graphene.

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Raman and FTIR Spectroscopy Analysis of Polyurethane-Based Composites

Ayobami A. Taiwo, Vladimir B. Pavlovic, Marko Perić, Milan Nikolić, Branislav Vlahovic

This study explores the molecular structure and vibrational characteristics of polyurethane-Bi2O3-based composites prepared through thermal decomposition. Raman responses of the samples have been analyzed by utilizing a 633nm laser excitation source. It has been found that the Raman spectrum of Bi2O3 powder exhibits a C2h symmetry group, revealing two distinct regions attributed to vibration modes. These modes correspond to heavy elements, such as bismuth, lattice vibrations, and oxygen vibrations. Raman spectra of the polyurethane -Bi2O3 composite material revealed a discernible broad diffusion band, which can be attributed to the presence of amorphous carbon. These results were correlated with FTIR analysis to gain further insights into the vibrational characteristics of the composite material.

Femtosecond microscopy imaging of charge carrier dynamics in electronically non-equilibrium semiconductor interfaces using low fluence spectroscopy

Robert A. Castaneda, Sarah C. Sutton, Cullen P. Walsh, James F. Cahoon

Semiconductors underpin most electronic technology including solar energy converters and optoelectronic devices. The efficiency of these devices is dictated by the motion of electrons and holes, i.e., charge carriers, where effective optoelectronic semiconductor devices typically have high diffusion rates, efficient charge separation, and low recombination of carriers. 1D and 2D nanostructures are a subject of interest for semiconductor nanodevices because of their high surface to volume ratios and interfacial areas. In standard devices, p-type/n-type or type II junctions create regions of energetically separated charge densities that form a built-in electrical field. The built-in electric field causes electrons to drift towards the p-type region and holes towards the n-type region and the kinetics of this process are directly related to carrier drift, and recombination. Yet, all optoelectronic devices operate under an applied bias, and it is in this non-equilibrium regime where built-in fields, depletion, and drift can affect carriers in a way that is not been previously understood. To resolve these highly local kinetics, a home-built ultrafast pump probe microscope is employed that, in conjunction with a gated integrator, allows for the direct imaging of charge carriers at a low fluence regime. The custom-built gated integrator allows for the integration of each individual pulse, wherein, small fluctuations will be averaged out to show a theorized increase in S/N of 2-3 orders of magnitude. Ultimately permitting for the study of dynamics with low carrier concentrations where built-in and external fields dominate carrier dynamics. Here transient carrier dynamics are imaged at the nano scale on proof-of-concept Si nanowires (NWs) and transition metal dichalcogenides (TMDCs). The work proves understanding interfacial dynamics is critical for energy efficiency of electronics, including photovoltaic efficiency or simply heat generation. The result points to a new tool to evaluate nanoscale semiconductor systems.

Extraction and Quantification of Antenna pigments to study Tailoring Photoresponse of Cyanobacteria

Swapna Kalkar, Dr. Daniel Herr, Dr. Tetyana Ignatova

Photosynthesis is crucial for food production and providing clean air, with the Synechococcus elongatus bacteria playing a significant role in carbon fixation globally. These bacteria, found in most light-exposed freshwater environments, utilize chlorophyll pigments that absorb light mainly in the blue and red regions but not efficiently in the "green gap" (500-550nm). To counter this, cyanobacteria contain phycobilisome pigments that serve as the primary light-harvesting antenna for Photosystem II and capture light from the green region. The energy transfer within the phycobilisome complex pigments, consisting of phycoerythrin, phycocyanin, and allophycocyanin, is vital for the bacteria's photoresponse. Although genetic modifications have been attempted to understand the role of these pigments, conclusive results on energy transfer mechanisms remain elusive. Recognizing the need for a non-genetic approach, the study aims to bind the phycobilisome pigments with SWCNT using peptides nblA . In this project we extract natural pigments of Synechococcus elongatus and study binding activity of nblA peptide separately to phycobilisome pigments and Chlorophyll a to identify the pigment responsible for quenching of bacteria photoresponse. This innovative method seeks to regulate the photoresponse of cyanobacteria and offer insights into the mechanism of energy transfer pathways. Such advancements can provide eco-friendly solutions to combat global warming.

A gut feeling: investigating the role of pollen morphology in reducing gut parasite infections in bees

April E. Sharp, Rebecca E. Irwin

Host diet is an important factor shaping the acquisition and outcome of pathogenic infections through nutrition, influencing the gut microbiome, immune responses, chemical and physical effects, and more. Given its importance, investigating the role of host diet in the context of pathogens may reveal effective strategies to combat infections, although disentangling the mechanisms by which diet influences infection can be complex due to confounding factors. For example, infections of Crithidia bombi, a common gut parasite of Bombus impatiens, the common eastern bumble bee, and contributing factor to bee population declines, are shown to be significantly reduced by a diet of sunflower pollen. The mechanism responsible for this effect is not fully understood; however, previous studies suggest that increased excretion and damage to parasite cells and the gut lining caused by sunflower pollen's echinate morphology may be key factors. If abrasive damage is being inflicted on the gut epithelial cells by the pollen's spines, this would likely upregulate detoxification responses in the bee, contributing to the expulsion of parasite cells. We used SEM imaging to investigate the midgut epithelial tissues for damage in bees fed sunflower pollen versus a control (buckwheat) pollen diet. This qualitative analysis provides a preliminary comparison of how pollen morphology interacts with the surface structure of the midgut epithelial lining.

Enhancing Fine-Mapping of Complex Traits in Farm Animals through Bayesian Mixed Model: A Case Study with Duroc Pigs

Junjian Wang, Christian Maltecca, Francesco Tiezzi, Yijian Huang, Jicai Jiang

Genome-wide association studies (GWASs) have identified many genetic associations for complex traits. Fine-mapping subsequently offers an approach to pinpointing the causal variants that underlie these associations. However, most fine-mapping methods have been designed for unrelated individuals, which can be problematic when dealing with farm animal samples consisting of closely related individuals. However, most fine-mapping methods have been developed for unrelated individuals, which may pose potential problems when applied to farm animal samples of closely related individuals. In this study, we leverage used the shotgun stochastic search method implemented in BFMAP (Bayesian Fine-Mapping and Association for Population and Pedigree Data) to analyze genetic associations in related individuals. To evaluate the performance of BFMAP, we simulated phenotype data based on the genotypes of 5,000 Duroc pigs. In this simulation, we introduced one to three quantitative trait nucleotides (QTNs) with effects accounting for one percent of the variance.In the simulation process, we simulated one to three quantitative trait nucleotides (QTNs), with effects designed to account for one percent of the variance. A polygenic term was simulated to account for a heritability of 0.5. The effects of QTNs, the polygenic effect, and an error term were then added to generate the phenotype data. Subsequently, we benchmarked BFMAP's performance against fine-mapping tools GCTA-COJO and FINEMAP utilizing the simulated data. The results demonstrated that compared to the other two methods, BFMAP exhibits higher power in detecting true causal mutations and a lower false positive rate in the most situations compared to the other two methods . It highlights the importance of using mixed-model-based methods like BFMAP over summary-statistics-based methods for fine-mapping farm animal traits. We subsequently conducted a GWAS on six quantitative traits, including off-test body weight (WT), off-test back fat thickness (BF), off-test loin muscle depth (MS), number of piglets born alive (NBA), number of piglets born dead (NBD), and number of piglets weaned (NW). The number of Duroc pigs included in the analysis ranged from 27,360 for WT to 3,290 for NBA, with all individuals having genotype data for 11,692,670 imputed sequence variants. A mixed-model association test was employed for GWAS. Fine-mapping was conducted on regions extending 1 Mb upstream and 1 Mb downstream from significant GWAS peaks, defined by a threshold of p<〖10〗^(-5). Genes with a posterior

probability of causality larger than 0.2 were selected as candidate genes. In our analysis, wWe detected 40 genome-wide significant peaks through GWAS, which led to the identification of 32 candidate causal genes by fine-mapping: 15 for BF, 9 for MS, 6 for WT, 1 for NBA, and 1 for NBD. Notably, among the candidate genes identified for back fat thickness were MRAP2 and LEPR. MRAP2 has been identified as a regulator of energy balance and body weight, while LEPR codes for the leptin receptor, a key regulator of appetite and energy expenditure. In summary, our findings provide valuable insights into the genetic basis of these six quantitative traits in Duroc pigs, which may pave the way for further functional research. Moreover, BFMAP stands out as a preferable tool for fine-mapping analysis in livestock when compared to other methods designed for unrelated individuals.Furthermore, BFMAP is the optimal tool for fine-mapping analysis in Duroc pigs compared to other methods developed for unrelated individuals.

Bioinspired Coordination Polymer Frameworks for Adsorption Desalination

Kelvin Adrah, Sheeba Dawood, Hemali Rathnayake

As per the United Nations, by 2025, an estimated 4 billion individuals will lack access to potable water, primarily due to the surge in population and industrial activities, resulting in increased water pollution. Traditional water treatment methods like ion exchange and reverse osmosis are time-consuming, generate substantial waste, and are financially demanding. Currently, adsorption technology has been implemented in water purification systems for contaminant removal owing to its cost-effectiveness and efficacy. However, it is hampered by its limited adsorption capacity, lack of environmental sustainability, and versatility. This project aims to overcome these technical constraints by developing a biomass-derived adsorbent capable of efficiently eliminating contaminants from water. The adsorbent consists of hierarchical microstructures with a robust metal-organic framework, synthesized by combining naturally occurring tannic acid with iron (II) acetate in an aqueous medium. The synthesis process adheres to green chemistry principles, rendering it an energy-efficient and adaptable approach. Comprehensive characterization techniques were employed to investigate the chemical composition, morphology, physicochemical properties, and colloidal stability of the microstructures. The results reveal the successful extraction of prevalent minerals (Na+, K+, Mg2+, and Ca2+) from seawater samples procured from Kiawah Island, SC, and Hatteras Beach, NC, employing a single-cycle adsorption procedure. The adsorption performance was analyzed under varying contact times and adsorbent dose-to-seawater volume ratios. Additionally, these adsorbents demonstrated antimicrobial properties by effectively destroying microorganisms present in the seawater samples. The proficient adsorption of these dissolved minerals onto the microstructures can be attributed to the highly branched and hydroxyl-dense polytopic tannic acid ligand, which provides numerous bonding sites via diverse chemical interactions. These extensively porous, amphoteric polyphenol-based coordination polymers are economically viable and readily scalable for pilot or industrial applications. Consequently, they exhibit substantial potential for employment in tertiary water treatment for remediation purposes.

Electron Interactions with Microstructures and Defects During Additive Manufacturing

Tim Horn, Temilola Gbadamosi-Adeniyi, Trevor McDonald1, Dylan Peverall, Victoria Himelstein, Chris Tassone

A critical problem facing additive manufacturing (AM) is that the benefits of rapid fabrication and microstructural control are overshadowed by long certification times associated with the prediction, measurement, and elimination of defects at different physical scales. The current state-of-the-art solution to this problem falls short, relying on post-fabrication nondestructive evaluation (NDE) with x-ray micro-computed tomography (umCT), the duration and cost of which easily exceeds AM. Moreover, such NDE is infeasible for high-density metals, large parts, or batch-size-one components. In-situ techniques typically involve infrared (IR) imaging, which operates at time scales several orders of magnitude larger than the phenomena at play. We will overcome the limitations of existing non-destructive testing and process monitoring by monitoring total electron emissions (TEE) in real-time during EB-PBF.

Magnetization of Al-based alloys by shear-assisted solid phase processing

Farhan Ishrak, Charles Perkins, Michael Lastovich, Bharat Gwalani

Aluminum (Al) alloys are very demanding structural materials in transportation and construction sectors due to their lightweight nature, corrosion resistance, machinability, and recyclability. Enhancing their multifunctional capabilities, like localized magnetic properties, corrosion resistance, and mechanical strength, is a challenge while keeping costs down. Friction stir-based processing and extrusion (FSP/E) can be an efficient solid-state metalworking technique by localized plastic deformation to develop fine-grained microstructures and highly refined metallic composites. Here, we study the multifunctional properties of Al alloys infused with hard magnetic $SmCo_5$ powders using FSP/E. By controlling the concentration and distribution of magnetic particles, we can create a material with both permanent magnetic and enhanced mechanical properties in the paramagnetic Al matrix. We extensively investigate the microstructural evolution and shear-induced particle comminution using multi-length scale characterization tools such as X-ray diffraction and tomography, scanning and transmission electron microscopy, and resulting magnetic properties with SQUID magnetometry and magnetic force microscopy.

Scalable Green Manufacturing of Microstructured Surfaces Using Viscoelastic Interfacial Instability

Sipan Liu, Md Didarul Islam, Benjamin Black, Myers Harbinson, Michael Pudlo, Himendra Perera,Mohammed Zikry, Saad Khan, Jong Eun Ryu

Natural nano and micro patterns created by living organisms can achieve various effects to help the organisms survive and thrive. The Lotus leaf's hierarchical microstructure creates superhydrophobicity and self-cleaning capabilities. The water strider microstructure superhydrophobic legs maximumly use the surface tension of the water to walk on the surface. The microstructure spatula of geckoes enables excellent adhesive capability. The mosquito eyes have an anti-fogging microstructure. The Cicadas have a periodic photonic structure that helps them have anti-reflection surfaces for camouflaging. The longicorn has a spike microstructure, which gives them a passive radiative cooling effect due to the reinforcing of mid-infrared thermal radiation. Inspired by the above-mentioned nature organism, microstructures are investigated and fabricated to improve the critical capabilities of artificial surfaces (passive radiative cooling, hydrophobicity, polarization, etc.). The current manufacturing method employed for microstructure (such as lithography, laser ablation, plasma etching, and nanoimprinting) can achieve high fabrication accuracy. However, these methods are expensive, time-consuming, and with limited scalability (centimeter-scale), which restricts the microstructure products for large-scale applications(such as building cooling film and ship reduction). Hence, it is urgent to develop a novel method to fabricate microstructure in a simple, cost-effective, and scalable process (meter-scale). In this research, the roll-to-roll method of manufacturing microstructure was studied thoroughly. The relationship between different microstructures (random spikes or linear ribbons) with the manufacturing parameter and the materials' properties are investigated and practiced for various applications, respectively. This roll-to-roll method is compatible with any viscous composite paste and makes the scalable applications possible. Last but not least, this research could potentially serve as a platform for broadening the applicability of the traditional roll-to-roll fabrication.

Dual Stiffness Substrates for Excellent Microscopy

William McLain, Joseph Szulczewski, Klaus Hahn, Richard Superfine

Biological Cells respond to the mechanical cues of their environment to modify gene expression, for cell motility and for force generation. Currently, research has determined that the stiffness of substrates can lead to cell movement bias, where cells exhibit preference towards the direction of higher stiffness. However, the molecular details of the subcellular response mechanical cues remain to be studied. To further the understanding of cell mechanics, our research investigates the novel fabrication method of flat (no topography) substrates with patterned regions of designed stiffness. Our goal is to study the sub-cellular responses in the structure and organization of cells at the molecular scale using single molecule microscopy. To achieve this, our substrates need to be optically clear and have a homogenous index of refraction for all patterned regions. Second, the substrates must also have a high refractive index to allow us to employ the technique of total internal reflection microscopy. Topographic characteristics of the sample were verified with fluorescence microscopy, scanning electron microscopy and atomic force microscopy. Further, stiffness patterns were analyzed with an atomic force microscope. In the future, we will apply these flat, patterned dual-stiffness substrates to study cell motility, allowing for characterization of mechanical cell responses based solely on stiffness gradients.

Dyeing Cotton Sustainably for Enduring Color Fastness with Reactive Dyes

Mohamed R. Eletmany and Ahmed El-Shafei

This work explores the application of reactive dyes to achieve both sustainability and long-lasting color fastness in cotton fabrics. Reactive dyes chemically bond with cellulose fibers, ensuring vibrant and durable colors. Sustainability is achieved through reduced water and energy consumption and eco-friendly dyeing practices. The process conserves water resources by optimizing dye fixation, reduces energy usage through lower-temperature dyeing, and minimizes hazardous chemical use. This presentation offers a scientifically sound and environmentally responsible approach to sustainable cotton dyeing, contributing to a greener textile industry and environmental conservation.

EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF TEMPERATURE VARIATIONS ON E. COLI GROWTH RATE

Frederick Adrah, Samuel Adekoge, Ignatius Yawlui, Dennis LaJeunesse

Escherichia coli (E. coli) is essential across various fields, from microbiology and biotechnology to environmental science and public health. It provides insights into microbial behavior, disease transmission, and the optimization of processes and systems. This knowledge contributes to advancements in science, technology, and our ability to address real-world challenge. Studying the temperature sensitivity and response of E. coli is of significant relevance in various scientific and practical contexts. E. coli is a well-studied and widely used model organism for research, and understanding its temperature-dependent behavior has several important implications. In this experiment, a standardized wild type E.coli was used. All equipment were sterilized and the experiment was conducted in a fume hood. The bacteria culture was plated on a sterile nutrient broth using aseptic techniques. Three incubators were set to maintain different temperatures of 25°C, 30°C and 37°C. The prepared broth plates were placed in each temperature-controlled environment. Bacterial growth was observed regularly for period of 8 hours for 1 hour intervals using a cuvette with a Nano-drop machine. The data for the cell optical densities were recorded and analyzed to determine how the growth rate and growth curve of E. coli varies with temperature fluctuations. The experiment was repeated 3 times and data showed E.coli growth increased with increasing temperature with high exponential phases, especially at 30°C and 37°C.

MOF-based hybrid aerogels for enhanced functionality

Muhammed Ziauddin Ahmad Ebrahim, Vahid Rahmanian, Seyedamin Razavi , Mai Abdelmigeed, Eduardo Barbieri, Stefano Menegatti , Gregory N. Parsons , Fanxing Li, Tahira Pirzada and Saad A. Khan

The need for lightweight and versatile advanced materials has increased significantly in recent years in order to facilitate sustainable development and environmental remediation. To meet this demand, various smart materials have been developed in the past few years with diverse structures and properties. Among these materials, Metal-organic frameworks (MOFs) are porous crystalline substances that belong to a group of coordination polymers and are typically produced in powder form. They have a three-dimensional network structure with exceptionally high surface area and pore volume. MOFs have been extensively researched and have shown potential in applications such as gas storage, separation, catalysis, sensing, drug delivery, and energy storage. Although the use of MOFs in powder form is limited, their applications can be expanded by incorporating them into hybrid composite materials like polymer aerogels that provide a solid host matrix. Aerogels are ultra-light, highly porous materials with low density and large specific surface area. Incorporating MOFs into a porous and interconnected 3D macrostructure can overcome the shortcomings of MOF powders, such as agglomeration, mechanical robustness, and limited accessibility to the pores of MOFs. This study presents a versatile and one-pot strategy to grow MOFs on aerogel utilizing vapor phase deposition and a solvent-free approach. Ultralight and mechanically strong aerogels were fabricated by successfully growing MOFs, thereby creating enhanced functionality. The microporosity of the MOF coupled with high specific surface area of the aerogels helped in a high CO2 adsorption capacity. The ZIF-8 also works in synergy with the aerogel matrix to provide a framework with tunable pore size, hierarchical porosity, and abundant functional groups, facilitating strong binding sites for copper. Importantly, the mechanical robustness of the aerogel, withstanding large deformations without collapsing, widens its applications in various fields. In summary, our study highlights the potential of MOF-based hybrid nanofibrous aerogels as sustainable and scalable materials with superior functionality across various domains.

A cost-effective method of identifying pollen and contaminants within honey based on an artificial neural network

Brayden Wilkins and Dr. John Muth

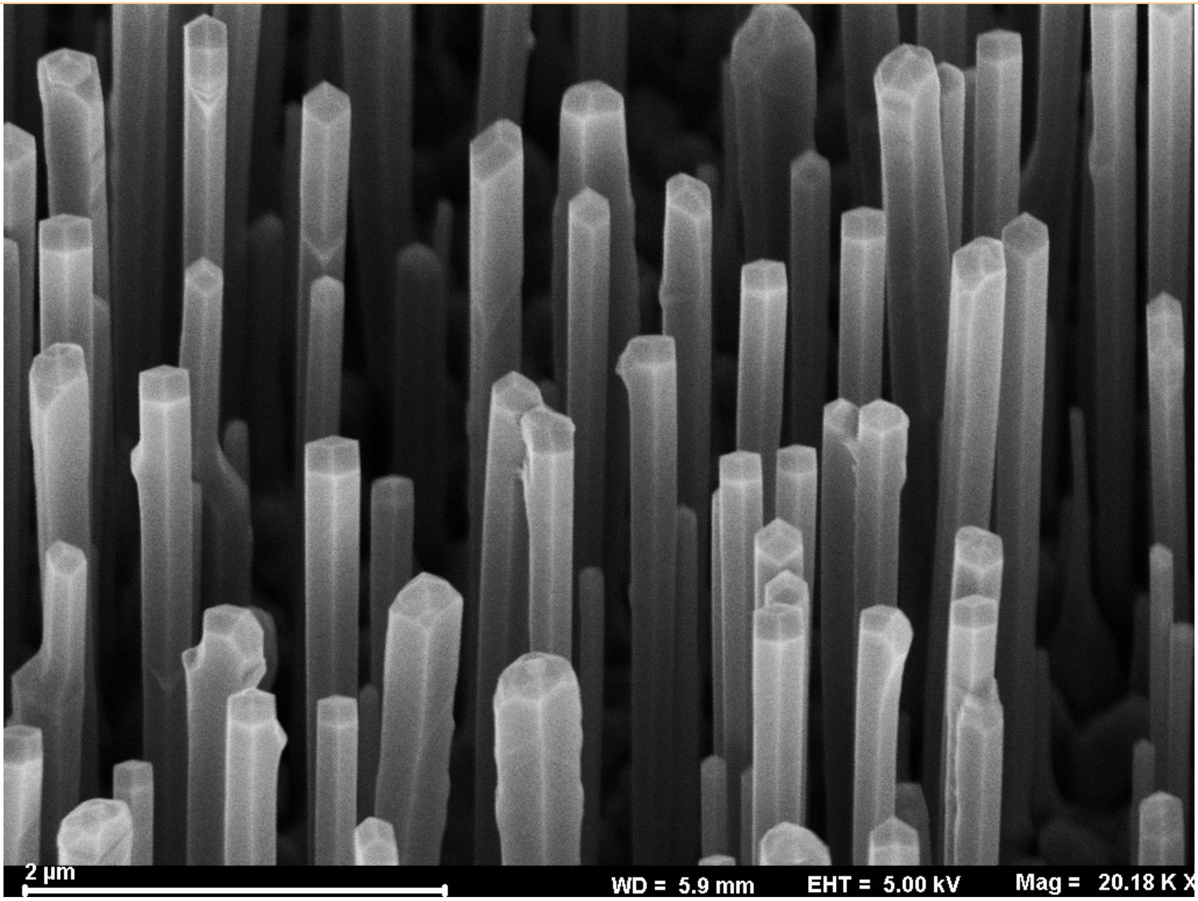
A honey's content can tell a stakeholder its origin, quality, and expected price point. The analysis of honey is used in many instances regarding consumer transparency and safety, as well as in safeguarding a country's honey markets from mislabeled honey. Since honey is the third-most-faked food in the world, it is imperative that stakeholders are able to cheaply and accurately analyze the quality and safety of the honey they eat. The contents of honey, organic and non-organic substances, are the main results of an analysis. However, analyzing honey is often an expensive process that requires the judgment of an expert. This judgment often includes an analysis of pollen, GMO(Genetically Modified Organisms), and chemical contamination(Bee pharmaceuticals, pesticides, and heavy metals) contents in honey. However, image libraries of honey samples might be used to train artificial intelligence to be as accurate as the experts. We aim to build a spin-coater for honey that will enable imaging and the examination of the ability of neural networks to classify honey.

Molecularly Imprinted Polymers as Sensitive Nanosensors for Organophosphate Pesticide Detection

Raphael D. Ayivi, Jianjun Wei, and Sherine O. Obare

Organophosphate pesticides (OPPs) are used for the control of pests and are acutely toxic. Organophosphate pesticide exposure even in trace concentrations to the environment could contaminate drinking water bodies, and agricultural produce, and affect biodiversity as well as result in neurodegenerative diseases in humans due to their level of toxicity. Molecularly imprinted polymers (MIP) are a class of synthetic antibodies employed as nanosensors that have been recommended for efficiently detecting trace concentrations of OPPs in various environmental matrices. MIPs are highly robust, cost-effective, and simple, and possess enhanced specificity and sensitivity for the recognition of OPPs. In this study, we developed and optimized a novel molecularly imprinted polymer that is bound to silver nanoparticles to enhance signal transduction to detect malathion and dimethoate OPPs in environmental samples. A precipitation polymerization technique was employed for the synthesis of the MIP with both malathion and dimethoate as the template molecules, acetonitrile as the porogen, azobisisobutyroronitrile (AIBN) as the initiator, and ethylene glycol dimethacrylate (EGDMA) as the cross-linker in several optimized ratios in conjunction with silver nanocomposite materials. A non-imprinted polymer (NIP) synthesized under the same conditions without the template molecules served as a control. Surface-enhanced Raman spectroscopy was employed as the signal transduction technique for detecting the OPPs. Our results were significant and suggest that the novel silver MIP nanosensors can potentially and selectively detect trace concentrations of malathion and dimethoate in environmental samples. Consequently, these MIPs can be recommended for environmental monitoring applications.

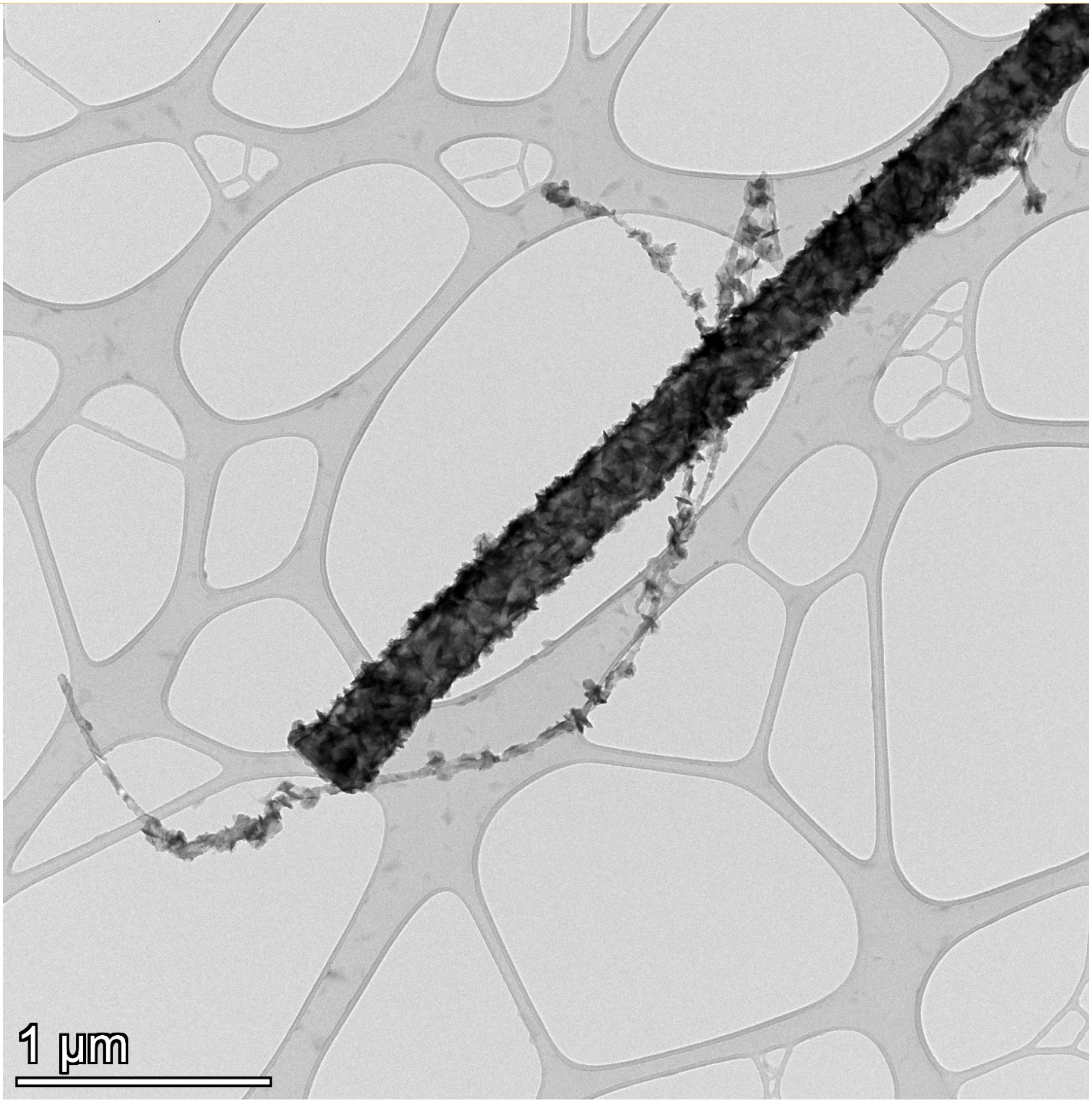
Mike Rigsbee Photo Competition



Capturing the Essence: GaAsSb Nanowires via Vapor-Solid-Liquid MBE on Silicon Canvas

GaAsSb nanowires represent a forefront innovation in semiconductor research, displaying unique electronic and photonic properties. Grown on silicon substrates via Molecular Beam Epitaxy (MBE) using Vapor-Liquid-Solid (VLS) mechanism. Utilizing metal catalyst particles, the VLS mechanism aids the directed growth of these nanowires. As the molecular beams provide the vapor phase elements, the catalyst particle absorbs them, creating a liquid alloy droplet. Upon saturation, the material precipitates, fostering the nanowire's elongation. This precise method ensures high-quality, single-crystalline GaAsSb nanowires with excellent interface compatibility with silicon. Such integrations promise to revolutionize optoelectronic applications, providing a bridge between traditional silicon platforms and advanced III-V semiconductor functionalities.

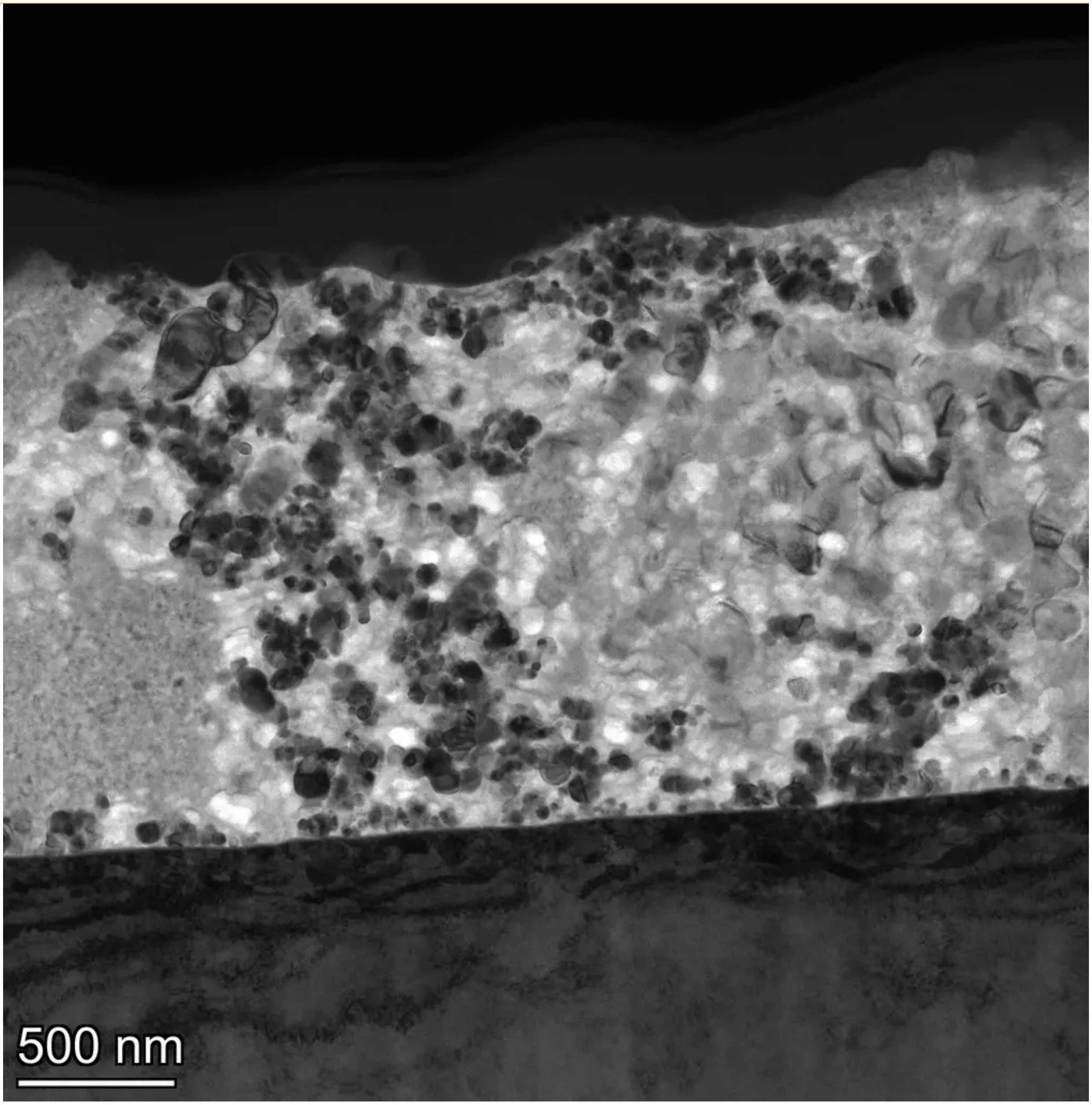
Rashmita Baruah and Dr. Shanthi Iyer



Thorns of Indium

This image is a multijunction silicon nanowire coated in an indium shell via photodeposition

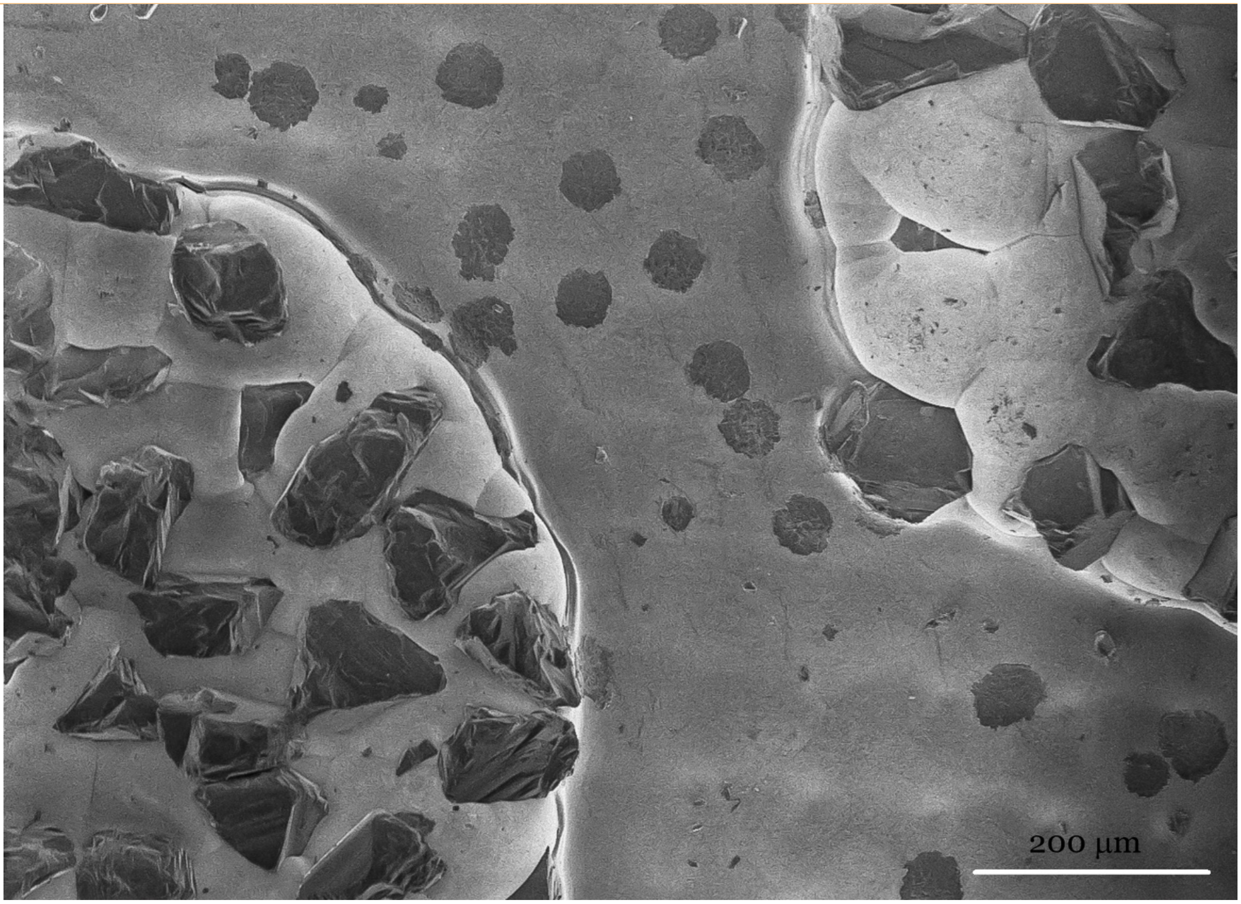
Sam Bottum



Holey coating

The micrograph was obtained using the Talos TEM at the AIF. The lamella was prepared from bulk stainless steel coated with SiCNO and heated up to 500 degrees Celsius. The coating contains ZrO2 and Al2O3 particles dispersed across the layer which show the granular structure on the top surface. The result: holes! The darkest rounded squares, almost hexagonal, features were found to be voids that resulted from the heating experiment. Further tailoring will improve this coating to make it an effective corrosion resistant coating for stainless steel.

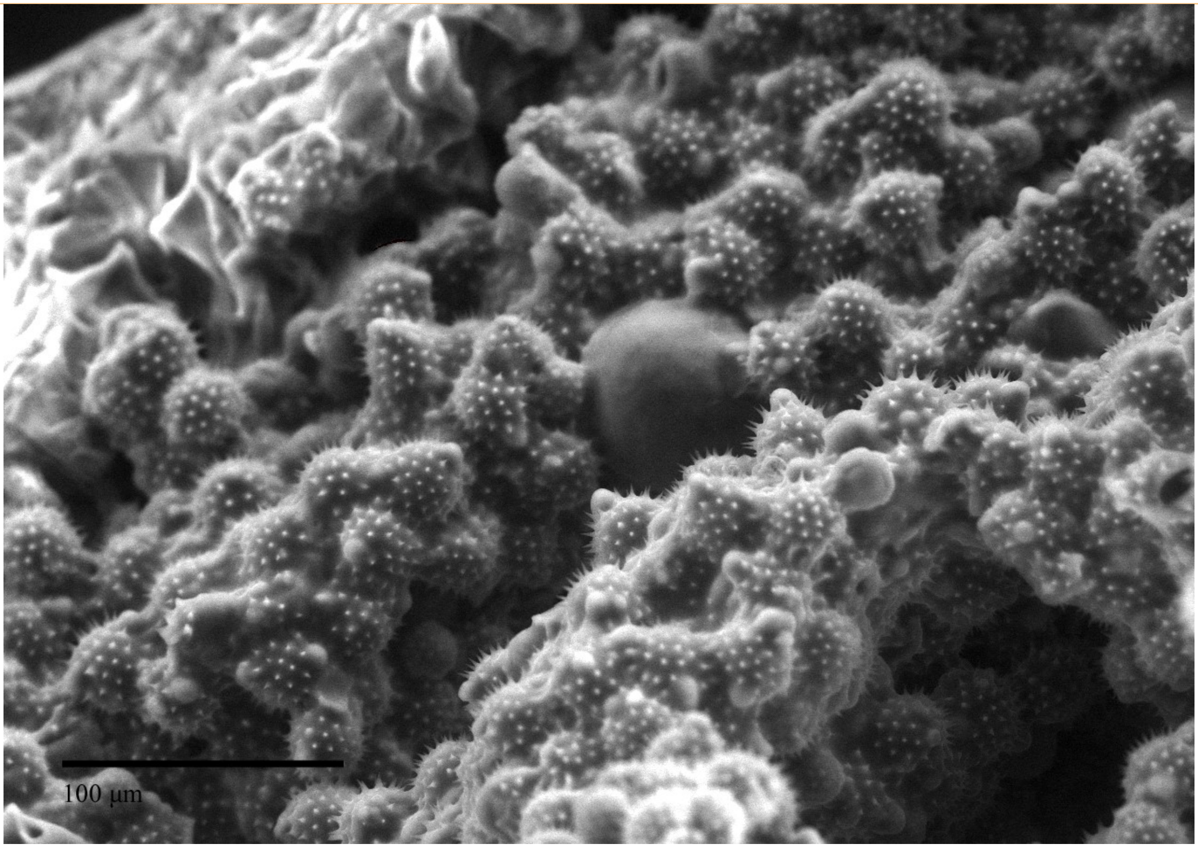
Lucia Gomez



Diamond chip cookies

Diamond based abrading material used for polymer mechanochemical degradation processes.

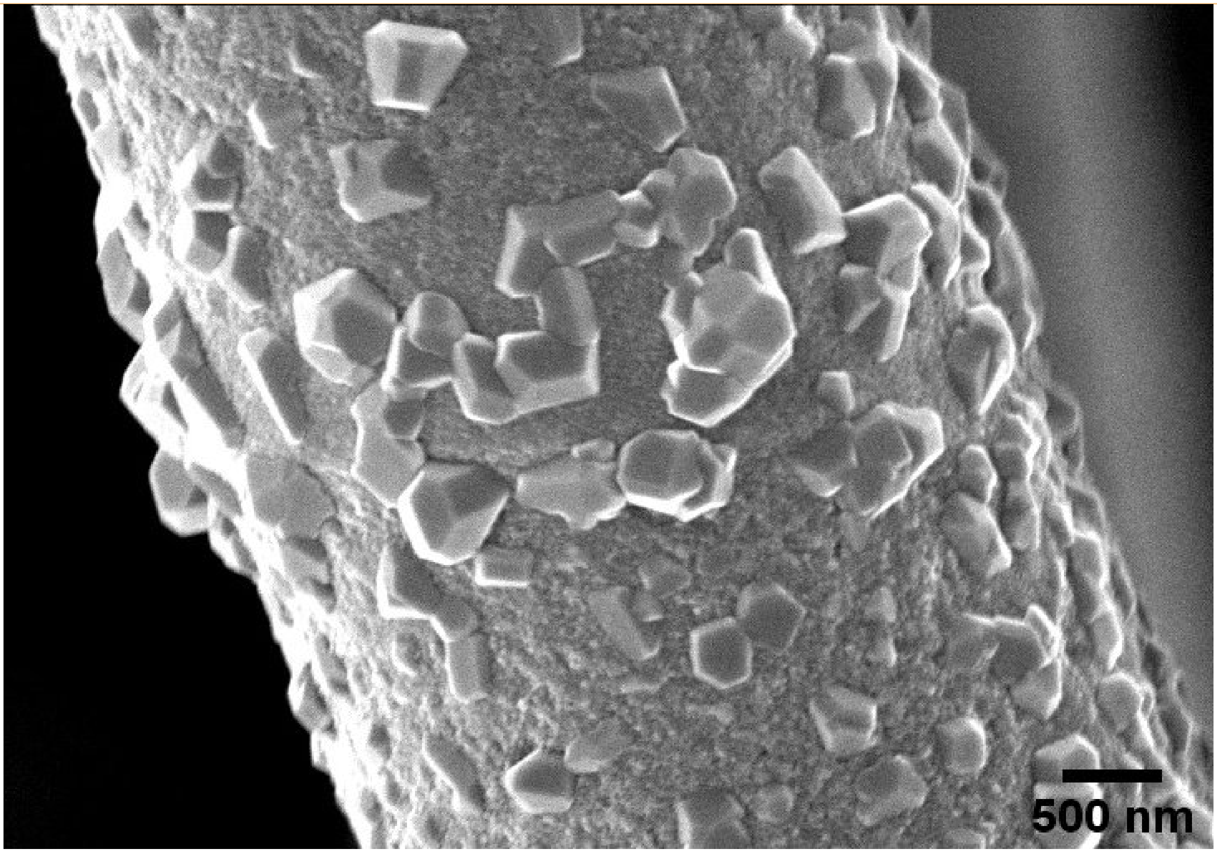
Julio E. Terán



Sunflower pollen upon bee gut epithelium

An SEM image of sunflower pollen grains coating the inner gut epithelial tissues of a common eastern bumble bee. This image was created with the assistance of Dr. Aaron Bell at the NCSU AIF.

April Sharp

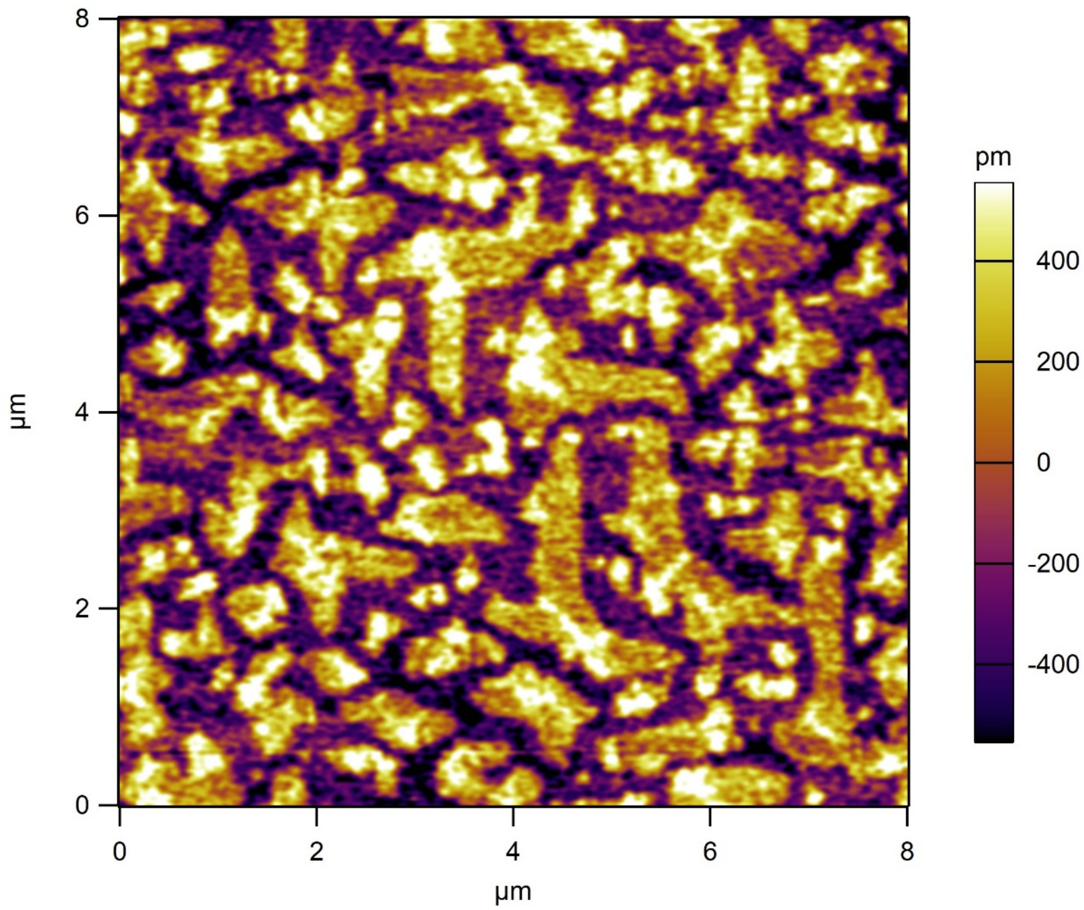


MOF- Nanofiber Kebabs

The scanning electron microscopy (SEM) image shows the growth of zeolite imidazolate metal-organic framework (ZIF-8 MOF) crystals on an electrospun nanofibrous aerogel made from a combination of polyacrylonitrile (PAN) and polyvinylpyrrolidone (PVP) polymers, as observed through). This composite aerogel offers various synergistic advantages, including a high surface area and porosity attributable to the MOF particles, as well as the robustness offered by the nanofibers. These advanced functional materials show great potential in various applications, such as CO2 adsorption, heavy metal removal, and anti-microbial properties.

Muhammed Ziauddin Ahmad Ebrahim

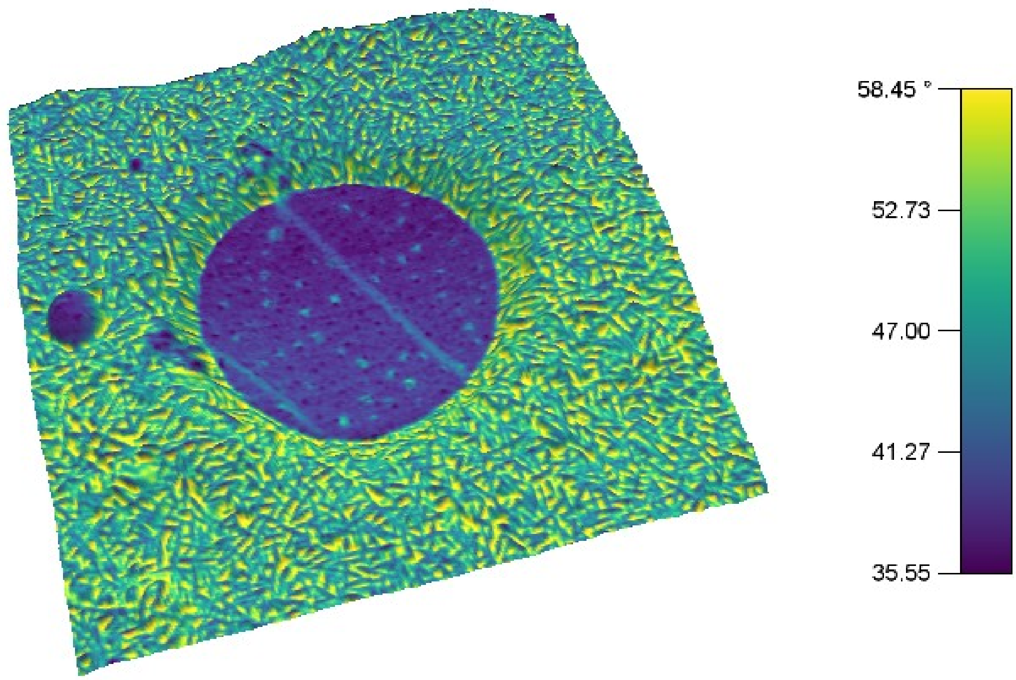
Asylum AFM Image Competition



surface topography of NaNbo3 thin films

This sample has been synthesized by pulsed laser deposition

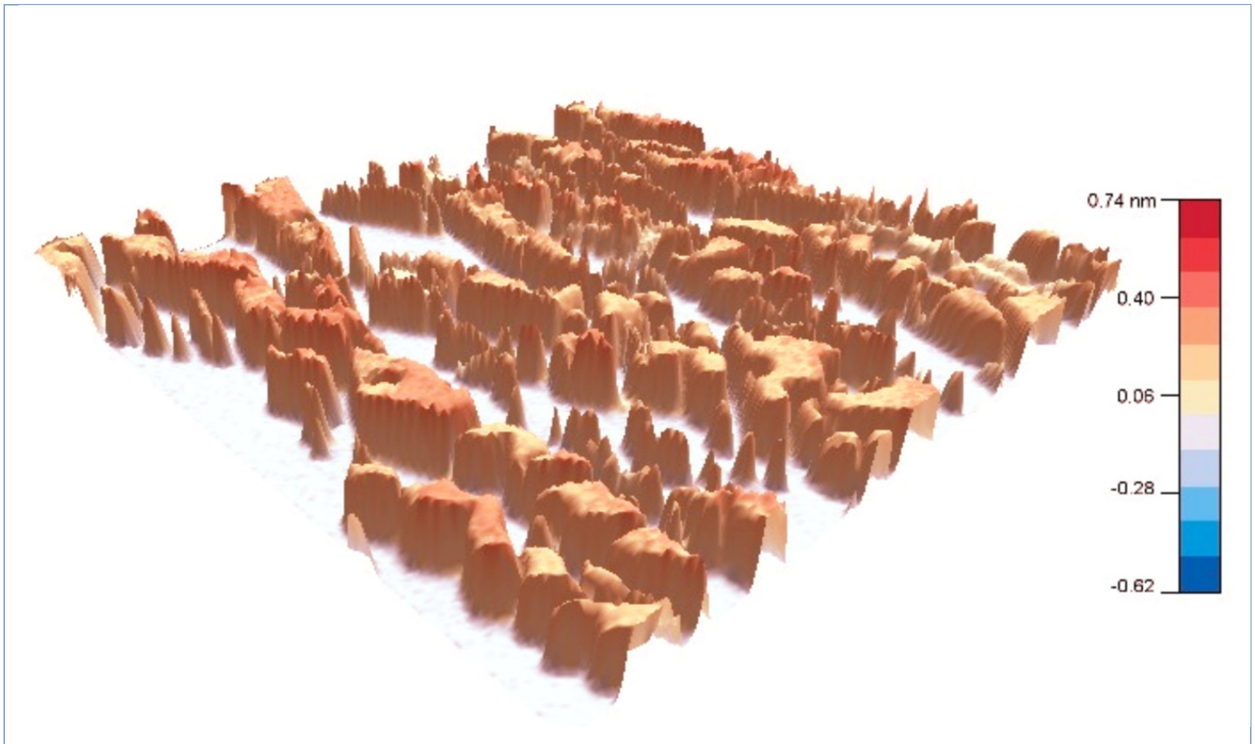
Reza Ghanbari Shokralikandi



Polymer Pool

Phase data overlaid on topography of a polystyrene (PS) polypropylene (PP) polymer blend that was heated to 120°C and then cooled. The round domain is PS, and the surrounding matrix is PP. The image is a 2.5 μm by 25 μm scan.

Tatiana Proksch

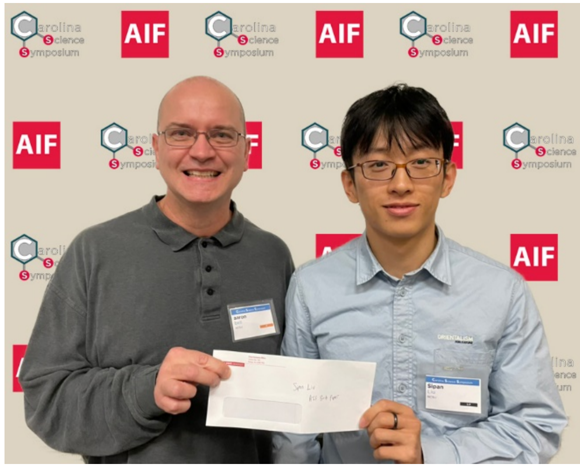


CIPS Canyon

Huimin Qiao

Carolina Science Symposium 2023 Winners

Best Paper Award sponsored by AIF



Sipian Liu and Eric Gabilondo

Sipian Liu (right) and Eric Gabilondo (not shown) receiving prize from Aaron Bell.

Best Student Oral Presentation sponsored by RTNN and Micross

Alicia Bryan and Kacie Wells

Alicia Bryan (first image on left) with John Lanon (right) and Kacie Wells (second image on left).

Second Place Student Oral Presentation sponsored by Micross

Akash Singh

Akash Singh (left) with John Lannon (right) from Micross.

Student Poster 1st Prize sponsored by AVS Mid- Atlantic

Panesun Tukar

Panesun Tukar (left) pictured with John Lannon (Micross)

Student Poster 2nd Prize sponsored by Protochips

Merna Melad

Merna Melad (left) with Aaron Bell (right) from AIF

Student Poster 3rd Prize Sponsored by Tescan

Becca Radomsky

Rebecca Radomsky (left) with Aaron Bell (right) from AIF

Vendor Poster Prizes

Sponsored by ThermoFisher

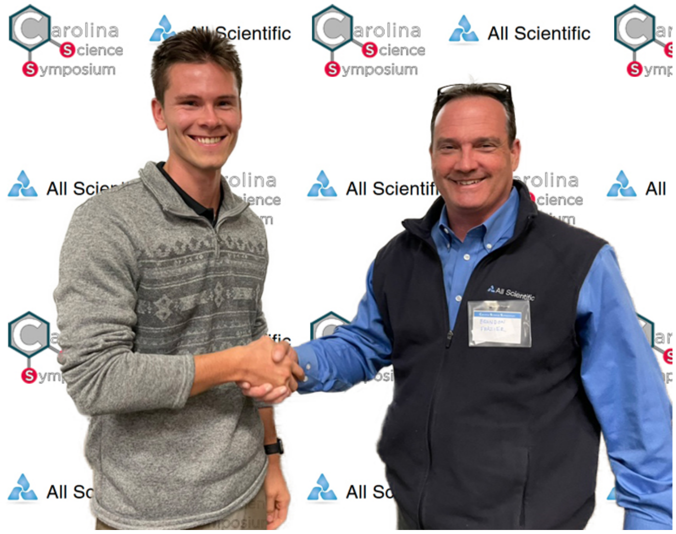
Shichen Guo and Samantha Litvin

Sponsored by Smart Materials Soluitons

Muhammed Ziauddin Ahmad Ebrahim

Muhammed Ziauddin Ahmad Ebrahim (left) pictured with Robin McDonald (right) from Smart Materials Solutions.

Sponsored by All Scientific



Conner Slamowitz

Conner Slamowitz (left) pictured with Brandon Frazier (right) from All Scientific

NNF Student Presentation Award

Ben Sekley

Ben Sekley (left) pictured with Phillip Barletta (right) from NNF

Hans Stadelmier Awards sponsored by Rigaku

Oluwatoyin Atikekeresola (1st) and Muhammed Ziauddin Ahmad Ebrahim (2nd)

Oluwatoyin Atikekeresola (Left image, left, 1st place) and Muhammed Ziauddin Ahmad Ebrahim (Right image, left, 2nd place) pictured with Jenny Forrester (right) of AIF

Mike Rigsbee Photo Contest sponsored by Hitachi

Julio Teran

Julio Teran (left) pictured with Aaron Bell (right) of AIF

Asylum Photo Contest sponsored by Oxford/Asylum

Reza Ghanbari Shokralikandi

Reza was not present at the time but Ryan Fuierer of Asylum Research congratulates you

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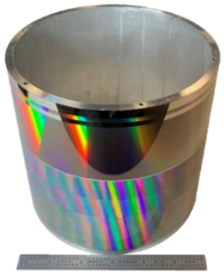


Nanocoining rapidly nanopatterns seamless drum molds for high-throughput, low-cost roll-to-roll nanofabrication.

High-speed process is hundreds of times faster than electron-beam lithography

Seamless patterning around a cylinder for roll-to-roll (R2R) processing

3D feature shapes

Chemical-free with no resist-development or etching

Roll-to-Roll Nanopatterning – *Nanopatterning very large areas*

Roll-to-roll (R2R) processes can rapidly nanopattern very large-areas (>100 m^2). MicroContinuum, Inc. recently nanopatterned 500 feet of polymer film by thermal embossing using an SMS drum mold.

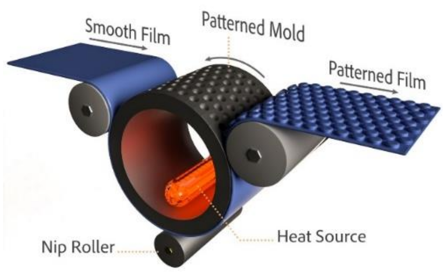
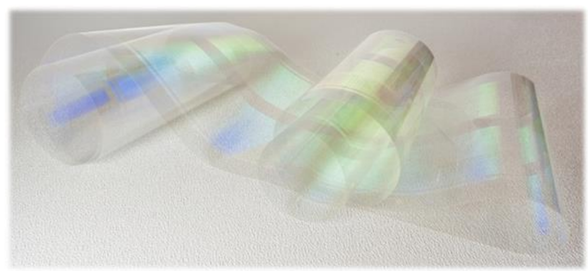


Illustration of R2R thermal embossing

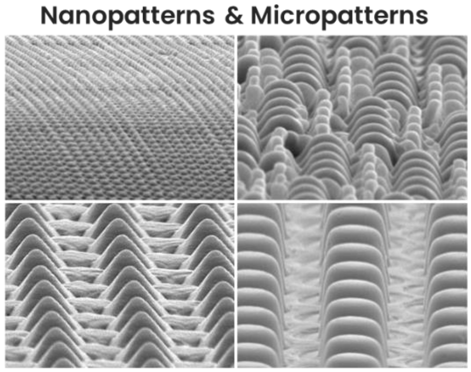


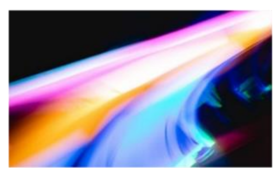
Polymer film R2R nanopatterned with an SMS drum mold

Application Areas

Solar Energy
Light trapping, self-cleaning coatings improve efficiency

Nanopatterns & Micropatterns





Metamaterials
Plasmonic effects and diffraction manipulate light

Displays
Moth-eye features extract light and reduce glare

AR/VR
Microlens arrays and waveguides redirect light

Dust mitigation
Nanofeatures limit particle adhesion

Advanced wetting
Superhydrophobic surfaces can be antimicrobial

SKRWR DOEXP

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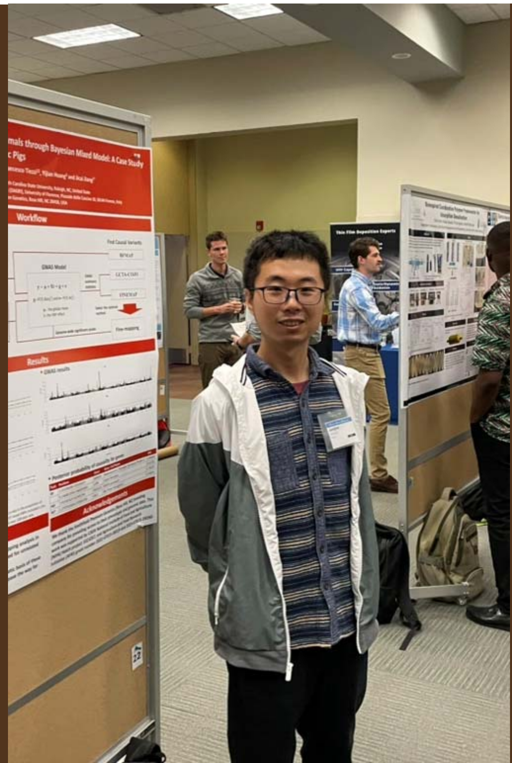
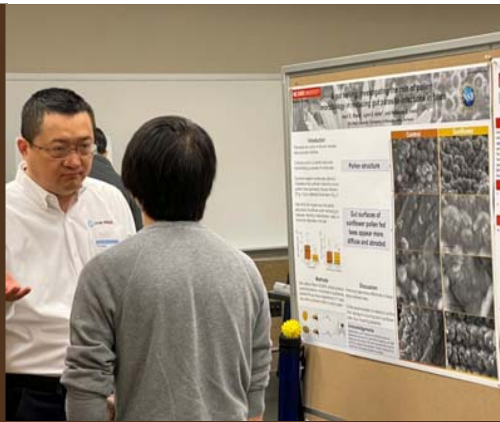
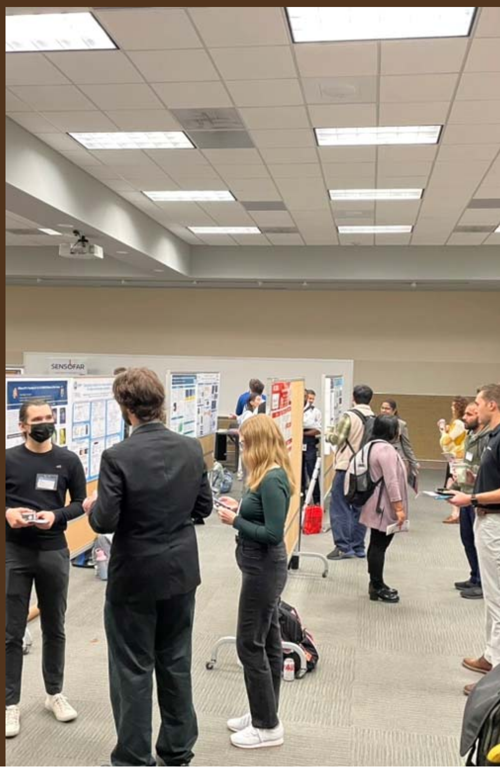
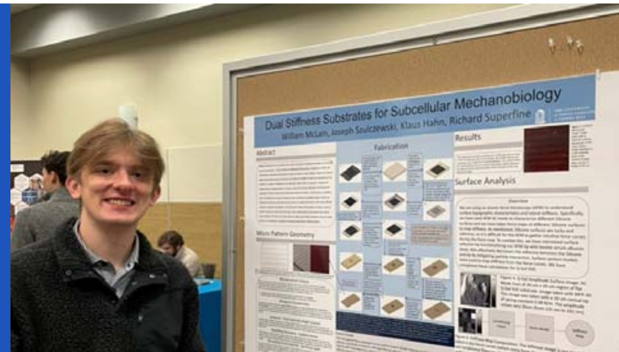
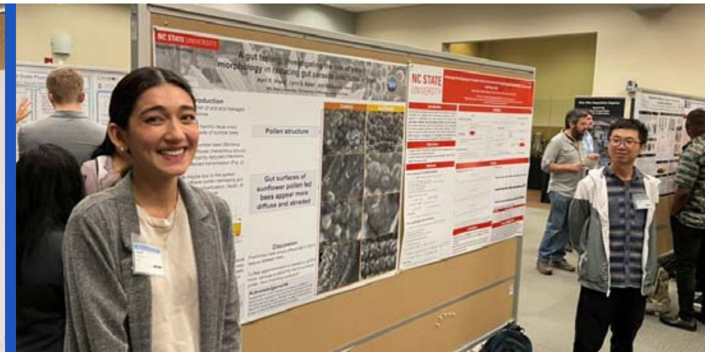
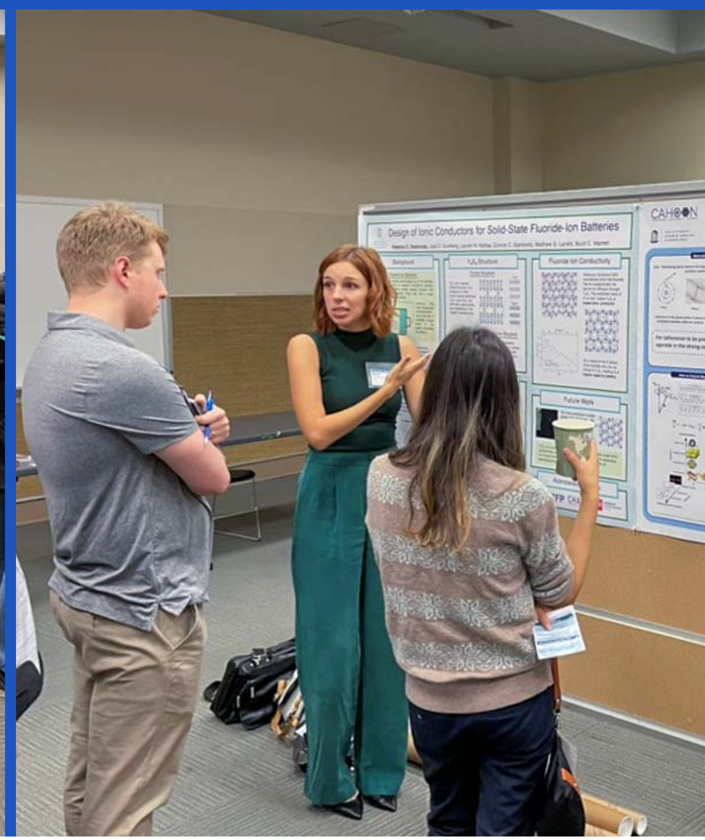




POSTER SESSION

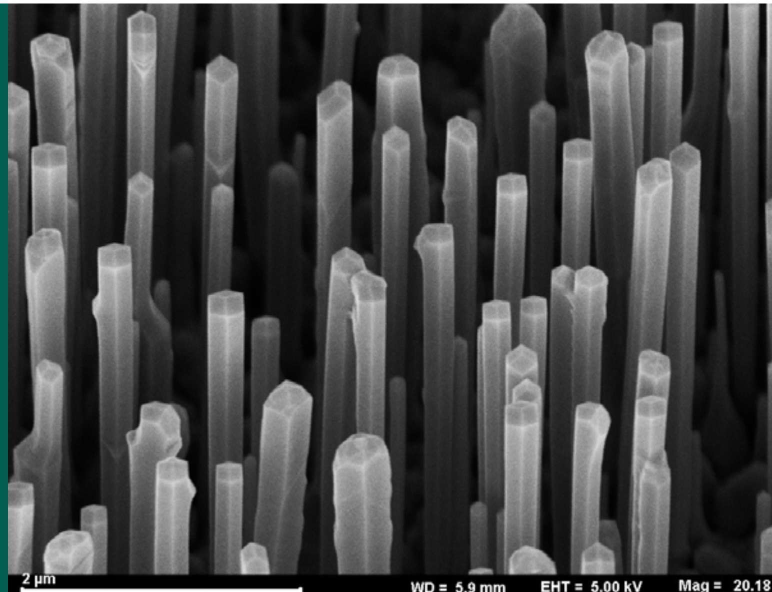

NC STATE
Synthesis Methods for Graphene
Materials Science and Engineering

Dual Stiffness Substrates for Subcellular Mechanobiology
William McLain, Joseph Szulczewski, Klaus Hahn, Richard Superfine
Abstract
Fabrication
Results
Surface Analysis
Micro Pattern Geometry

NC STATE UNIVERSITY
Pollen structure
Gut surfaces of sunflower pollen fed bees appear more diffuse and striated

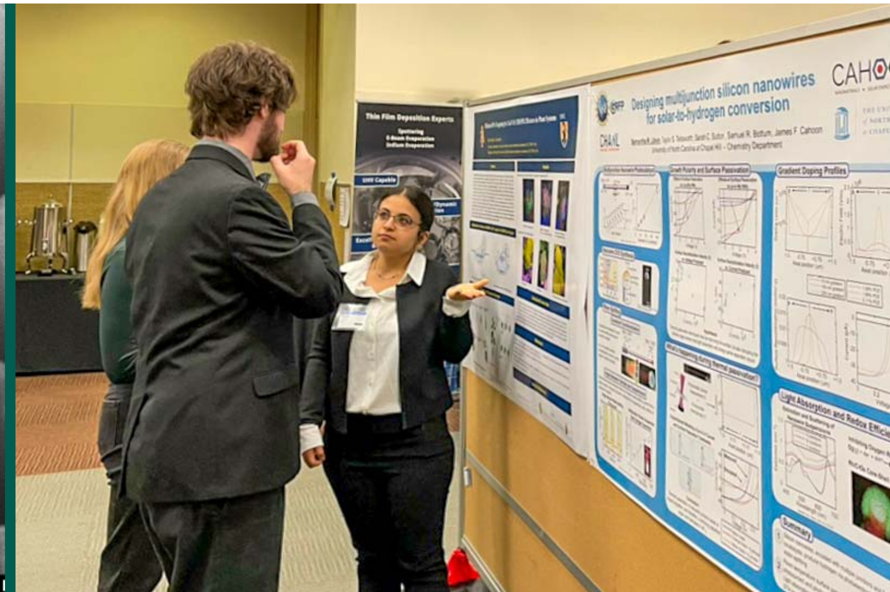

Design of Ionic Conductors for Solid-State Fluoride-Ion Batteries
Background
Fluoride-Ion Conductivity
Future Work

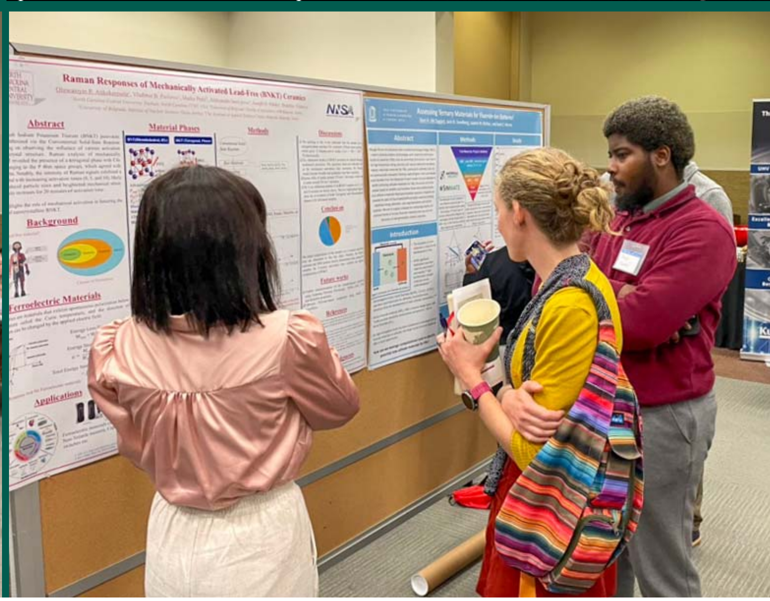

Electrical signatures at the biotic-abiotic interface


Applications: Heavy metal removal

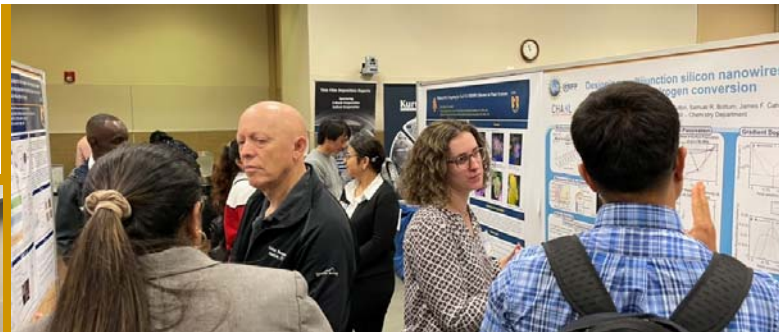

eurofins

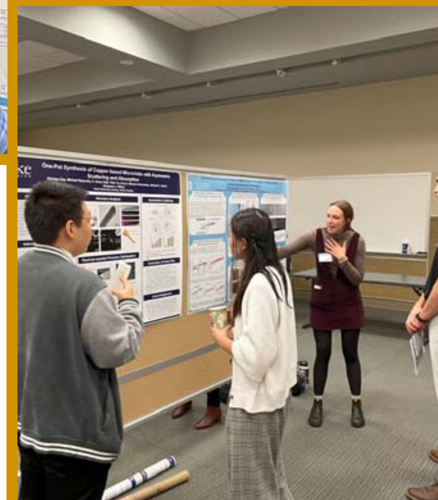

2 µm
WD = 5.9 mm
EHT = 5.00 kV


Designing multijunction silicon nanowires for solar-to-hydrogen conversion
Thin Film Deposition Experts
Gradient Doping Profiles
Summary


Raman Responses of Mechanically Activated Lead-Free (BNKT) Ceramics
Abstract
Material Phases
Methods
Background
Ferroelectric Materials
Applications


Semiconductor Chips

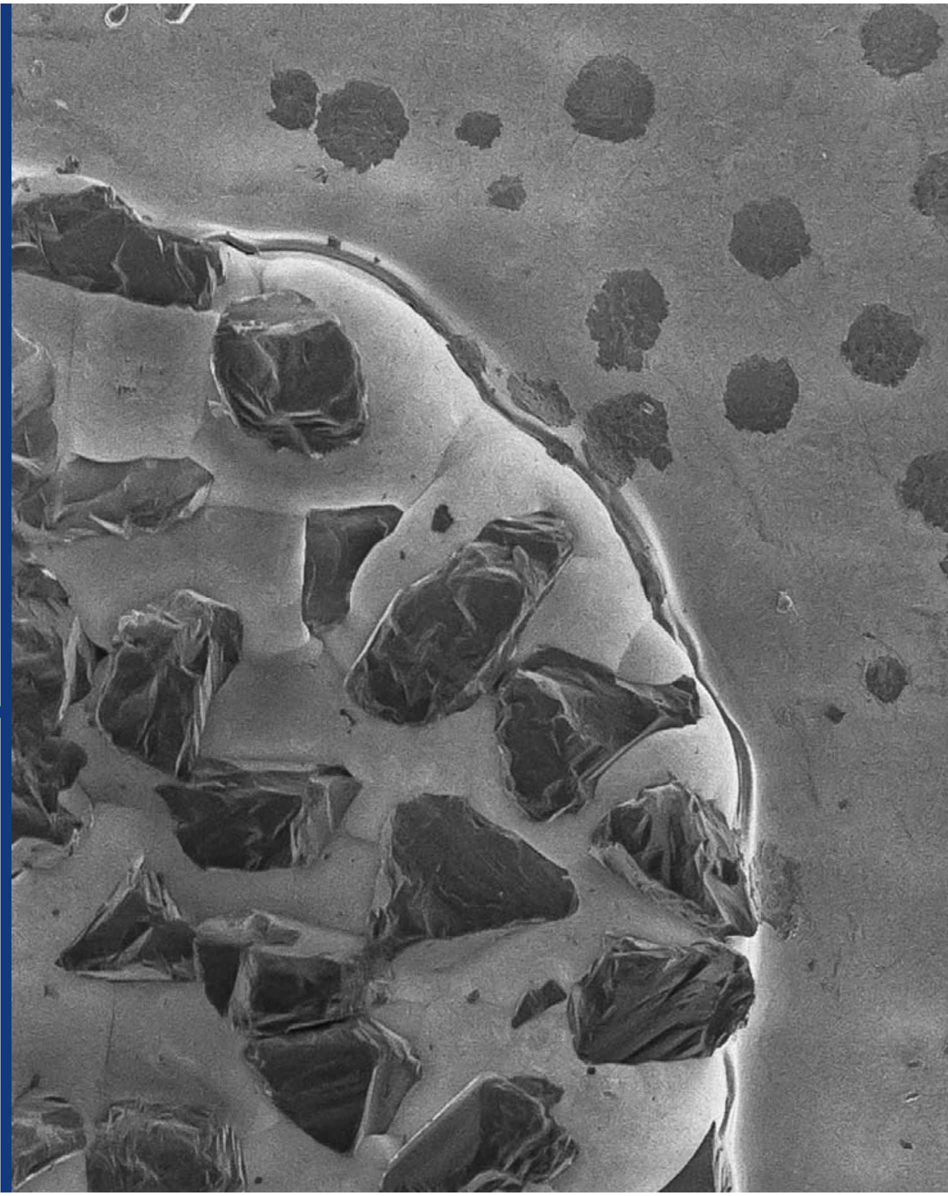




BETTER

TOGETHER

RIGSBEE PHOTO CONTEST



Carolina Science Symposium

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