

DEPARTMENT OF  
**CHEMICAL & BIOMEDICAL**  
ENGINEERING



FAMU-FSU  
College of Engineering

# Research Day

20  
26

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Research &  
Student Profiles



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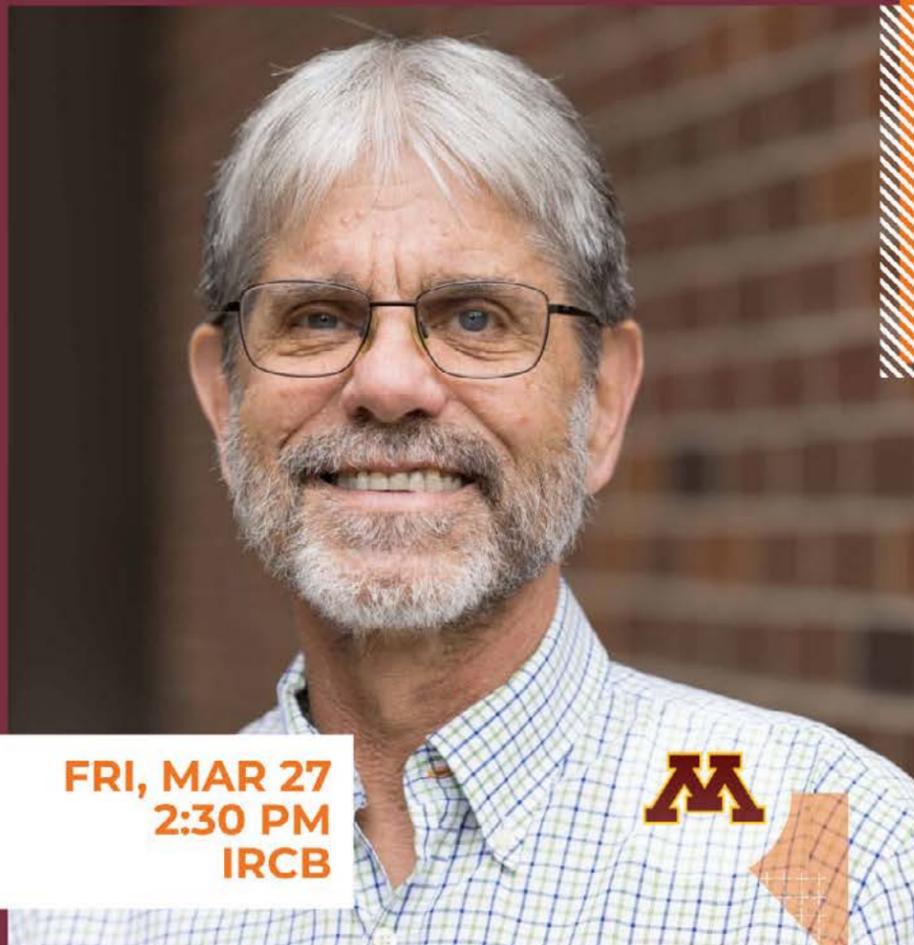
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# FRANK BATES

NATIONAL ACADEMY OF ENGINEERING  
NATIONAL ACADEMY OF SCIENCES  
AMERICAN ACADEMY OF ARTS AND SCIENCES  
NATIONAL ACADEMY OF INVENTORS  
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**FRANK BATES** is a Regents Professor and a member of the Chemical Engineering and Materials Science department at the University of Minnesota. He received a B.S. in Mathematics from SUNY Albany and M.S. and Sc.D. degrees in Chemical Engineering from MIT. Between 1982 and 1989 Bates was a member of the technical staff at AT&T Bell Laboratories then joined the University of Minnesota where he served as department Head from 1999 to 2014. Bates conducts research on a range of topics related to polymers, including the thermodynamics, dynamics, structure, and properties of block polymers, polymer blends and solutions. He has published more than 560 articles in leading peer reviewed journals and lectured worldwide at universities, international scientific and engineering conferences, and at numerous companies. His research has resulted in several commercial products and he co-founded two startup companies with colleagues from the University of Minnesota: Valerian Materials in 2015 pursuing sustainable plastics, and Elymus in 2025, which deals with bottlebrush poloxamers. He has mentored more than 100 PhD students and over 50 post-doctoral fellows during his career and these alumni have prospered as leaders in industry, academia and national laboratories. Bates has been recognized for his scholarly accomplishments by the American Physical Society, the American Chemical Society, the American Institute of Chemical Engineers, and the Materials Research Society.



FRI, MAR 27  
2:30 PM  
IRCB

## Bottlebrush Block Copolymer Prevents Disease Onset in Duchenne Muscular Dystrophy

Duchenne muscular dystrophy (DMD) is a rare genetic disorder that appears in about 3,600 newborn boys in the US annually. This progressive degenerative muscle disease leads to disability and death as the afflicted individual matures to adult age. My colleagues and I have discovered that a bottlebrush (BB) version of poly(ethylene oxide-b-propylene oxide) block copolymer, a variation on commercial compounds known as Poloxamers, has a remarkable effect on genetically modified DMD mice. These results will be discussed in the context of recent studies dealing with the interaction of Poloxamer triblock copolymers with model lipid bilayers and comparison with the new BB diblock compound.



## Colin Esmonde

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**Research Interests:** Extracellular Vesicles, Glioblastoma, Alzheimer's Disease

**Advisor:** Yan Li, Ph.D.

**Presentation:** Oral

### Personal Statement

Hello, I'm Colin Esmonde, a 4th year Ph.D. student at the FAMU- FSU College of Engineering, in Dr. Li's lab. My research focuses on stem cell and extracellular vesicle engineering in therapeutics. I have several projects ongoing, including 2 on glioblastoma treatment and 1 on Alzheimer's Disease progression. The College of Engineering has been my home for both of my degrees, and I love it here.

### Genetically Engineered Extracellular Vesicles with Chimeric Antigen Receptor of Human Stem Cell-Derived Neutrophils for Treating Glioblastoma

Glioblastoma multiforme (GBM) is the most commonly occurring tumor in the central nervous system, accounting for 80% of brain tumors. Work in gene editing and immunology has led to the development of chimeric antigen receptors (CARs). However, such cells are liable for inducing body wide off-target effects that can be deadly. Extracellular vesicles (EVs) secreted by the cells have been shown to share properties with their parent cells including the expression of CARs and tumor-lytic effects. However, this has never been investigated in CAR Neutrophils.

Results showed that EVs are secreted in high quantities, display exosomal markers, and display exosomal morphology. Multi-omic analysis revealed the presence of tumorlytic neutrophil markers and of several miRNAs active in apoptotic and tumor suppressive pathways that are dysregulated in cancer. In vitro analysis revealed ample EV uptake and resultant cytotoxicity in both 2D and 3D models. These results show a correlation between protein and miRNA cargo of CAR Neutrophil EVs, their uptake, and the function of EVs in GBM treatment.

### Selected Publications and Presentations

Esmonde, C. Genetically Engineered Extracellular Vesicles with Chimeric Antigen Receptor of Human Stem Cell-Derived Neutrophils for Treating Glioblastoma. Presented at the American Institute of Chemical Engineering National Meeting, Boston, MA, November 5, 2025.

Esmonde, C. ApoE4 Mutation alters the Inflammatory and Metabolic Properties of Extracellular Vesicles Presented at the Biomedical Engineering Society National Meeting, Sand Diego, CA, October 9, 2025.



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**Research Interests:** Microbial engineering and plasma bioprocess design, with expertise in engineering *Pseudomonas putida* for resilience in non-thermal gas-liquid plasma wastewater treatment.

**Advisors:** Bruce Locke, Ph.D. and Cesar Rodriguez, M.D.

**Presentation:** Oral

### Personal Statement

By integrating microbial engineering with non-thermal plasma reactor design, I aim to develop hybrid processes that overcome fundamental time-scale and energy limitations in water treatment. My long-term goal is to create scalable, biologically integrated plasma systems that expand the role of electrically driven chemistry in sustainable environmental and biomanufacturing applications.

## Development of an Enhanced Bioreactor Cell for Coupling with Gas-Liquid Plasma Chemical Reactors in Wastewater Treatment

Plasma reactors can mineralize recalcitrant water pollutants but require high energy, while biological treatments are slower and limited for xenobiotics. Sequential plasma-bioreactor coupling reduces energy use but mismatched time scales require large volumes. To address this, we engineer microbial cells to survive plasma-treated water and maintain high metabolic activity. Using *Pseudomonas putida*, we show survival, enzyme activity, and degradation of plasma-generated byproducts, including formic acid and hydrogen peroxide. Fluorescent protein expression confirms functional metabolism post-plasma. This framework enables compact, efficient plasma-bioreactor systems and new plasma-assisted bioprocessing strategies.

### Selected Publications and Presentations

B.R. Locke, E. Petkus, C. Rodriguez, Plasma Chemistry and Plasma Processing, 45, 463–483 (2025).



## Pavan Polisetty

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**Research Interests:** Polymers, Nanocomposites, Polymer-grafted Nanoparticles

**Advisor:** Daniel Hallinan Jr., Ph.D.

**Presentation:** Oral

### Personal Statement

My research focuses on the intersection of soft matter physics and materials engineering. As a PhD candidate, I am driven by the challenge of designing hybrid materials where macroscopic properties can be precisely tuned at the molecular level. My work on polymer-grafted nanoparticles aims to propose structure-property relationships of polymer-grafted nanoparticles. By resolving fundamental questions regarding viscoelasticity and flow, I hope to contribute to the development of next-generation composites with predictable mechanics.

## Graft Density as a Design Parameter for Dynamics and Flow of Neat Poly(dimethylsiloxane)-Grafted Silica Nanoparticles

Polymer-grafted nanoparticles (PGNs) combine polymer processability with inorganic filler functionality. We synthesized poly(dimethylsiloxane) (PDMS) grafted silica nanoparticles below the entanglement molecular weight ( $M_e$ ) to investigate how grafting density ( $M_g$ ) governs viscoelasticity in the neat, matrix-free state. Rheology and time-temperature superposition reveal that high- $\sigma$  PGNs behave like unentangled PDMS melts. Conversely, medium  $\sigma$  and low  $\sigma$  systems exhibit viscoelastic-solid dynamics, characterized by a storage modulus plateau and shear-thinning. Activation energy analysis confirms a shift from free-polymer-like to NP-influenced relaxation, supported by soft glassy rheology. While grafting density dramatically impacts flow, its effect on chain dynamics is minor, with only a slight glass transition temperature ( $T_g$ ) increase at high density. These results highlight grafting density as a key parameter for tuning PGN flow, mechanical reinforcement, and stability.

### Selected Publications and Presentations

Polisetty, V. S. P. K.; Hallinan, D.; Germanton, G.; Ramakrishnan, S. In Effect of Graft Density on Entangled and Unentangled Polymer-Grafted Nanoparticle Structure and Dynamics, 2025 AIChE Annual Meeting, AIChE: 2025.

Germanton, G.; Gnanasekar, P.; Ponder, J. F., Jr.; Posey, N. D.; Polisetty, P.; Hallinan, D., Jr.; Dickerson, M. B.; Ramakrishnan, S., Understanding the Influence of Nanoparticle Core Size on the Rheology and Ceramic Yield of Pre-ceramic Polymer-Grafted Nanoparticles: Implications for Thermal Protection Systems and Aerospace Propulsion Components. ACS Applied Nano Materials 2025, 8 (50), 24065-24075.

Germanton, G.; Martin, K. L.; Hossain, M. A.; Posey, N. D.; Ponder, J. F., Jr.; Ramirez, C.; Gnanasekar, P.; Wiegart, L.; Polisetty, P.; Hallinan, D. T., Jr.; Dickerson, M. B.; Ramakrishnan, S., Insights into Pre-ceramic Polymer-Based Additive Manufacturing Inks via Rheological and Scattering Studies of Pre-ceramic Polymer-Grafted Nanoparticles Suspended in Polycarbosilane. ACS Applied Engineering Materials 2024.



## Chidiogo Rita Akunne

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**Research Interests:** Optimizing MnO<sub>2</sub> Cathode Electrodeposition and Stripping for Redox Flow Batteries through study of nucleation, growth, morphology, and substrate-electrolyte interactions

**Advisor:** Egwu Eric Kalu, Ph.D.

**Presentation:** Poster

### Personal Statement

My research focuses on MnO<sub>2</sub> cathodes for aqueous flow batteries, exploring how nucleation, growth, crystal structure, and morphology influence deposition and dissolution, and ultimately battery reversibility. I investigate the effects of substrate and electrolyte modifications on these processes using physical and electrochemical characterization techniques. By linking MnO<sub>2</sub> structure and morphology to cathode performance, my work aims to establish structure-performance relationships that guide the design of efficient, stable, and sustainable energy storage systems.

## Substrate and Electrolyte Effects on MnO<sub>2</sub> Electrodeposition: Linking Nucleation, Morphology, and Performance in Aqueous Zn/MnO<sub>2</sub> Batteries

Understanding the nucleation and growth mechanisms of manganese dioxide (MnO<sub>2</sub>) during electrodeposition is crucial for optimizing the performance of manganese-based aqueous batteries. This study uses potentiostatic chronoamperometry to investigate MnO<sub>2</sub> deposition in mild aqueous electrolytes, both with and without complexing agents, across various substrates, including bare carbon, pyrolytic carbon (PyC), and Ni/Ni-alloy-coated KAPTON and carbon.

Analysis of current-time transients reveals substrate-dependent nucleation mechanisms, with deviations from classical Scharifker–Hills behavior attributed to surface heterogeneity, double-layer effects, and concurrent side reactions. Further studies show that electrolyte modification with complexing agents alters the nucleation mechanism, reinforcing the significance of electrolyte chemistry. Overall, these results highlight the combined influence of electrode surface and electrolyte engineering on MnO<sub>2</sub> electrodeposition and stripping, providing insights for the rational design of high-performance aqueous battery electrodes.



## Cyril C. Anorundu

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**Research Interests:** Single-ion conducting polymer blend electrolytes for lithium-ion batteries, optical imaging, differential scanning calorimetry, small angle neutron scattering

**Advisor:** Daniel Hallinan Jr., Ph.D.

**Presentation:** Poster

### Personal Statement

I'm a second-year Ph.D. student interested in energy sustainability, with a B.S. in Chemical Engineering from the Federal University of Technology, Owerri (Nigeria). Outside the lab, I volunteer in Leon County high schools to help students get excited about science.

## Phase behavior and interactions in polymer blend electrolytes

Single-ion conducting polymer electrolytes (SIPes) are a promising route to safer, high-transference number lithium-ion batteries, but their performance is tightly coupled to blend miscibility. My research focuses on understanding the phase behavior of SIPE polymer blends comprising polyanions and polysolvents. The polyanions that I am currently studying are poly(4-phenyl-cyclopentene-sulfonate-Li) (p5PhS-Li), poly(styrene sulfonate-Na) (PSS-Na), and poly(styrene sulfonate-Li) (PSS-Li), while the polysolvents include poly(ethylene oxide) (PEO), poly(vinyl alcohol) (PVA), and polyethyleneimine (PEI). To connect morphology to thermodynamics across relevant temperatures and compositions, I combine differential scanning calorimetry (DSC) with optical imaging to study macroscopic phase behaviour, and small-angle neutron scattering (SANS) to quantify nanoscale phase behaviour, correlation lengths, and composition fluctuations. These techniques will provide a good picture of how ion polysolvent dielectric constant and counterion identity govern miscibility.



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**Research Interests:** Clinical and preclinical MRI imaging; neurodegenerative diseases; ischemic stroke; drug delivery; MRI contrast agents; quantitative MRI biomarkers; translational neuroimaging

**Advisor:** Yan Li, Ph.D.

**Presentation:** Poster

### Personal Statement

I was born in Iran and earned my bachelor's degree in chemical engineering. I am a 4th-year PhD student in Biomedical Engineering at the FAMU-FSU College of Engineering, focusing on MRI and extracellular vesicle-based drug delivery. Outside of research, I enjoy kittens and playing the piano.

## Multimodal In Vitro Validation of MRI-Visible Extracellular Vesicles Using Glucose-Functionalized Iron Oxide Nanocrystals

Stroke remains a major cause of long-term disability, highlighting the need for effective therapies and reliable, noninvasive imaging tools. Mesenchymal stem cell-derived extracellular vesicles (MSC-EVs) are promising therapeutic carriers; however, rigorous validation of labeling strategies is required before translational imaging studies. Here, we present an in vitro characterization framework for glucose-functionalized iron oxide-labeled EVs designed for MRI visibility. EVs isolated from MSC cultures will be labeled with dual-tagged glucose iron oxide nanocrystals to enable magnetic and fluorescent readouts. Transmission electron microscopy (TEM) will assess EV morphology and nanoparticle association, while fluorescence microscopy will evaluate labeling efficiency and cellular uptake. Viability and bioactivity assays will be used to confirm preservation of EV therapeutic potential. Together, these studies establish a multimodal validation pipeline supporting reliable MRI tracking of EV-based drug delivery for future neuroimaging applications.

### Selected Publications and Presentations

Procida, J.; Mattoussi, H.; Arbabian, A.; Li, Y.; Grant, S. Design and Optimization of Glucose-Labeled Iron Oxide Nanocrystals for Extracellular Vesicle MRI Tracking; Poster at the American Chemical Society National Meeting, March 2026.

Arbabian, A.; Procida, J.; Richter, D. L.; Mattoussi, H.; Li, Y. Engineered Iron Oxide Interfaces Enable Reliable MRI Tracking of Therapeutic Extracellular Vesicles; Poster and Oral Presentation, 53rd Southeastern Magnetic Resonance Conference (SEMRC), November 2025; Awarded 3rd Place, Oral Presentation.



## Daniel Barzycki

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**Research Interests:** Vitrimers, Dynamic Covalent Polymer Network, Rheology, Sustainability, Diffusion

**Advisor:** Ralm Ricarte, Ph.D.

**Presentation:** Poster

### Personal Statement

I am a Ph.D. candidate in the Department of Chemical and Biomedical Engineering at the FAMU-FSU College of Engineering. My research lies at the intersection of polymer physics and sustainable materials design, with a specific focus on vitrimers—polymer networks capable of dynamic topological rearrangement. Currently, I am investigating the molecular origins of macroscopic flow in polystyrene-imine vitrimers, seeking to decouple the effects of network architecture from chemical exchange kinetics. My goal is to establish fundamental structure-property relationships that enable the engineering of next-generation recyclable thermosets, ultimately contributing to a more circular polymer economy.

## Tailoring Vitrimer Dynamics: The Impact of Cross-linker Architecture and Stoichiometry

Vitrimers are polymer networks with dynamic covalent bonds that enable topological rearrangements, imparting unique viscoelastic properties critical for processing and recycling. This work investigates the molecular parameters governing the macroscopic flow of polystyrene vitrimers constructed with dynamic imine cross-links. We synthesized three distinct network series to systematically decouple the effects of excess amines, nucleophilicity, and cross-linker length on dynamics. Rheological analysis via oscillatory shear and creep compliance revealed two relaxation mechanisms: fast segmental motion and a slow mode attributed to associative exchange. While excess free amines altered stiffness, the temperature dependence of relaxation remained unaffected. In contrast, the activation energy of the slow mode scaled directly with cross-linker pKa and diffusion activation energy, whereas increasing cross-linker length using PEG diamines significantly reduced this barrier. These findings provide fundamental insights into the structure-property relationships governing the flow of vitrimers.

### Selected Publications and Presentations

Barzycki, D. C.; Ezzeddine, D.; Shanbhag, S.; and Ricarte, R. G. Interplay of Cross-linker Nucleophilicity and Diffusion on Polystyrene Vitrimer Dynamics. Submitted to ACS Applied Polymer Materials.

Barzycki, D.; Ezzeddine, D.; Shanbhag, S.; Ricarte, R. G. Linear Viscoelasticity of Polystyrene Vitrimers: Segmental Motions and The Slow Arrhenius Process. *Macromolecules* 2025, 58 (8), 3949–3963. \*Equal authorship.



## Jennifer Berg Sen

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**Research Interests:** Biomaterials, Hydrogels, Induced Pluripotent Stem Cells, Extracellular Vesicles, Alzheimer's Disease, Nutrition, Lipid Metabolism

**Advisor:** Yan Li, Ph.D.

**Presentation:** Poster



## Danyale Berry

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**Research Interests:** Engineering cellular microenvironments and surface chemistries for enhanced extracellular vesicle production, microcarrier-based MSC culture, and scalable EV biomanufacturing.

**Advisor:** Changchun Zeng, Ph.D. and Yan Li, Ph.D.

**Presentation:** Poster

### Personal Statement

I grew up in the Midwest; having lived in both Illinois and Michigan. I moved to Florida for my undergraduate studies and have been in Florida for the past 10 years. I earned a bachelor's degree in biomedical engineering from Florida Tech in 2019. I earned a master's degree in nutrition and food science from Florida State University in 2023. Currently, I am a 2nd year PhD student in the groups of Dr. Yan Li and Dr. Changchun Zeng. In addition to research, I am part of the Chemical and Biomedical Engineering Graduate Student Association (CBEGSA) and the FSU Institute for Connecting Nutrition and Health (ICON-Health).

## Exploring Extracellular Vesicles in the Lipid Metabolism of Induced Pluripotent Stem Cell-Derived Astrocytes with Differing ApoE Isoform Types

Alzheimer's Disease is the leading cause of dementia worldwide and affects over 55 million people globally. The ApoE4 allele is the strongest genetic risk factor for developing Alzheimer's disease. In the central nervous system, astrocytes are the primary producers of ApoE and cholesterol. While extracellular vesicles (EVs) act as critical cellular messengers transporting proteins, lipids, RNA, and DNA, their specific influence on astrocyte lipid metabolism in the context of ApoE is under-explored. This project aims to investigate if EV signaling modulates lipid storage and cellular health in an ApoE isoform context. To investigate this, iPSC-derived astrocytes (iASCs) expressing different ApoE isoforms are cultured under lipid-rich or lipid-depleted conditions and treated with iASC-derived EVs. We utilize fluorescent imaging of lipid droplets alongside MTT and ROS assays to evaluate lipid storage, metabolic activity and oxidative stress.

### Selected Publications and Presentations

Berg Sen, J. "Bridging Bioengineering and Nutrition Science to Explore Neurodegenerative Disease." Presentation at FSU ICON-Health Kickoff Event, Tallahassee, FL, October 2025.

Zheng, X., Berg Sen, J., Li, Z., Sabouri, M., Samarah, L., Deacon, C. S., Bernardo, J., & Machin, D. R. (2023). High-salt diet augments systolic blood pressure and induces arterial dysfunction in outbred, genetically diverse mice. *American journal of physiology. Heart and circulatory physiology*, 324(4), H473-H483.

Zheng, X., Li, Z., Berg Sen, J., Samarah, L., Deacon, C. S., Bernardo, J., & Machin, D. R. (2023). Western diet augments metabolic and arterial dysfunction in a sex-specific manner in outbred, genetically diverse mice. *Frontiers in nutrition*, 9, 1090023.

### Personal Statement

Born in Chicago, Illinois, raised in Las Vegas, Nevada. I earned a B.S. in exercise science from Winston-Salem State University in 2020, and a M.S in industrial Engineering from Florida A&M University in 2024. Currently, I am a 5th year Ph.D candidate, co-advised by Dr. Changchun Zeng and Dr. Yan Li. In addition to research, I am an active member of Alpha Kappa Mu National Honors Society and Delta Sigma Theta Sorority, Inc., as well as a volunteer with STEMs4Girls, a non-profit organization committed to encouraging children from underrepresented communities to explore STEM. Outside of work, I enjoy playing indoor and beach volleyball, listening to music, and traveling.

## Metal-Phenolic Network Functionalization of Microcarriers to Modulate Mesenchymal Stromal Cell Behavior and Extracellular Vesicle Production

Microcarrier-based culture systems are widely used for scalable expansion of mesenchymal stem cells; however, surface properties influence cell attachment, phenotype, and extracellular vesicle production. In this study, Plastic Plus microcarriers were modified using sequential tannic acid-metal coordination to form metal-phenolic network coatings with tunable surface characteristics. Microcarriers were coated via controlled TA and iron deposition and compared to coatings incorporating calcium ions as a secondary modulator of the TA-Fe network. Coating reproducibility was evaluated using prior mass-uptake measurements under identical conditions, allowing estimation of relative layer thickness across experiments. Coated and uncoated microcarriers were assessed in MSC cultures to evaluate effects on cell attachment, EV yield, and expression of EV biogenesis markers by RT-PCR. This work presents a modular strategy for microcarrier surface engineering that enables tunable MSC culture environments and supports optimization of EV biomanufacturing through ion-mediated phenolic coatings.

### Selected Publications and Presentations

Berry, D.; Ene, J.; Nathani, A.; Singh, M.; Li, Y.; Zeng, C. Effects of Physical Cues on Stem Cell-Derived Extracellular Vesicles toward Neuropathy Applications. *Biomedicines* 2024, 12, 489. <https://doi.org/10.3390/biomedicines12030489>.

Berry, D.; Boirie, B.; Singh, M.; Sun, L.; Jung, S.; Li, Y.; Zeng, C. Engineering Human Bone Marrow-Derived Mesenchymal Stromal Cell Aggregates for Enhanced Extracellular Vesicle Secretion in a Vertical-Wheel Bioreactor. *Front. Bioeng. Biotechnol.* 2026, 13, 1664302. <https://doi.org/10.3389/fbioe.2025.1664302>.



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**Research Interests:** Extracellular vesicles and their application in drug delivery, glioblastoma

**Advisor:** Yan Li, Ph.D.

**Presentation:** Poster

### Personal Statement

Grown up in a small village in far-east region of Nepal, I did my graduate degree in Biomedical Engineering from Purbanchal University in Nepal. I worked in a government owned national public health reference laboratory for about 2 years and shifted in non-profit organization (Save The Children) and worked with government of Nepal in diagnosis and treatment of HIV, TB and COVID-19 for 7 years before joining my Ph.D. at Florida State University in 2024. Currently, I am a second year Ph.D. student at Dr. Li's Lab and doing research in Glioblastoma. Beside research, I enjoy spending my time with my family and friends and I enjoy hiking, travelling, and cooking (but I am not a good cook).

## Comparative characterization and dose dependent effect of extracellular vesicles isolated from Glioblastoma Multiforme (GBM) and stem cell-derived forebrain organoids on GBM

Glioblastoma Multiforme (GBM), highly aggressive malignant tumor in adult brain, generally causes the death of a patient in less than 2 years. Consequently, induced pluripotent stem cells (iPSCs) derived forebrain organoids as a brain tissue mimetic, are used in research related to brain cancer and other neural disease. Extracellular vesicles (EVs), lipid bilayers secreted by these the cells, are being used in research for their application in therapeutics and drug delivery. However, study related to the comparison and effect of iPSC derived forebrain organoid secreted EVs and GBM secreted EVs in GBM progression are limited. Here EVs with size around 100-200nm are isolated using the collected culture media from GBM and organoid cell culture. This study focuses on the comparative characterization of the EVs. We also use the characterized EVs from both sources to interact with GBM cells in varying doses and the influence of both EV types on GBM cells is studied using viability assays.

### Selected Publications and Presentations

Luo, H.; Jin, J.; Jin, J.; Lou, K.; He, H.; Feng, S.; Zeng, F.; Zou, J. Emerging Applications of Extracellular Vesicles in Tumor Therapy. *Cancer Nanotechnology* 2023, 14 (1), 63. <https://doi.org/10.1186/s12645-023-00217-3>.

Russo, M. N.; Whaley, L. A.; Norton, E. S.; Zarco, N.; Guerrero-Cázares, H. Extracellular Vesicles in the Glioblastoma Microenvironment: A Diagnostic and Therapeutic Perspective. *Molecular Aspects of Medicine* 2023, 91, 101167. <https://doi.org/10.1016/j.mam.2022.101167>.



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**Research Interests:** Membrane Electrode Assembly (MEA) studies for PEM water electrozers and fuel cells

**Advisor:** Egwu Eric Kalu, Ph.D.

**Presentation:** Poster

### Personal Statement

I grew up in southeastern Nigeria, in a community where people adapted creatively to everyday energy needs. Those experiences made me care deeply about dependable, clean energy systems. Today, I'm a Ph.D. student at the FAMU-FSU College of Engineering working with Dr. Eric Kalu to understand and slow membrane-electrode-assembly degradation in proton exchange membrane fuel cells. I combine accelerated stress testing with EIS, Kramers-Kronig validation, and DRT/circuit analysis, then carry age-dependent parameters into drive-cycle models to predict real-world losses. I'm especially interested in how catalyst-layer fabrication (hand-sprayed vs ultrasonic deposition) changes transport pathways and durability. My goal is to help design fuel cells that last longer and scale for transportation.

## Cathode Deposition Effects on PEMFC Degradation

Proton exchange membrane fuel cells (PEMFCs) promise efficient, zero-emission power, but durability is limited by catalyst-layer degradation. We quantify how cathode deposition affects aging and drive-relevant performance. Two 25 cm<sup>2</sup> MEAs, identical except for cathode application (hand-sprayed vs SonoTek ultrasonic), underwent square-wave accelerated stress testing. EIS spectra were Kramers-Kronig validated and analyzed with DRT and circuit fitting to follow changes in ohmic, kinetic, and mass-transport resistances. The SonoTek cathode showed stronger initial protonic pathways and higher efficiency, but compacted faster and experienced earlier transport collapse. The more porous hand-sprayed cathode aged more slowly and preserved reactant accessibility longer. A New York Bus drive-cycle model then propagated age-dependent resistance parameters to predict voltage losses, hydrogen use, and energy efficiency; predictions matched EIS trends. This integrated approach links fabrication to durability trajectories and guides design of resilient, application-ready PEMFCs.



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**Research Interests:** Biomedical and bio-inspired adhesive materials, Smart and stimuli-responsive polymer systems, Polymer functionalization of two-dimensional materials

**Advisor:** Hoyong Chung, Ph.D.

**Presentation:** Poster

### Personal Statement

I am a polymer chemist and biomedical engineer specializing in the design of functional polymeric materials for healthcare applications. My research integrates polymer synthesis, interfacial chemistry, and engineering principles to develop smart polymers and functionalized materials that address challenges in biomedical adhesives, diagnostics, and biointerfaces. I am particularly interested in leveraging structure-property relationships to create materials that balance mechanical performance, functionality, and biocompatibility. Through this work, I aim to develop responsive polymer systems that move beyond passive materials toward clinically relevant, high-impact biomedical solutions.

## Rapidly Photocured, Ultra-Strong Catechol-Thiol Adhesive Designed for Wet-Surface Biomedical Applications

The development of safe, fast-acting, and pressure-free biomedical adhesives remains a major challenge for internal tissue sealing, as current cyanoacrylate- and fibrin-based products are limited by heat generation, toxicity, and weak wet adhesion. Here, we report a photocurable biomedical adhesive that integrates catechol chemistry, thiol-ene UV curing, and disulfide exchange to achieve strong adhesion in wet and mucosal environments. The adhesive rapidly forms a crosslinked network under brief UVA irradiation, producing strong and flexible adhesion with dry strengths of 164 kPa and sustained performance under wet (144 kPa) and underwater (56 kPa) conditions, outperforming commercial fibrin adhesives. Flow cytometry analysis of NIH-3T3 cells showed viabilities above 96% after 72 hours, demonstrating excellent cytocompatibility. Overall, this work presents a fast-curing, biocompatible adhesive platform for next-generation biomedical applications.

### Selected Publications and Presentations

Boykin, J.; Zamani, N.; Gunjan, A.; Chung, H. Multifunctional Bio-Inspired Biomedical Adhesive Featuring Fast-Acting Adhesion for Topical Drug Delivery. *J. Mater. Chem. B* 2025, 13 (35), 11032–11045. <https://doi.org/10.1039/D5TB00175G>.

Saha, B.; Boykin, J.; Chung, H. Unveiling the Architectural Impact on the Salt-Tunable Adhesion Performance and Toughness of Polyzwitterions. *J. Am. Chem. Soc.* 2024, 146 (33), 23467–23475. <https://doi.org/10.1021/jacs.4c06877>.

Boykin, J. Multifunctional Bio-Inspired Biomedical Adhesive Featuring Fast-Acting Adhesion for Topical Drug Delivery. Presented at American Chemical Society Fall Meeting, Washington D.C., August 2025.



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**Research Interests:** Electron upconversion and catalysis, remediation of microplastics via nonthermal plasma, photoredox catalysis, and drug design

**Advisors:** Igor Alabguin, Ph.D. and Bruce Locke, Ph.D.

**Presentation:** Poster

### Personal Statement

I have always had an insatiable appetite to know how things work, understand why things happen, and how to fix broken devices. My passion for solving puzzles and working with devices is a trait was nurtured by my father—a chemical engineer who constantly involved me in home renovations. Naturally, I gravitated toward solving chemical puzzles, earning a B.S. in Chemistry from Lakehead University. Shortly after graduating, an internship at a chemical engineering plant inspired me to pursue graduate school with the goal of solving complex problems with societal impact. Currently, I use computational methods to explain, predict, and solve challenges at the intersection of chemistry and engineering. In my spare time, you can find me playing tennis, the piano, or painting in watercolors.

## Engineering Energy Efficient PFAS Remediation via Electron Catalysis

Electrons are often regarded as reagents in PFAS remediation, yet they possess the capacity to act catalytically when coupled to electron upconversion, i.e., the generation of stronger reductants in situ. Here, we develop a computational framework showing how electron upconversion can be harnessed to drive the degradation of PFOS, among the most recalcitrant PFAS. We identify radical anions of sulfonic acids as viable intermediates where the C-S and C-F bonds are weakened by up to 100 kcal/mol, enabling pathways inaccessible to neutral or deprotonated PFASs. Electrons and hydrogen atoms emerge as the dominant agents for bond activation, while hydroxyl radicals play only a minor supporting role. We further show that radical and anion cross-reactions can regenerate upconverted electrons, establishing the basis for catalytic defluorination cycles. Experiments support theory showing that degradation of PFOS increases 4.5 times. These findings unify plasma, photoredox and redox catalysis through a shared mechanistic principle and point toward more energy-efficient PFAS destruction.

### Selected Publications and Presentations

Christopher, K.; Bulusu, R.K.M.; Shteyman, M.; Locke, B.; Alabguin, I.V.; Design of Energy Efficient PFAS Remediation via Electron Catalysis. *Nature Chemistry* 2026, Unpublished work, January 29, 2026.

Alabugin, I.V.; Eckhardt, P.; Christopher, K.M.; Opatz, T. The Photoredox Paradox: Electron and Hole Upconversion as the Hidden Secrets of Photoredox Catalysis. *J. Am. Chem. Soc.* 2024 146 (14), 27233–27254. DOI: 10.1021/jacs.4c10422.

Ilyina, I.; Patrusheva, O.; Goltsova, V.; Volcho, K.; Sidorenko, A.; Christopher, K.M.; Alabugin, I.; Agabekov, V.; Salakhutdinov, N. Unusual Cascade Reactions of 8-Acetoxy-6-hydroxymethylimonene with salicylic aldehydes: Diverse Oxygen Heterocycles from Common Precursors. *J. Org. Chem.* 2024, 89 (16), 11593–11606. DOI: 10.3390/ijms241612637.



## Harrison Craythorne

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**Research Interests:** Directional mechanotransduction, traction force microscopy, nuclear and cytoskeletal forces, stem cell dedifferentiation, cartilage regeneration

**Advisor:** Tristan Driscoll, Ph.D.

**Presentation:** Poster

### Personal Statement

I was born and raised in Tampa, Florida, home to the greatest baseball and football teams in the nation. I have always been interested in biomechanics as I was a pitcher in baseball and a state finalist pole vaulter in high school. In my free time I like to go rock climbing, running, and read a whole variety of books.

## Chondrocyte Expansion Results in Dedifferentiation Through Alterations in Contractility and Nuclear Engagement

Modern autologous chondrocyte-based arthritis therapies are effective at treating small cartilage defects. However, the short timeframe for cell proliferation before chondrocyte dedifferentiation becomes detrimental limits the number of available cells. This short culture period limits treatment of large defects which would require significantly more chondrocytes. In vitro expansion of chondrocytes drives de-differentiation due to cellular engagement with a stiff culture environment that activates cell spreading, nuclear flattening, and cytoskeletal remodeling. One cytoskeletal complex that is impacted by this is the linker of nucleoskeleton and cytoskeleton (LINC) complex. Previous work has identified that components of the LINC complex are lost with de-differentiation of chondrocytes and alterations in expression are observed with a wide range of other differentiation processes. Here, we investigated changes in contractility and the LINC complex during chondrocyte expansion and tested whether an imbalance in expression contributes to a contractile phenotype with de-differentiation.

### Selected Publications and Presentations

Craythorne H. Chondrocyte expansion results in dedifferentiation through alterations in cytoskeletal and nuclear engagement. The Florida State University; 2025.



## Justice Ene

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**Research Interests:** Non-invasive cell-based therapeutics, Neuronal Senescence, exosome-based drug delivery, Alzheimer's Disease

**Advisor:** Yan Li, Ph.D.

**Presentation:** Poster

### Personal Statement

I grew up in Tallahassee, FL. I earned at B.S. in biomedical engineering from FAMU-FSU College of Engineering in 2018. Currently, I am a 4th year graduate student in the Yan Li lab. My research focuses on neuronal therapeutics with an emphasis on exosomal cargo and exosomal use as delivery vehicles. Outside of work, I enjoy active sports such as basketball, lacrosse, and disc golf as well as poker and lock picking.

## Alzheimer's Disease Effects on Exosomal Cargo and Therapeutic Efficacy

Alzheimer's disease (AD) is a neurodegenerative disorder representing approximately 60-70% of dementia cases. Due to the complexity of AD, it has been hard to pinpoint a direct cause of the disease. Genetics, age, and environment have all been linked to AD and have resulted in multiple theories to explain its development and progression. Genetic mutations such as the M146V mutation causes the formation of large Amyloid beta (A $\beta$ ) plaques that have trouble being cleared by the body, yielding brain degradation. In this study, we characterized the extracellular vesicles (EVs) released from AD patients. The cargo these EVs carry elevated levels of ROS and decreased mitochondrial activity within healthy cells. Proteomics revealed a decreased level of cytoskeleton proteins and an increase in proteins responsible for ferroptosis. qPCR showed a differential response regarding genes that regulate ferroptosis. Utilization of these EVs as delivery systems for therapeutic drugs can provide insight on potential penetrability and uptake differences between healthy and AD-ridden cells.

### Selected Publications and Presentations

Ene J, Liu C, Syed F, Sun L, Berry D, Durairaj P, Liu ZL, Zeng C, Jung S, Li Y. Biomanufacturing and lipidomics analysis of extracellular vesicles secreted by human blood vessel organoids in a vertical wheel bioreactor. *Stem Cell Res Ther.* 2025 Apr 24;16(1):207. DOI: 10.1186/s13287-025-04317-2. PMID: 40275401; PMCID: PMC12023677.

Ene, J., Muok, L., Gonzalez, V., Sanchez, N., Nathani, A., Syed, F., Liu, Z. L., Singh, M., Driscoll, T., & Li, Y. (2025). Biomanufacturing and Curcumin-Loading of Human Choroid Plexus Organoid-Derived Extracellular Vesicles from a Vertical-Wheel Bioreactor to Alleviate Neuro-Inflammation. *Biomedicines*, 13(5), 1069. <https://doi.org/10.3390/biomedicines13051069>.

Ma, S.; Ene, J.; McGarraugh, C.; Ma, S.; Esmonde, C.; Liu, Y.; Li, Y. Extracellular Vesicle Secretion from 3D Culture of Human Adipose-Derived Mesenchymal Stem Cells in Scalable Bioreactors. *Bioengineering* 2025, 12, 933. <https://doi.org/10.3390/bioengineering12090933>.



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**Research Interests:** Polymer synthesis & characterization; Vitrimers; Rheology

**Advisor:** Ralm Ricarte, Ph.D.

**Presentation:** Poster

### Personal Statement

As a 5th-year Ph.D. candidate in chemical engineering, I am driven by the challenge of translating fundamental polymer physics into scalable material solutions. My research targets the molecular level design of vitrimers, recyclable dynamic networks that bridge the gap between thermoplastics and thermosets. However, my interests extend beyond the fume hood into leadership roles. As a lab safety officer and co-founder of a non-profit STEM outreach program, I have cultivated skills rooted in safety, communication, and mentorship. I have learned to manage complex projects and diverse teams effectively, and I am eager to leverage this dual expertise in dynamic polymer systems and operational leadership to drive R&D innovation in industry.

## Investigating Viscoelasticity in Elastomeric and Glassy Vitrimers via Network Topology and Associative Bond Exchange

Vitrimers represent a class of covalently cross-linked polymer networks that enable topological rearrangement through associative dynamic bond exchange while maintaining network integrity. This poster investigates the interplay between network structure and exchange dynamics in elastomeric polybutadiene (PB) and glassy polystyrene (PS) vitrimers. We synthesized PB vitrimers with dioxaborolane linkages via thiol-ene photochemistry. Using network disassembly and 1H NMR spectroscopy, the cross-link density was quantified. Higher cross-link density increased the glass transition temperature and plateau modulus, consistent with reduced structural defects compared to permanent networks. Glassy PS vitrimers were synthesized with imine linkages at varying amine-to-aldehyde ratios. We investigated chain diffusion and microscopic relaxations using dynamic light scattering and DOSY NMR. Bulk linear rheology identified two distinct relaxation modes: a high-frequency response associated with fast segmental motions, and a low-frequency mode governed by dynamic cross-link exchange.

### Selected Publications and Presentations

Ezzeddine, D.; Barzycki, D. C.; Ricarte, R. G. Impact of Cross-link Density on Polybutadiene Permanent and Vitriemer Networks. *ACS macro letters* 2025, 1011–1018. <https://doi.org/10.1021/acsmacrolett.5c00267>.

Barzycki, D. C.;\* Ezzeddine, D.;\* Shanbhag, S.; Ricarte, R. G. Linear Viscoelasticity of Polystyrene Vitrimers: Segmental Motions and the Slow Arrhenius Process. *Macromolecules* 2025. <https://doi.org/10.1021/acs.macromol.4c03161>. (\*Equal Authorship).



## Masahiro Fukuda

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**Research Interests:** Phagocytosis, macrophage biology, innate and adaptive immunity, intracellular biomolecule degradation, quantitative fluorescence imaging, and image analysis pipelines

**Advisor:** Jingjiao Guan, Ph.D.

**Presentation:** Poster

### Personal Statement

Came to the U.S. from Japan in 2017 to pursue engineering training. I earned my B.S. in Chemical Engineering at the FAMU-FSU College of Engineering and am currently a fifth-year Ph.D. student in Biomedical Engineering.

## Engineered Microparticles Reveal Proteolysis as a Critical Prerequisite for Chromatin Clearance in Macrophage Phagosomes

Defective clearance of phagocytosed DNA contributes to inflammation, yet the molecular determinants of DNA degradation within phagosomes remain unclear. We present a materials-based platform using engineered microparticles to dissect DNA processing inside macrophage phagosomes. Using microcontact printing, we fabricated two classes of DNA-containing microparticles: thermoresponsive poly(N-isopropylacrylamide) (PNIPAM) microspheres encapsulating intercalator-labeled DNA, and chromatin-mimetic particles composed of multilayered histone-DNA assemblies with tunable crosslinking. These systems enable controlled modulation of DNA accessibility. Upon phagocytosis, DNA embedded within hydrated PNIPAM networks remained intact, indicating restricted enzymatic access. In contrast, histone-bound DNA was degraded only after proteolytic removal of the histone barrier, whereas chemical crosslinking inhibited degradation. These findings identify proteolysis of DNA-associated proteins as a prerequisite for DNase-mediated cleavage in macrophage phagosomes.

### Selected Publications and Presentations

Wenhao Cheng, Masahiro Fukuda, Sundol Kim, Yuan Liu, Xingchi Chen, Christina Holmes, Yan Li, Hoyong Chung, Yi Ren., Jingjiao Guan. "Osmotically Rupturing Phagosomes in Macrophages Using PNIPAM Microparticles." *ACS applied materials & interfaces* 15, no. 20 (2023): 24244-24256.

Masahiro Fukuda, Grace Lin, Yang Liu, Grace Hammel, Abigail Kizer, Maryam Ayazi, Sailesti Joshi, Yuan Liu, Yi Ren., Jingjiao Guan. "Development of Engineered Microparticles for Investigating Enzymatic Degradation of Proteins and Peptides within Phagosomes." *ACS Applied Materials & Interfaces* 2025, 17, 13617-13631.



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**Research Interests:** Ceramic precursors, nanoparticles, preceramic polymers, direct ink write 3D Printing, powder processing, nanotechnology, structure-function relationships

**Advisor:** Subramanian Ramakrishnan, Ph.D.

**Presentation:** Poster

### Personal Statement

My research focuses on designing preceramic polymer-grafted nanoparticle systems for additive manufacturing of advanced ceramics which are capable of operating in extreme thermal and mechanical environments. Through my Ph.D. work, I integrate synthesis, rheology, nanoscale dynamics, and thermal characterization to establish structure-property relationships in order to improve processability, ceramic yield, and structural fidelity during pyrolysis. I have collaborated closely with AFRL, ARL, and Brookhaven National Laboratory, gaining experience translating fundamental materials physics into aerospace-relevant performance metrics. My long-term goal is to develop scalable ceramic materials and processing strategies that allow for superior hypersonic and propulsion systems.

## Rheological and Thermal Behavior of Polymer-Grafted Nanoparticle Systems

Preceramic polymer-grafted nanoparticles (PCPGNPs) are a promising route to high-performance ceramics for extreme aerospace environments, but shrinkage, cracking, and porosity during pyrolysis limit utility. Here, we study dynamics, rheology, and ceramic yield of PCPGNP blends in polycarbosilane matrices of varying molecular weight. Silica nanoparticles (10–20 nm) were grafted with poly(1,1-dimethylpropylsilane) to form viscoelastic hairy nanoparticle fluids and blended with SMP-877. Rheology shows sharp increases in viscosity and modulus above the percolation threshold (50–60 wt%), consistent with network formation. Nanoscale dynamics transition from diffusive to ballistic motion with increasing PCPGNP loading, indicating constrained motion from chain overlap. Thermogravimetric analysis shows improved thermal stability and ceramic yield, with up to a 30% synergistic increase. These results guide optimization of processability and final performance for additively manufactured ceramics.

### Selected Publications and Presentations

Germanton, G.; Martin, K. L.; Hossain, M. A.; Posey, N. D.; Ponder, J. F. Jr.; Ramirez, C.; Gnanasekar, P.; Wiegart, L.; Polisetty, P.; Hallinan, D. T. Jr.; Dickerson, M. B.; Ramakrishnan, S. Insights into Preceramic Polymer-Based Additive Manufacturing Inks via Rheological and Scattering Studies of Preceramic Polymer-Grafted Nanoparticles Suspended in Polycarbosilane. *ACS Appl. Eng. Mater.* 2024.

Germanton, G.; Gnanasekar, P.; Ponder, J. F. Jr.; Posey, N. D.; Polisetty, P.; Hallinan, D. Jr.; Dickerson, M. B.; Ramakrishnan, S. Understanding the Influence of Nanoparticle Core Size on the Rheology and Ceramic Yield of Preceramic Polymer-Grafted Nanoparticles: Implications for Thermal Protection Systems and Aerospace Propulsion Components. *ACS Appl. Nano Mater.* 2025. <https://doi.org/10.1021/acsnm.5c04471>.

Martin, K. L.; Clarkson, C. M.; Thompson, C.; Germanton, G.; Posey, N.; Wiegart, L.; Ramakrishnan, S.; Dickerson, M. B. Influence of Thermal Treatment on Preceramic Polymer Grafted Nanoparticle Network Formation: Implications for Thermal Protection Systems and Aerospace Propulsion Components. *Acs Appl. Nano Mater.* 2022, 5 (10), 15288–15297. <https://doi.org/10.1021/acsnm.2c03379>.



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**Research Interests:** Ink rheology, additive manufacturing, developing a sensor (strain sensor)

**Advisor:** Subramanian Ramakrishnan, Ph.D.

**Presentation:** Poster

### Personal Statement

My academic and research interests lie at the intersection of materials science, additive manufacturing, and flexible electronics, with a particular focus on the development of high-performance printed strain gauges. In my dissertation work, I have learned various characterization techniques for polymer composite ink. The techniques include rheology, TGA, DSC, FTIR, microscopy, and profiling. I am well-versed in additive manufacturing, particularly Direct Ink Writing. This know-how supports my long-term goal of developing scalable, manufacturable strain-sensing platforms that combine high sensitivity, mechanical robustness, and long-term durability for applications in wearable electronics, soft robotics, and structural health monitoring.

## The Effect of Laser on Silver Ink Resistance Via Design of Experiment

Printing strain gauges with conductive inks directly onto large, complex structures (conformal printing) is of interest to the aerospace industry, such as NASA. However, traditional thermal curing methods are unsuitable for conformally printed strain gauges due to their larger size. Alternative methods are required to cure conformally printed strain gauges. Laser curing could be an alternative to thermal curing due to its portability, energy efficiency, and fast curing, while achieving electrical resistance values similar to or even lower than those of conventional thermal curing. The effectiveness of laser curing depends on properly tuning the incident laser dose. When the laser's operation mode, wavelength, beam shape, spot diameter, and ink are known, the curing depends on the tuning of laser parameters- laser power, scanning speed, and number of scans. The goals of this research are: (1) to explore the effect of individual parameters on the ink resistance; (2) to explore the interaction effect of laser parameters on the ink resistance using the Design of Experiment (DoE) method.

### Selected Publications and Presentations

Hossain, M. A., Plautz-Ratkovski, G., DeGraff, J., Dickens, T. J., Liang, Z., Hill, C., ... & Ramakrishnan, S. (2025). Tuning Printability and Adhesion of a Silver-Based Ink for High-Performance Strain Gauges Manufactured via Direct Ink Writing. *ACS omega*, 10(1), 1429-1439.

Hossain, M.A. Tuning Printability and Adhesion of a Silver-Based Ink for High-Performance Strain Gauges. Presented at NASA MOSAICS Summer Student Symposium 2025, Greenbelt, MD, US, July 11, 2025.

Hossain, M.A. High-performing Strain Gauges for NASA Application. Presented at NASA MOSAICS Fall 2024 Symposium, Georgetown, Washington, DC, US, December 7, 2024.



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**Research Interests:** Synthesis, Characterization and Rheology of Vitrimers

**Advisor:** Ralm Ricarte, Ph.D.

**Presentation:** Poster



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**Research Interests:** Plasma technology, Reactor Modelling, Waste Management, Machine learning and Energy Systems

**Advisor:** Bruce Locke, Ph.D.

**Presentation:** Poster

### Personal Statement

I grew up in Tarkwa, a small town located in the Western Region of Ghana. I earned my B.Sc. in Chemical Engineering from Kwame Nkrumah University of Science and Technology in 2023. Currently, I am a second-year graduate student in the Ricarte Group. In addition to research, I volunteer with STEM Theory, an outreach organization that visits high schools in Tallahassee to perform science experiments. I also enjoy listening to music and working out.

### Investigating the Impact of Vitriemer Additives on Commercial Thermoplastics

Vitrimers are covalently cross-linked polymers that undergo dynamic bond exchange, enabling them to be still reprocessible. Here, we investigate polystyrene (PS) vitrimers as a rheology modifiers for commercial PS thermoplastics. First, we synthesized a PS vitriemer precursor using reversible addition-fragmentation chain transfer (RAFT) polymerization. Next, we functionalized with aldehydes and crosslinked with diamines to form PS vitrimers. We verified chemical structure, molecular weight and thermal transitions of the prepolymer and vitriemer compositions using nuclear magnetic resonance, Fourier transform infrared spectroscopy, and ultraviolet-visible spectroscopy, size exclusion chromatography, differential scanning calorimetry and thermogravimetric analysis. For commercial PS thermoplastics with molecular weights of 45 and 170 kDa, we evaluated the linear rheology controls using small-amplitude oscillatory shear, creep, and stress relaxation to establish a baseline for future blend comparisons.

### Personal Statement

I am a second year Ph.D. student in Chemical Engineering at the FAMU-FSU college of engineering, with research interests in low-temperature plasma systems, plasma-assisted chemistry, and sustainable technologies. My work focuses on plasma-liquid interactions and reaction kinetics, using a combination of experimental analysis and modeling to understand these non-equilibrium processes. Outside the lab, I enjoy painting as a creative outlet and building mobile and web applications. Music plays an important role in helping me relax, stay inspired, and maintain balance.

### Reactive Nitrogen Species Production in a Nanosecond Pulsed Plasma Gas-Liquid Reactor: An Investigation of Pulse Delivery Mode

Plasma-based nitrogen fixation offers a way to produce nitrate-rich liquid fertilisers directly from air and electricity. This study investigates the performance of a Nanosecond Pulsed Gas-Liquid Reactor designed to generate these essential chemicals at the interface of a flowing water film. The influence of pulse delivery mode on the production of  $H_2O_2$ ,  $NO_2$ , and  $NO_3$  in the liquid phase and  $NO$ , and  $NO_2$  in the gas phase was examined. Energy efficiency of “uniform” pulsing against a “burst” mode approach were compared. A custom-made nanosecond pulsed power supply at constant input voltage of 10 kV and a pulse width of 96 ns was used. For uniform pulsing, we varied the frequency between 5 and 50 kHz. In burst mode, three parameters: the number of pulses per burst (N-cycles) from 1 to 50, the internal frequency from 1 kHz to 1 MHz, and the burst period between 0.1 ms and 1 ms were studied.



## Muhammad Jamiu Garba

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**Research Interests:** Magnetophoresis

**Advisor:** Hadi Mohammadigoushki, Ph.D.

**Presentation:** Poster

### Personal Statement

My research focuses on understanding magnetophoretic transport of paramagnetic and diamagnetic ions in porous media using numerical modeling. I develop multiphysics frameworks that couple fluid flow, species transport, and magnetic forces to study ion migration under non-uniform magnetic fields. By comparing porous-media models and validating against experiments, my work aims to improve predictive modeling of magnetically driven transport relevant to separation, and concentration.

## Modeling Transport of magnetic Metal Solutes in Different Porous Media Under a Non-uniform Magnetic Field

Magnetic particles aggregate under non-uniform magnetic fields during magnetophoresis, this finds application in drug delivery and pollutant removal. Despite its utility, magnetophoretic transport in porous media remains poorly understood. This study numerically investigates the transport of paramagnetic and diamagnetic ions in saturated porous media under static magnetic field gradients. A multiphysics framework coupling fluid flow, species transport, and magnetic forces is developed. Two porous-media formulations are compared: a Stokes-based model with effective diffusivity and a Brinkman model accounting for permeability. Comparison with recent experiments shows that the Brinkman model better reproduces observed transport trends. Simulations predict field-induced aggregation of both ion types at concentrations of 1–100 mM under magnetic gradients up to  $100 \text{ T}^2 \text{ m}^{-1}$ . Transport is dominated by the Kelvin magnetic force, while concentration-gradient magnetic forces are negligible. These results highlight the importance of accurate porous-flow modeling in magnetophoretic transport.

### Selected Publications and Presentations

Rassolov, P.; Ali, J.; Siegrist, T.; Humayun, M.; Mohammadigoushki, H. Magnetophoresis of paramagnetic metal ions in porous media. *Soft Matter* 2024, 20 (11), 2496–2508.  
Fujiwara, M.; Chie, K.; Sawai, J.; Shimizu, D.; Tanimoto, Y. On the movement of paramagnetic ions in an inhomogeneous magnetic field. *J. Phys. Chem. B* 2004, 108 (11), 3531–3534.



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**Research Interests:** Biomimetic 3D liver models using hydrogels for extrusion-based 3D bioprinting applications

**Advisor:** Jamel Ali, Ph.D.

**Presentation:** Poster

### Personal Statement

In terms of my research, I am motivated by the need for more physiologically relevant liver models that improve drug screening and, particularly, to reduce reliance on animal testing. My research combines biomaterials, mechanobiology, and biofabrication to develop tunable 3D liver culture systems that better mimic native tissue. Equally important to me is mentorship. Throughout my Ph.D., I have been training and supporting undergraduate women in research, by providing hands-on experience in advanced tissue engineering and fostering confidence in scientific careers. Through research and mentorship, I aim to contribute to both scientific innovation and an inclusive research community.

## Expansion and 3D Bioprinting of Functional Hepatocytes Using Novel Fibrous Bioscaffold

Liver tissue engineering seeks to address the demand for transplantable organs and improved treatments for liver disease. A major challenge is sustaining hepatocyte expansion and function in vitro over extended culture periods. We developed a mechanically tunable 3D alginate hydrogel incorporating a novel microfibrous bioscaffold to better support long-term hepatocyte growth. By tuning the shear storage modulus ( $G'$ ) to  $\sim 1 \text{ kPa}$ , we mimicked the mechanical properties of healthy human liver tissue. Rheological testing confirmed consistent viscoelastic properties with minimal batch variability. THLE-2 human hepatocytes encapsulated in these fiber-laden hydrogels demonstrated increasing viability over two weeks. We also confirmed the printability of this system for extrusion-based 3D bioprinting, enabling scalable fabrication of biomimetic liver models for high-throughput drug screening and liver disease research.

### Selected Publications and Presentations

Kaur, N.; Savitsky, M. J.; Lipscomb, M.; Yang, D.; Ali, J. *ACS Pharmacology & Translational Science* 2026, 9 (1), 89–100. <https://doi.org/10.1021/acspsci.5c00567>.



## Sophie Jermyn

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**Research Interests:** Micro/nanorobotics, immune modulation, cancer therapeutics, minimally invasive magnetic delivery systems

**Advisor:** Jamel Ali, Ph.D.

**Presentation:** Poster

### Personal Statement

My research focuses on therapeutic interventions at microscopic scales, I study bio-inspired microswimmers in low-Reynolds-number environments to better understand how physical constraints shape efficient movement. Through this work, I have gained experience with microscopy, cell culture, coding, image analysis, and experimental design. I am motivated by a desire to improve the current therapeutic options in oncology and provide new knowledge at the intersection of physics, biology, and engineering, to apply towards future research and innovation.

## Biotemplating Archaella for Nanorobotic Applications

As interest in micro and nano-delivery systems for biomedical applications continues to rise, novel materials and fabrication strategies must be introduced. In particular, designs for swimming micromotors that take inspiration from nature have shown great promise for in vivo applications, and therefore many small-scale actuators have been developed by mimicking the widely investigated bacterial flagellum. However, in this work we directly utilize archaella isolated from *Halobacterium salinarum* as biotemplates to fabricate nanoscale microrobots capable of precise magnetic actuation in low-Reynolds number fluids. Swimming dynamics are investigated, and the results show a nanorobot that efficiently navigates low-Reynolds number fluids under the direction of a uniform rotating magnetic field. This work provides a facile, cost-effective method for fabrication using a bottom-up approach as well as demonstrates the potential of extremophile derived biotemplated nanorobots for precise delivery applications.

### Selected Publications and Presentations

Wang, Q., Jermyn, S., Quashie, D., Jr., Gatti, E., Katuri, J., & Ali, J. (2023). Magnetically Actuated Swimming and Rolling Erythrocyte-based Micromotors. *RSC Adv.*, 2023, 13, 3095. DOI: 10.1039/d3ra05844a.

Quashie, D., Jr., Wang, Q., Jermyn, S., Katuri, J., & Ali, J. (2023). Dynamics of Rigid Achiral Magnetic Microswimmers in Shear-Thinning Fluids. *Physics of Fluids* 35, 092016 (2023). DOI: 10.1063/5.0167307.

Jermyn, S., Katuri, J., & Ali, J. (presented 2021, October). Biotemplating Biological Filaments for Nanorobotic Applications. Presentation at 2026 Biomedical Engineering Society Annual Meeting, Biomedical Engineering Society, San Diego, California. (National).



## Aidan Lowery

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**Research Interests:** Chemical and magnetic separations, magnetic particles, high-gradient magnetic fields, and chemical engineering education

**Advisor:** Hadi Mohammadigoushki, Ph.D.

**Presentation:** Poster

### Personal Statement

I am a Tallahassee native (born and raised!). I have earned two degrees at the FAMU-FSU College of Engineering through Florida State University, including a B.S in 2023 and an M.S. in 2025, both in chemical engineering. I am currently a third-year Ph.D. candidate at the Center for Rare Earths, Critical Minerals, and Industrial Byproducts at the National High Magnetic Field Laboratory (MagLab). In addition to my research, I teach physics part-time at Leon High School. Teaching is my passion, and I hope to continue this by becoming a teaching faculty member at the university level in chemical engineering upon my doctoral graduation. Outside of work, I enjoy baking and playing video games.

## Magnetic Field Gradient Enhanced Liquid-Liquid Extraction of Metal Ions using Ionic Liquids

The extraction of ions using ionic liquids (ILs) has been widely studied in liquid-liquid extraction processes as an alternative to traditional solvents such as dodecane or kerosene. ILs offer many environmental benefits, including low volatility, low flammability, and potential reusability. Previous work has largely relied on added extractants (i.e., TBP or D2EHPA) to improve the transfer of metal ions from the aqueous phase into the organic phase. However, due to the high cost of ILs and extractants, there is interest in enhancing separation performance while reducing chemical usage. Now, for the first time to our knowledge, we report experimental results demonstrating the efficacy of magnetic field gradients in enhancing the extraction of metal ions from the aqueous phase into the IL phase. Batch extraction experiments of para- and dia-magnetic ions using [C6mim][Tf2N] were conducted under magnetic gradients up to 140 Tesla squared per meter and compared to separations performed under similar conditions without magnetic gradients and showed up to 95% separation within 2 hours.

### Selected Publications and Presentations

Lowery, A.; Ali, J.; Siegrist, T.; Humayun, M.; Mohammadigoushki, H. The Separation and Aggregation of Transition Metal Particles in a Continuous, Flow Through Magnetic Separation Process. Poster presented at the Department of Chemical & Biomedical Engineering Research Day, Tallahassee, FL, April 18, 2025.

Lowery, A.; Hunter, K. Energy Balances on Reactive Processes. Invited Guest Lecture for ECH 3024 Mass and Energy Balances II, FAMU-FSU College of Engineering, Tallahassee, FL, July 1, 2025.

Lowery, A.; Hunter, K. Mass Balances on Single Units. Invited Guest Lecture for ECH 3024 Mass and Energy Balances II, FAMU-FSU College of Engineering, Tallahassee, FL, January 15, 2026.



## Garrett McDaniel

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**Research Interests:** Cellular mechanobiology, fibrotic disease, tissue stiffness, stem-cell therapeutics, extracellular vesicles, fluorescent imaging

**Advisor:** Tristan Driscoll, Ph.D. and Yan Li, Ph.D.

**Presentation:** Poster

### Personal Statement

I grew up in a small town in North Florida attending FSU as an undergraduate to get my B.S. in Biomedical Engineering in 2022. I am a 4th year Ph.D. student in Dr. Tristan Driscoll's lab and I am co-advised by Dr. Yan Li. Outside of the lab, most of my time is taken up by my two cats, Ori and Midas.

## Assessment of stretch-induced changes of human mesenchymal stem cells and their extracellular vesicles in maintaining tissue homeostasis and fibrotic disease progression

Extracellular Vesicles (EVs) are small, membrane-bound vesicles composed of protein, small mRNA, and lipids that are characteristic of their originating cell and play a role in intracellular communication and tissue homeostasis. Fibrotic disease is characterized by a positive feedback loop of ECM deposition and tissue stiffening triggered by injury, inflammation, or increased mechanical stimuli like tissue stretching. Dynamic stretch occurs within the body in tissues like lung or muscle where, in physiological amounts, it can help to maintain homeostasis and promote proliferation and EV secretion. A tensile stretch bioreactor was used to simulate cyclic stretch to assess its impact on stretched cells and their EVs. Strain validation of thin-film PDMS was shown to perform uniaxial strain up to 30%. Stem cell-seeded PDMS gels stretched at 3% strain for 8hrs at 1 Hz showed alignment perpendicular to the direction of strain and increased YAP activation. Released EVs will be assessed for their amount, contents, and ability to mitigate or promote fibrotic and inflammatory phenotypes.

### Selected Publications and Presentations

McDaniel, G.; Li, Y.; Driscoll, T. miR29a-Loaded Extracellular Vesicles Derived from Human Mesenchymal Stem Cells Inhibit Fibrotic and Inflammatory Signaling. ACS Omega 2025 10.10.1021/acsomega.5c03490.



## Jesufane Mentor

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**Research Interests:** Battery optimization, polymer electrolytes, thermal diffusion

**Advisor:** Daniel Hallinan Jr., Ph.D.

**Presentation:** Poster

### Personal Statement

I was born and raised in West Palm Beach, FL and I earned my B.S. in Chemical Engineering from Florida State University in 2019. Following four and half years as a design engineer and project manager, I recognized critical inefficiency in current battery grid integration methods. This sparked my transition to graduate research in order to advance electrochemical energy storage. As a Master thesis student in Dr. Hallinan's lab, it gives me the opportunity to optimize battery design in order to maximize energy density paving the way to minimize thermal hazards and spatial footprints. Parallel to my studies, I serve the graduate students through the Chemical and Biomedical Engineering Graduate Student Association(CBEGSA).

## Investigating the Effect of Thermal Diffusion in Symmetric Cells

Thermal galvanic cells can convert low grade waste heat into electrical energy by generating a voltage when a temperature gradient is applied across an electrolyte. In this project, the voltage response was investigated in poly(ethylene oxide) (PEO) with lithium bis(trifluoromethanesulfonyl)imide (LiTFSI) and sodium bis(trifluoromethanesulfonyl)imide (NaTFSI). Poly(ethylene oxide) was studied at a molecular weight of 8,000 g/mol and 4,000,000 g/mol at a fixed salt loading of 0.085 mol cation per mole ethylene oxide and over a temperature range of 60 °C to 85 °C. Symmetric cells were subjected to controlled temperature differences and the open circuit voltage was recorded from the transient regime to steady state. Seebeck coefficients were extracted from the steady state slope of the voltage versus temperature difference. Across both molecular weights, the LiTFSI-PEO systems produced higher Seebeck coefficients than the NaTFSI-PEO system. These results suggests that cation identity and ion-PEO coordination dominate the thermoelectric response in these symmetric cells.



## Hussaini Nuhu

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**Research Interests:** Monoclonal antibodies interaction at hydrophobic interface, protein-protein interactions, solution state NMR, differential scanning calorimetry, circular dichroism

**Advisor:** Hadi Mohammadigoushki, Ph.D.

**Presentation:** Poster

### Personal Statement

I am from Katsina, Nigeria, and I earned my B.Eng. and M.Sc. in Chemical Engineering from Ahmadu Bello University. Before starting my Ph.D., I worked as a Process/Production Engineer at Dangote Refinery and Petrochemicals, where I saw how small changes in operating conditions can turn into serious quality and reliability issues. That experience still guides how I think about research. Now I am a Ph.D. student studying how monoclonal antibodies behave at hydrophobic interfaces, with the goal of contributing to better formulation and device design that reduces aggregation and particle formation. Outside the lab, I enjoy playing soccer, and I'm a Manchester United fan.

### NMR spectroscopy of protein in emulsion

Understanding how proteins behave at fluid interfaces is key to designing stable emulsion systems in food and pharmaceutical applications. We combined DOSY NMR with CD, DSC, UV-Vis, and microscopy to investigate lysozyme structure and mobility in water and high internal phase emulsions (HIPEs). First, we established a baseline by subjecting lysozyme to mechanical shear to isolate homogenization effects. DOSY showed intact and sheared lysozyme had similar apparent diffusion coefficients, while denatured protein diffused nearly three times faster, consistent with preserved integrity under shear. CD confirmed  $\alpha$ -helical structure and DSC showed a melting temperature of 62 °C. In HIPEs, DOSY reported slower diffusion (ADCs  $\sim 3.5 \times 10^{-11} \text{ m}^2/\text{s}$ ) from interfacial confinement. Protein extracted from HIPEs after freeze-thawing showed solution-like diffusion and retained secondary structure. These results showed that lysozyme forms stable HIPEs that largely preserve native folding while maintaining its structural integrity under interfacial confinement.



## Alwell Nwachukwu

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**Research Interests:** Magnetic Separations

**Advisor:** Hadi Mohammadigoushki, Ph.D.

**Presentation:** Poster

### Personal Statement

My research explores how magnetic fields drive the movement of metal ions through porous media, revealing how differences in magnetic susceptibility shape may transport behavior. By studying both paramagnetic and diamagnetic species, I've gained some insight into how magnetic field gradients can be leveraged to enhance separation processes.

### Magnetophoresis of Metal ions in Porous Media: Effects of Magnetic Susceptibility and Magnetic Field Gradients

Magnetophoresis is the transport of magnetic solutes through a fluid under the influence of a non-uniform magnetic field. This technique provides a straightforward and efficient mechanism for solutes transport and is widely used in chemical separation, environmental cleanup, and biotechnology applications. This work examines the magnetophoretic transport of metal ions with different magnetic susceptibility. Specifically, paramagnetic ions ( $\text{MnSO}_4$ ,  $\text{NiSO}_4$ ,  $\text{CoSO}_4$ ) and diamagnetic ions ( $\text{LiSO}_4$ ), as they migrate through a silica based porous medium under the influence of a magnetic field gradient. Under an applied field, paramagnetic ions migrate toward with stronger field regions, while diamagnetic ions migrate away. Experiments show that ions with higher magnetic susceptibility have greater enrichment in strong field zones, while diamagnetic ions deplete in those areas. Furthermore, increasing the magnetic field gradient further enhances these effects by strengthening the magnetic force driving ion migration.

### Selected Publications and Presentations

Chie, K., et al. "Magnetic separation of metal ions." *The Journal of Physical Chemistry B* 107.51 (2003): 14374-14377.

Franczak, Agnieszka, Koen Binnemans,; Jan Fransaer. "Magnetomigration of rare-earth ions in inhomogeneous magnetic fields." *Physical Chemistry Chemical Physics* 18.39 (2016): 27342-27350.



## Cletus Obi

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**Research Interests:** Nanodiscs for drug delivery and membrane protein NMR study. Amphiphatic biopolymer synthesis, Nonionic biopolymer, Nanodisc characterization by solid-state NMR.

**Advisor:** Ayyalusamy Ramamoorthy, Ph.D.

**Presentation:** Poster



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**Research Interests:** Magnetic-driven separation, magnetophoretic ion transport, magnetic susceptibility effects, multiphysics transport in batch and flow systems, and sustainable recycling processes

**Advisor:** Hadi Mohammadigoushki, Ph.D.

**Presentation:** Poster

### Personal Statement

I grew up in the vibrant commercial town of Nnewi, Anambra State, Nigeria, and earned my B.Eng. in Chemical Engineering from the Federal University of Technology, Owerri. I am currently a second-year graduate student in Ramamoorthy's research group at Florida State University. Beyond my research, I serve as the FSU liaison for the Chemical and Biomedical Graduate Student Association (CBEGSA). Outside the lab, I enjoy playing and watching soccer, spending time with friends, and exploring new ideas and skills.

### Saponin Nanodiscs for NMR studies, membrane protein reconstitution, and future drug delivery applications

Lipid nanodiscs are useful tools for drug delivery and membrane protein research because they are biocompatible, flexible, and closely mimic natural lipid bilayers. Saponin-formed nanodiscs stand out among others because they are natural, detergent-free amphiphiles that can form nanodiscs suitable for NMR studies. In this talk, we examine how crude and purified saponins, when mixed with DMPC, facilitate lipid dissolution, form nanodiscs, and achieve magnetic alignment. Since anionic lipids are common in biological membranes, we also studied how saponin-based nanodiscs with both zwitterionic and anionic lipids form, stay stable, and align magnetically. We tested binary and ternary mixtures of pure saponins and crude Quillaja saponins (CQS) with DMPC and the anionic lipid DMPG using optical transmittance and temperature-dependent  $^{31}\text{P}$  solid-state NMR. These results demonstrate that natural saponins are effective, tunable alternatives to synthetic polymers or membrane scaffold proteins for nanodisc formation in membrane protein studies and advanced drug delivery applications.

### Selected Publications and Presentations

McCalpin, S. D.; Ravula, T.; Ramamoorthy, A. Saponins Form Nonionic Lipid Nanodiscs for Protein Structural Studies by Nuclear Magnetic Resonance Spectroscopy. *J Phys Chem Lett* 2022, 13 (7), 1705–1712. <https://doi.org/10.1021/acs.jpcllett.1c04185>.

McCalpin, S. D.; Kassinger, K.; Gilmore, M.; Ramamoorthy, A. Characterization of Lipid Solubilization, Bicelle Formation, and Magnetic-Alignment Induced by Saponins. *J Colloid Interface Sci* 2025, 702 (Pt 2), 139008. <https://doi.org/10.1016/j.jcis.2025.139008>.

### Personal Statement

I grew up in Lagos state in my home country Nigeria. I earned my B.S. in chemical engineering from the Federal University of Technology Owerri in 2023. I am currently a 2nd year graduate student in the Rare Earth Initiative (REI) group under the supervision of Dr Hadi Mohammadigoushki. In addition to research, I have a background in Data analytics with professional and teaching experience. Outside of work, I enjoy listening to music, cooking and trying out adventurous activities.

### Magnetically Assisted Separation of Critical Metals from Spent Lithium-Ion Batteries

Variations in magnetic susceptibility among lithium-ion battery (LIB) metal ions offer a path for physics-based separation, bypassing reagent-intensive chemical methods. This research investigates the magnetically assisted separation of  $\text{Li}^+$ ,  $\text{Ni}^{2+}$ ,  $\text{Co}^{2+}$ , and  $\text{Mn}^{2+}$  ions from aqueous mixtures using non-uniform magnetic fields. While paramagnetic ions experience magnetophoretic forces proportional to their susceptibility and field gradients, diamagnetic lithium responds oppositely, enabling differential transport.

In this study, I will present a preliminary experimental design for ion migration in batch and flow systems. Results indicate that while paramagnetic ions are moderately captured by a magnetic mesh, diamagnetic ions remain unaffected. Ongoing work utilizes magnetic meshes to amplify field gradients and enhance magnetophoretic attraction/repulsion.

The ultimate goal is a scalable, low-waste recovery framework guided by transport physics.



## Ononiwu Maureen Chiamaka

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**Research Interests:** Molecular simulations of vitrimer polymer network investigating behaviour in solvent

**Advisor:** Joshua Mysona, Ph.D.

**Presentation:** Poster

### Personal Statement

Ononiwu Maureen is a second-year Ph.D. candidate in the Mysona Research Group at the FAMU-FSU College of Engineering. Her research leverages molecular simulations to investigate the fundamental behavior of vitrimers, a novel class of polymers that combine the processability of thermoplastics with the durability of thermosets. Driven by a passion for innovation, Maureen aims to transition into industrial R&D following her graduate studies, where she intends to apply computational insights to develop next-generation materials.

### Swelling behaviour of vitrimers

Vitrimers are a new class of polymers, merging the mechanical robustness of thermosets with the recyclability of thermoplastics through the mechanism of dynamic bond exchange. While an ideal polymer network assumes a fully connected architecture, in the real world, networks have defects such as dangling chains and loops. These defects fundamentally alter the network's mechanical properties and chemical resistance, in turn altering swelling behavior of these materials.

Current theories of network swelling behavior primarily describe static networks, and do not account for the formation of defects due to osmotic pressure driven bond exchange in dynamic covalent systems such as vitrimers. This research utilizes molecular simulations to investigate the formation and evolution of these structural imperfections within vitrimers, with a focus on loop defects. By quantitatively predicting the formation of loops, this work aims to refine and extend classical polymer theories to accurately reflect the behavior of non-ideal, dynamic networks.



## Samuel Pagan

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**Research Interests:** Cellular mechanosensing, cytoskeletal organization, focal adhesion dynamics, and quantitative fluorescence microscopy (polarized excitation and FRET-based force sensing)

**Advisor:** Tristan Driscoll, Ph.D.

**Presentation:** Poster

### Personal Statement

I grew up in Orlando, Florida moving to Tallahassee to earn my bachelor's degree in biomedical engineering at FSU, graduating in 2019. I then went on to graduate school where I am currently a second-year Ph.D. student in Biomedical Engineering in the Driscoll lab studying how cells sense and respond to mechanical cues through the actin cytoskeleton and focal adhesions.

### Actin Branching Regulates Adhesion Molecular Orientations Quantified by Polarized Excitation Microscopy

Actin branching is regulated by the Arp2/3 complex and plays a critical role in cellular spreading, protrusion, and migration. Recently, our group has shown that this branching can also regulate the distribution of molecular forces on individual focal adhesion proteins, with implications for cellular sensing of mechanical signals. Here, we combine polarized excitation microscopy with focal adhesion imaging to quantify changes in focal adhesion molecular orientations after perturbation of actin branching. We observe that pharmacologic inhibition of Arp2/3 to reduce actin branching results in more aligned actin (indicated by the polarization amplitude) as well as actin alignment that is more strongly correlated with the long axis of the focal adhesion (indicated by the orientation of actin filaments relative to the adhesion). These results help to explain how decreased actin branching can reduce force per talin molecule in the adhesion, without significant perturbations to cellular-level traction stresses.

### Selected Publications and Presentations

Villalobos, C., Sadeghifar, A., Maggiorani, J., McDaniel, G., & Driscoll, T. P. (2025). Actin Branching Regulates Cell Spreading and Force on Talin, but not Activation of YAP. Cellular and Molecular Bioengineering, 12. DOI: <https://doi.org/10.1007/s12195-025-00852-3>.



## Dayna Richter

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**Research Interests:** Brain sodium homeostasis and ion transport, cerebrospinal fluid (CSF) dynamics, multinuclear MRI (including  $^{23}\text{Na}$  and  $^{31}\text{P}$ ), MRI methods development

**Advisor:** Yan Li, Ph.D. and Ayyalusamy Ramamoorthy, Ph.D.

**Presentation:** Poster

### Personal Statement

I am from East London, South Africa and moved to Florida in high school. I earned my B.S. in Chemical Engineering at FSU and continued for my Ph.D. My extracurricular involvement has included: organizing financial literacy and career development workshops for graduate students and postdocs at the MagLab and participating in STEM community outreach. I enjoy taking walks in nature, crafting, and going to concerts and theme parks.

## Imaging Sodium and CSF Dynamic Coupling in a Female Preclinical Model of Migraine

Regulation of brain ionic sodium ( $\text{Na}^+$ ) is essential for neuronal function and fluid homeostasis, but its in vivo dynamics remain unclear. Altered  $\text{Na}^+$  handling at the blood-CSF interface, including the choroid plexus (CP), may contribute to migraine. Here, quantitative  $^{23}\text{Na}$  and slow-flow phase-contrast MRI measured time-dependent changes in brain and CSF  $\text{Na}^+$  and flow in a female nitroglycerin (NTG) migraine model with and without prophylactic ouabain. Repeated  $^{23}\text{Na}$  MRI showed transient, region-specific  $\text{Na}^+$  increases after NTG, greatest in the third ventricle, cisterna magna, and cerebellum within 1.5 hours. Unlike prior male studies, females did not show sustained widespread increases, possibly due to uncontrolled estrous stage. NTG+ouabain produced significant  $\text{Na}^+$  increases in ventricular and hindbrain regions. At low doses, ouabain may modulate CP  $\text{Na}^+$  transport rather than inhibit neuronal pumps. Findings suggest altered CSF-coupled  $\text{Na}^+$  handling, with CSF flow data enabling further coupling analysis.

### Selected Publications and Presentations

Richter, D. L.; Radovich, J.; Blan, C.; Roy, A.; Elumalai, M.; Grant, S. C. Measuring Slow Cerebrospinal Fluid Velocities in Preclinical Models Using Optimized Phase Contrast MRI at 21.1 T. South Eastern Magnetic Resonance Conference (SEMRC), Gainesville, FL, 2025; Oral Presentation.

Richter, D. L.; Holder, S. W.; Grant, S. C.  $^{23}\text{Na}$  MRI at 21.1 T Reveals the Impact of Estrogen Deprivation in Preclinical Migraine. International Society for Magnetic Resonance in Medicine (ISMRM) Annual Meeting, Toronto, Canada, 2023; Poster Presentation.



## Anamika Roy

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**Research Interests:** Stem cell culture, neuro-degenerative diseases, in vivo MRI, regenerative medicine, drug delivery, secretome properties of stem cells

**Advisor:** Yan Li, Ph.D. and Tristan Driscoll, Ph.D.

**Presentation:** Poster

### Personal Statement

I am from Bangladesh. I earned a B.S. and a non-thesis M.S. in chemical engineering from Bangladesh University of Engineering and Technology in industrial safety. But I always wanted to work with regenerative medicine. Finally, the opportunity came when Florida State University accepted me as a graduate student in fall 2021. Currently, I am a 5th year graduate student in the group of both Yan Li & Tristan Driscoll working with stem cell therapy in ischemic stroke and Alzheimer disease. In addition to research, I am also a teaching assistant and enjoy teaching students.

## Preconditioning the Mesenchymal Stromal Cells with Forebrain Organoid Conditioned Media to Observe Preconditioning Effect on Extracellular Vesicle Biogenesis

Forebrain organoids generated from induced pluripotent stem cell-derived neural progenitors (iNPC) and mesenchymal stromal cells (MSC) secrete therapeutic factors for neurodegenerative disease. Conditioning MSCs with forebrain organoid-derived media may enhance the potency of MSC-derived extracellular vesicles (EV). This study examines how organoid-conditioned media influences bone marrow MSC behavior and whether aggregate culture improves EV yield and function. MSCs were cultured as dynamic aggregates and exposed to organoid-conditioned media at day 2 to generate iNPC-influenced EVs. EVs were isolated via the PEG precipitation method and characterized by nanoparticle tracking, proteomics, and lipidomic analysis. Aggregate viability and size were assessed, and EV function was tested through macrophage polarization during LPS/IFN- $\gamma$ -induced M1 activation and oxygen-glucose deprivation modeling ischemic injury. These findings clarify how organoid cues and aggregate culture shape EV yield and immunomodulatory potential, informing strategies for more potent EV-based therapies.

### Selected Publications and Presentations

Roy, A.; Driscoll, T.; Grant, S. C.; Li, Y. Human stem cell-derived extracellular vesicles: A pioneering path from biogenesis to cerebral ischemic stroke therapy. *Int. J. Mol. Sci.* 2025, 26 (21), 10550.

Roy, A.; Bhagu, J.; Richter, D.; Grant, S. C. Differences in super paramagnetic iron oxide labeling of adipose and bone marrow derived mesenchymal stem cells for MRI cell tracking. Poster presented at Biomedical Engineering Society (BMES) Annual Meeting, Baltimore, MD, 2024.



## Falak Syed

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**Research Interests:** Extracellular vesicle (EV) therapeutics and induced pluripotent stem cell (iPSC)-derived neural organoids, particularly on their assembly, disease modeling, and EV production

**Advisor:** Yan Li, Ph.D.

**Presentation:** Poster



## Nazifa Tasnim Ahmad

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**Research Interests:** Protein misfolding and aggregation, amyloid assembly pathways, lipid-protein and metal-protein interactions, protein cross-interaction, biophysical characterization techniques

**Advisor:** Ayyalusamy Ramamoorthy, Ph.D.

**Presentation:** Poster

### Personal Statement

I earned a B.S. and M.S. in biomedical engineering in 2021 and 2023 respectively, from the University of Florida. From there I went on to join the biomedical engineering Ph.D. program at Florida State University, where I am currently a third year student in Dr. Yan Li's group.

## Investigating Fibroblast Activation Protein (FAP)-Targeted Chimeric Antigen Receptor Neutrophil-Derived Extracellular Vesicles for Modulating the Tumor Microenvironment

Extracellular vesicles (EVs) derived from chimeric antigen receptor (CAR) neutrophils retain the receptors and targeting ability of their parent cells while being less invasive. Cancer associated fibroblasts have been shown to have a significant presence in the glioblastoma tumor (~12% of cells on average) and a protumoral effect on its microenvironment (Jain et al. 2023); therefore using fibroblast activated protein (FAP) CAR neutrophil derived EVs presents a promising therapeutic approach.

U87 glioma cells were co-cultured with either normal fibroblasts (3T3) or tumor-associated fibroblasts (TAFs), treated with FAP CAR EVs and wild-type neutrophil EVs over the course of the co-culture, and assessed using MTT and LDH assays. After two weeks, U87 cells co-cultured with 10% 3T3 fibroblasts showed no significant response to FAP CAR EV treatment, whereas one week of co-culture with 10% TAFs produced significant metabolic changes. Ongoing studies include EV uptake imaging, metabolic gene expression analysis by RT-qPCR, and increasing TAF abundance to determine treatment responses.

### Selected Publications and Presentations

Ene, J.; Muok, L.; Gonzalez, V.; Sanchez, N.; Nathani, A.; Syed, F.; Liu, Z. L.; Singh, M.; Driscoll, T.; Li, Y. Biomanufacturing and curcumin-loading of human choroid plexus organoid-derived extracellular vesicles from a vertical-wheel bioreactor to alleviate neuro-inflammation. *Biomedicines* 2025, 13 (5), 1069 DOI: 10.3390/biomedicines13051069.

Ene, J.; Syed, F.; Ma, S.; Ma, S.; Joshi, S.; Li, Y. Extracellular vesicle production from human blood vessel organoids in a vertical wheel bioreactor. *Methods in Molecular Biology* 2025 DOI: 10.1007/7651\_2025\_661.

Liu, C.; Ene, J.; Lu, W.; Syed, F.; Sun, L.; Raulin, A.; Ren, Y.; Wang, X.; Kanekiyo, T.; Li, Y. Immuno-regulation of brain region-specific organoids containing isogenic microglia-like cells. *Advanced Healthcare Materials* 2025 DOI: 10.1002/adhm.202503579.

### Personal Statement

I have lived most of my life in Dhaka, the very crowded capital city of Bangladesh. I've always been fascinated by biology and how the human body works, especially how such small processes can shape such large outcomes. I earned my bachelor's in biomedical engineering from Bangladesh University of Engineering and Technology. Currently, I am a 3rd year graduate student in Rams Lab pursuing PhD in Biomedical Engineering. I enjoy learning with others and mentoring young students who are just beginning their journey. In my free time, I often unwind by painting, reading and cooking

## Cofactor-Mediated Modulation of Insulin Amyloid Aggregation and Toxicity in Context of Amyloidogenic Diseases

Insulin amyloid aggregation is a major clinical concern in Type 2 Diabetes (T2D), where amyloid deposits can reduce insulin's therapeutic efficacy and cause cytotoxicity. Insulin aggregation is regulated by the biochemical environment, including lipids, metals, and interactions with other amyloid proteins, which redirect aggregation pathways and generate structurally distinct polymorphs with varying toxicity. Study of ganglioside lipids GD3 and GM3 reveals that they alter the insulin amyloid pathway through electrostatic interactions that favor off-pathway aggregation and reduce toxicity. Analysis of metal-mediated aggregation studies show  $Al^{3+}$  coordination chemistry can modulate aggregation pathway and toxicity. Crosstalk between insulin and amyloid  $\beta$ , and its implications for T2D and Alzheimer's disease, are examined. Aggregation kinetics, structure, and cytotoxicity are assessed using fluorescence, spectroscopy, microscopy, NMR, and cellular assays. These studies show how biochemical cofactors alter insulin aggregation pathways and toxicity in amyloidogenic disease contexts.

### Selected Publications and Presentations

Ahmad, N. T.; Saha, J.; Mao, Y.; Silvers, R.; Abulaban, Z.; Mysona, Josh.; Ramamoorthy, A. "Ganglioside Lipids Modulate Insulin Amyloid Aggregation Pathways and Reduce Cytotoxicity Through Structural Remodeling" Poster Presentation at the 53rd Southeastern Magnetic Resonance Conference (SEMRC), Gainesville, FL, 2025.

Ahmad, N.T., Saha, J., Ramamoorthy, A. "Effects of Gangliosides on Amyloid Aggregation of Insulin". 6th International Symposium on Pathomechanisms of Amyloid Diseases, Tallahassee, FL, 2024.



## Rukiye Tuna

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**Research Interests:** My research focuses on cellular biomechanics, mechanotransduction, and targeted drug delivery, with emphasis on pathological hemodynamic forces

**Advisor:** Leo Liu, Ph.D.

**Presentation:** Poster

### Personal Statement

I am a Ph.D. student in the Department of Chemical and Biomedical Engineering at the FAMU-FSU College of Engineering. I earned my M.S. in Mechanical Engineering from the University of Massachusetts Lowell and gained five years of industry experience before pursuing my doctoral studies. In 2023, she joined the Liu lab in the Department of Chemical and Biomedical Engineering, where my research focuses on rheo-biology—the study of how the rheological properties of blood influence cellular and molecular mechanobiology.

## Flow-Activated Drug Release from Red Blood Cell Carriers in Arterial Stenosis

Red blood cells (RBCs) hold exceptional promise as innovative drug carriers, offering unique advantages due to their natural abundance, biocompatibility, and prolonged circulation time in the bloodstream. Designed by nature to efficiently transport oxygen throughout the body, RBCs provide an ideal, non-immunogenic vehicle for therapeutic delivery. Recently, cellular hitchhiking, in which nanoparticles are attached to the surface of RBCs, has shown promising results for first-pass delivery to target organs. Another approach involves loading therapeutic agents directly into RBCs. Recently, transient pore formation during membrane stretching in constricted microchannels has been exploited to load therapeutic agents into RBCs and other cell types. However, mechanical disruption of cells, particularly RBCs, has not been explored to trigger drug release at disease sites. Here, we study the drug-release mechanism by which RBC carriers deliver their cargo to stenotic arteries via transient pore opening in their membranes, induced by hemodynamic forces at these sites.

### Selected Publications and Presentations

Tuna, R., Amar, D.N., Mekler, T., Korin, N., Liu, Z. L. "Flow-Activated Drug Release from Red Blood Cell Carriers in Arterial Stenosis". Presented at the Biomedical Engineering Society Annual Meeting, San Diego, CA, 2025.

Tuna, R., Amar, D.N., Mekler, T., Korin, N., Liu, Z. L. "Flow-Activated Drug Release from Red Blood Cell Carriers in Arterial Stenosis". Presented at the 10th International Biofluid Mechanics and Mechanobiology Symposium, Irvine, CA, 2025.



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**Research Interests:** Targeted drug delivery using biohybrid micromotors, magnetic control, microfluidic platforms, and therapeutic treatment in cancer-relevant 2D and 3D models

**Advisor:** Jamel Ali, Ph.D.

**Presentation:** Poster

### Personal Statement

I grew up in a northern city in China and earned a B.S. in Chemical Engineering from China University of Petroleum. In 2019, I came to Florida State University as a transfer student and continued my studies, earning an M.S. in Chemical Engineering in 2022. I am currently a fourth-year Ph.D. student in biomedical engineering in Dr. Jamel Ali's group. My research focuses on erythrocyte-based biohybrid micromotors for targeted drug delivery and cancer therapy. Outside the lab, I enjoy spending time with my dog, playing badminton, and pickleball.

## Erythrocyte-Based Achiral Micromotors for Localized Therapeutic Delivery

Micromotors are microscopic devices that convert local energy into directed propulsion, with applications in drug delivery, diagnostics, and biosensing. Biohybrid micromotors improve biocompatibility by combining synthetic particles with biological components. Erythrocytes (RBCs) are ideal drug carriers due to their deformability, long circulation time, and high drug-loading capacity. Here, we present a simple method to fabricate RBC micromotors using biotin-streptavidin interactions. These micromotors are driven by a single rotating magnetic field, exhibiting both swimming and rolling motions. Drug loading and navigation through microfluidic channels are demonstrated. Single-, two-, and three-cell micromotors were fabricated to enhance propulsion efficiency, with the three-cell configuration performing best. The micromotors are hemocompatible, biocompatible, and effectively deliver doxorubicin for targeted cancer treatment.

### Selected Publications and Presentations

Wang, Q.; Katuri, J.; Dridi, N.; Ali, J. Erythrocyte-based achiral micromotors for localized therapeutic delivery. *J. Biol. Eng.* 2025, 19, 64. DOI: 10.1186/s13036-025-00537-5.

Wang, Q.; Jermyn, S.; Quashie, D.; Gatti, S. E.; Katuri, J.; Ali, J. Magnetically actuated swimming and rolling erythrocyte-based biohybrid micromotors. *RSC Adv.* 2023, 13, 30951–30958. DOI: 10.1039/D3RA05844A.



## Mohd Bilal Khan

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**Research Interests:** My research focuses on High Gradient Magnetic Separation, studying magnetic-hydrodynamic interactions to optimize capture of weak magnetic particles for efficient separations

**Advisor:** Hadi Mohammadigoushki, Ph.D., Jamel Ali, Ph.D., Theo Siegrist, Ph.D. and Munir Humayun, Ph.D.

**Presentation:** Poster

### Personal Statement

I have always been interested in how fundamental physical principles can be applied to solve practical engineering problems. This interest led me to work on High Gradient Magnetic Separation (HGMS), where I study how magnetic fields, fluid flow, and particle properties interact to influence separation performance. My research focuses on improving the capture of weakly magnetic and fine particles through a mix of theoretical understanding, modeling, and experimental work. I am especially motivated by the potential of HGMS in sustainable resource recovery and environmental remediation, and I hope to continue developing practical, efficient separation technologies through advanced research and training.

## Magnetophoresis of Weakly Magnetic Nanoparticle Suspension Around a Wire

We present a combined experimental and numerical study of magnetophoresis in weakly magnetic nanoparticle suspensions near a wire under a non-uniform magnetic field and negligible inertia. Experiments were conducted in a closed rectangular cuvette with a wire placed between electromagnet poles. Paramagnetic manganese oxide and diamagnetic bismuth oxide nanoparticles were examined over concentrations of 10–100 mg/L, magnetic fields of 0.25–1 T, and wire diameters of 0.8–3.17 mm. Paramagnetic nanoparticles are strongly attracted toward the wire, generating vortices and secondary flows that deplete particles from the bulk and concentrate them near the wire surface. Their magnetophoretic behavior scales with particle concentration, wire diameter, and magnetic field strength. In contrast, diamagnetic nanoparticles show weak dependence on concentration and field strength, with dynamics mainly governed by wire diameter. Numerical simulations support the experiments and reveal field-induced clustering of paramagnetic nanoparticles.

### Selected Publications and Presentations

Khan, M. B.; Rassolov, P.; Ali, J.; Siegrist, T.; Humayun, M. Magnetophoresis of weakly magnetic nanoparticle suspension around a wire. *Journal of Chemical Physics*, 163 (2), 024903-14. <https://doi.org/10.1063/5.0269000>.



## Kyoungmin Kim

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**Research Interests:** Polymer science, polymer processing, membranes

**Advisor:** Daniel Hallinan Jr., Ph.D.

**Presentation:** Poster

### Personal Statement

My research interests focus on the engineering polymer systems across multiple scales, from molecular-level design to scalable processing, for energy and environmental applications. With extensive experience in polymer melt processing, film manufacturing, polymer synthesis, and spectroscopic characterization, I have conducted research on polymer membranes for ion transport. Through my postdoctoral experience, I aim to broaden my research scope to the preparation, processing, and application of functionalized polymer membranes tailored for advanced electrochemical systems and selective separation for resource sustainability.

## Non-Fluorinated Precision Polymer Cation-Exchange Membrane

In this study, the influence of ionic interactions between the functional groups of a sulfonated polymer membrane and cations (Li<sup>+</sup>, Na<sup>+</sup>, K<sup>+</sup>, Mg<sup>2+</sup>, and Ca<sup>2+</sup>) on ion transport was investigated using a non-fluorinated precision polymer. A novel polymer with phenyl pendant at every fifth backbone carbons was synthesized, and the degree of sulfonation was accurately controlled via “soft sulfonation method”. Correlations between ionic interaction, water uptake, and ion transport properties were studied using Fourier transform infrared spectroscopy (FTIR), electrochemical impedance spectroscopy (EIS), gravimetric analysis, and permeation cell measurements. Higher water uptake was observed from monovalent cations and was found to enhance ion transport, while the stronger ionic interactions of divalent cations enhanced the dimensional stability of membranes. The findings highlight the potential of ionic crosslinking to broaden the engineering scope for tuning IEC for further optimization of mechanical durability and ionic mobility.

### Selected Publications and Presentations

Kim, K. and Hallinan Jr, D.T., 2020. Lithium salt diffusion in diblock copolymer electrolyte using Fourier transform infrared spectroscopy. *The Journal of Physical Chemistry B*, 124(10), pp.2040-2047.

Kim, K., Kuhn, L., Alabugin, I.V. and Hallinan Jr, D.T., 2020. Lithium salt dissociation in diblock copolymer electrolyte using fourier transform infrared spectroscopy. *Frontiers in Energy Research*, 8, p.569442.

Kim, K., Nguyen, N., Marxsen, S.F., Smith, S., Alamo, R.G., Kennemur, J.G. and Hallinan Jr, D.T., 2021. Ionic transport and thermodynamic interaction in precision polymer blend electrolytes for lithium batteries. *Macromolecular Chemistry and Physics*, 222(22), p.2100269.



## Radha Krishna Murthy Bulusu

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**Research Interests:** Nonthermal plasma, PFAS degradation, electron density, electron temperature, Reactor efficiency

**Advisor:** Bruce Locke, Ph.D.

**Presentation:** Poster

### Personal Statement

My current research is using nonthermal plasma to study the degradation of forever chemicals. I plan to expand my research into using nonthermal plasma to extract rare earth metals and degradation of microplastics.

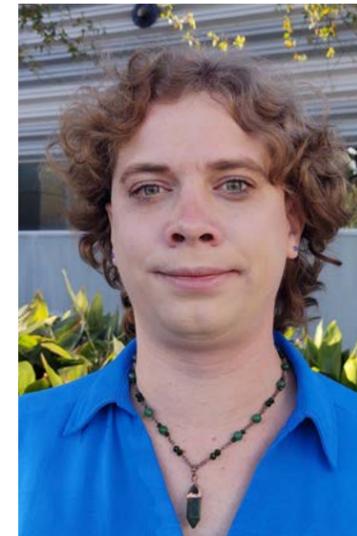
## Defluorination of Perfluorooctanoic Acid (PFOA) Using Uniform Pulsing and Burst Mode of Pulse Delivery Methods in a Gas-Liquid Flowing Film Reactor

In this study, a continuous gas-liquid film reactor with argon as carrier gas along with a custom-made power supply manufactured by Airity Technologies (Palo Alto, CA) were utilized. Burst mode, i.e., a train of high-frequency pulses with relaxation time, was used to generate nonthermal plasma. The F<sub>2</sub> production from PFOA was examined as a function of burst parameters i.e., a) variation of the time between bursts of pulses (burst period), b) internal frequency (time between the pulses in the burst), and c) variation of number of pulses in a burst (N-cycles). F<sub>2</sub> production varied between 7.34 – 13.98 nmol/s when the burst period was varied between 0.1 ms – 1 ms, 7.34 – 6.41 nmol/s internal frequency was varied between 100 kHz – 1 MHz, and 2.95 – 8.14 nmol/s the N-cycles were varied between 1 – 20. F<sub>2</sub> production rate was then correlated to the plasma properties i.e., electron density using Stark broadening of H<sub>α</sub> at 656.28 nm and electron temperature using line intensity ratio of Balmer-H lines varying in a single burst using time resolved optical emission spectroscopy.

### Selected Publications and Presentations

Bulusu, R. K.; Wandell, R. J.; Zhang, Z.; Farahani, M.; Tang, Y.; Locke, B. R. Degradation of PFOA with a Nanosecond-Pulsed Plasma Gas-Liquid Flowing Film Reactor. *Plasma Processes Polym.* 2020, 17 (8), 2000074. <https://doi.org/10.1002/ppap.202000074>.

Bulusu, R. K. M.; Yatom, S.; Patterson, C. W.; Wandell, R. J.; Locke, B. R. Effects of Frequency and Pulse Width on Electron Density, Hydrogen Peroxide Generation, and Perfluorooctanoic Acid Mineralization in a Nanosecond Pulsed Discharge Gas-Liquid Plasma Reactor. *J. Vac. Sci. Technol. A* 2022, 40 (6), 063001. <https://doi.org/10.1116/6.0001889>.



## Natalia Rassolov

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**Research Interests:** Magnetic fields, multiphysics modeling, rheology, renewable energy, critical minerals, multidisciplinary engineering

**Advisors:** Hadi Mohammadigoushki, Ph.D., Jamel Ali, Ph.D., Theo Siegrist, Ph.D. and Munir Humayun, Ph.D.

**Presentation:** Poster

### Personal Statement

As an engineering researcher who has worked on teams with people of various professional backgrounds, I've identified a critical strength in synthesizing knowledge from different sciences and engineering disciplines to solve the complex technical problems of the near future. During my undergraduate studies, I contributed chemical engineering knowledge to a multidisciplinary team developing systems simulation software. In my graduate studies, I improved the rheo-optical apparatus that was central to my research, balancing research needs with manufacturability and operability. In my current role, I synthesize experiments with numerical simulations to study the magnetic transport of non-ferromagnetic materials under high gradient magnetic fields.

## Magnetophoresis of paramagnetic nanoparticles under a high-gradient magnetic field

Magnetophoresis, or the transport of materials driven by differences in magnetization under nonuniform magnetic fields, presents a promising mechanism for chemical separations. While the magnetophoresis of ferromagnetic and superparamagnetic colloidal particles has been extensively studied, the magnetophoresis of paramagnetic and diamagnetic materials is still poorly understood. We study the magnetophoresis of paramagnetic manganese oxide nanoparticles using experiments and multiphysics simulations. The experiments show that the manganese oxide particles undergo magnetophoresis, leading to depletion at a rate that strongly depends on the magnetic field gradient. Unlike a previous study of the magnetophoresis of iron oxide particles [Leong et al., 2015, *Soft Matter*], observable concentration gradients emerge during the depletion of particles. We hypothesize that this discrepancy is due to the relatively low magnetic Grashof number ( $1 < Gr_m < 10$ ) of the weakly paramagnetic particles compared to the much greater  $Gr_m (> 1000)$  of the superparamagnetic particles in the previous study.

### Selected Publications and Presentations

Rassolov, P.; Ali, J.; Siegrist, T.; Humayun, M.; Mohammadigoushki, H. Magnetophoresis of paramagnetic nanoparticles in suspensions under magnetic field gradients. *Physical Review Fluids* 2025, 10 (7), 073701. DOI: <https://doi.org/10.1103/vm4j-73p6>.



## Pia Dinamarca

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**Research Interests:** Thermogalvanic cells, Solid polymer electrolytes batteries, Sodium-ion batteries, Waste heat recovery systems, Thermal–electrochemical transport phenomena

**Advisor:** Daniel Hallinan Jr., Ph.D.

**Presentation:** Poster

### Personal Statement

I was born and raised in Santiago, Chile, and moved to the United States to pursue my bachelor's degree in Chemical Engineering. I am currently a senior undergraduate student working as an undergraduate researcher at the Aero-Propulsion Mechatronics Facility in the PAES Lab (Polymers for Advanced Energy and Sustainability). In addition to my research, I serve as the Director of Corporate Relations for the Society of Hispanic Professional Engineers and work in the administrative department at Florida State University Information Technology Services.

### Thermal Gradient Infrared Spectroscopy of Polymer Electrolytes for Sodium Batteries

Fourier Transform infrared – attenuated total reflectance (FTIR-ATR) spectroscopy was used to measure salt diffusion in solid polymer electrolytes for sodium batteries. The polymer electrolyte was poly(ethylene oxide) (PEO) mixed with sodium bis-trifluoromethanesulfonylimide (NaTFSI) salt. This approach presents an induced temperature gradient to observe thermally driven mass diffusion (via the Soret Effect). The system is then returned to isothermal state to measure Fickian Diffusion. Concentration changes due to mass diffusion driven by temperature and salt concentration gradients are tracked using FTIR-ATR absorbance that is related to concentration through the Beer-Lambert Law. This study covered one molar ratio and three different temperature gradients 10 C, 15 C, 20 C. Even though lithium provides higher energy density, costs are higher and availability is limited, making sodium a proposed alternative. This technique provides a systematic framework to investigate the potential of sodium in both batteries and thermogalvanic cells for waste heat recovery.



## Erica Hamel

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**Research Interests:** Microparticle/nanoparticle design, therapies for Alzheimer's disease, polymer science, targeted drug delivery and release

**Advisor:** Jingjiao Guan, Ph.D.

**Presentation:** Poster

### Personal Statement

I grew up in Patterson, NY, which is a small town about an hour north of New York City. I will be graduating in May with a B.S. in Biomedical Engineering with a focus in biomaterials and biopolymers. Currently, I am conducting research developing microparticles under Dr. Jingjiao Guan in his lab. Outside of school and research, I am an event coordinator for FSU CHAARG, which is an all-girls workout club where we try new workouts every single week (which I help plan!). In my free time, I love reading, watching movies, playing card/board games, and dancing.

## Development and Characterization of Microparticles for Understanding Phagosomal Environments During Phagocytosis

Macrophages are immune cells that eliminate pathogens through phagocytosis, in which foreign material is internalized into a membrane-bound phagosome and exposed to dynamic biochemical changes. The phagosomal microenvironment evolves rapidly during this process, including changes in pH that play a vital role in pathogen degradation. However, the ability to simultaneously characterize phagosomal conditions within individual macrophages remains limited, restricting the use of macrophages in immunotherapy and drug delivery research.

In this work, we propose the development of engineered fluorescent microparticles that can be readily engulfed by macrophages and used to probe phagosomal environments during phagocytosis. These particles are designed to report environmental conditions through changes in fluorescence intensity which are proportional to pH. This project aims to enable improved characterization of phagosomal dynamics at the single-cell level, providing new insight into macrophage behavior and supporting their use in therapeutic applications.



## Thomas Lockhart

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**Research Interests:** Dynamic Hydrogels, Polymers, Dynamic Light Scattering, Diffusion Ordered Spectroscopy, Thin film tribology

**Advisor:** Ralm Ricarte, Ph.D.

**Presentation:** Poster

### Personal Statement

Growing up in Hilo, Hawaii, I decided to travel across the country to Florida State University to seek a fresh start and new academic challenges. My research began through the FSU Undergraduate Research Opportunities Program (UROP), where I conducted tribology experiments in Dr. Brandon Krick's lab. As I advanced in my coursework, I sought to align my research more closely with Chemical Engineering. This led me to Dr. Ricarte's Polymer Laboratory, where I am currently completing my Honors in the Major thesis project on dynamic hydrogels.

## Dynamic Light Scattering, Diffusion Ordered Spectroscopy, and Rheology of Poly (vinyl alcohol)-Borax Hydrogels

Hydrogels are hydrophilic networks whose mechanical properties depend on crosslinking chemistry. Poly(vinyl alcohol) (PVA)-borax hydrogels use dynamic covalent crosslinks which are both mechanically strong and reversible. This study used dynamic light scattering (DLS), diffusion ordered spectroscopy (DOSY), and rheology to characterize the microscopic and bulk dynamics of PVA-Borax gels. Borax concentrations were varied to study both above and below the gel point and construct phase diagrams. Linear viscoelasticity was evaluated using small-amplitude oscillatory shear on stable gels. Both DLS and DOSY indicated two decay modes. The fast decay was diffusive, corresponding to individual polymer chains. Below the gel point, the slow mode corresponded to diffusing crosslinked aggregates. Above the gel point, DLS indicated the mode was non-diffusive, while DOSY showed significantly slower diffusion. Temperature sweeps revealed that below the gel point, diffusion of both modes increased with temperature; above it, the slow mode transitioned from non-diffusive to diffusive.



## Brianna McVay

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**Research Interests:** Tissue engineering, regenerative medicine, cell engineering, and biomaterials

**Advisor:** Ayyalusamy Ramamoorthy, Ph.D.

**Presentation:** Poster

### Personal Statement

Brianna McVay is an undergraduate research fellow and Biomedical Engineering B.S. candidate at Florida State University, concentrating in cell and bioprocess engineering. Her research investigates protein aggregation mechanisms in neurodegenerative disease, focusing on amyloid beta 42 and  $\alpha$ -synuclein interactions with lipids and metal ions using cellular, structural, and biophysical approaches to characterize aggregation pathways, intermediate species, and cytotoxicity. Her work has been supported by academic scholarships and institutional support. She plans to pursue a Ph.D. in Biomedical Engineering to contribute to the development and evaluation of late-stage therapeutics, bridging research and clinical application.

## Interactions Between Amyloid beta-42, Iron, and GM1 Gangliosides: Implications for Neurotoxicity

Amyloid beta 42 (A $\beta$ 42) aggregation is a central molecular event in Alzheimer's disease and is strongly influenced by the neural microenvironment. Ferric iron and the ganglioside GM1 are abundant in the brain, colocalize with amyloid deposits, and independently promote A $\beta$  aggregation and neurotoxicity, yet their combined effects remain poorly understood. This study examines how Fe<sup>3+</sup> and GM1 together influence the kinetics, structural evolution, and toxicity of A $\beta$ 42 assemblies.

Monomeric A $\beta$ 42 was recombinantly expressed, purified by high-performance liquid chromatography, and freshly isolated by size-exclusion chromatography prior to analysis. Aggregation kinetics were measured using Thioflavin T fluorescence to resolve lag and growth phases and to identify reproducible timepoints for intermediate formation. Early- and mid-growth-phase aggregates from iron-only and A $\beta$ 42-Fe<sup>3+</sup>-GM1 systems were isolated and characterized by circular dichroism spectroscopy to assess secondary structure and by transmission electron microscopy to visualize aggregate morphology.



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**Research Interests:** Nonthermal plasma, plasma chemistry, plasma physics, nanosecond pulsed discharges, PFOA degradation, optical emission spectroscopy

**Advisors:** Bruce Locke, Ph.D. and Robert Wandell, Ph.D.

**Presentation:** Poster

### Personal Statement

I am a senior at Florida State University majoring in Physics. Currently, I work in the group of Bruce Locke and Robert Wandell studying nonthermal plasma applications to pollutant degradation. I am also involved in FSU's Society for Physics Students and TEDx organizations. Outside of school, I enjoy reading, crocheting, and baking.

## Effect of Burst Mode on Plasma Properties in a Continuous Flowing Gas-Liquid Nonthermal Reactor

Nonthermal plasma in contact with liquid generates highly reactive oxidative and reductive species such as  $\bullet$ OH,  $\bullet$ H, e-aq, H<sub>2</sub>O<sub>2</sub>, H<sub>2</sub> and O<sub>2</sub>. This study investigates the effect of "burst mode" on plasma properties i.e., electron density, electron temperature, and gas temperature in a continuous flowing gas-liquid nonthermal plasma reactor using optical emission spectroscopy. The "burst" parameters varied in this study were (i) N-cycles (number of pulses in a burst) between 1-20 (ii) internal frequency (time between the pulses in a single burst) between 100 kHz - 1 MHz (iii) burst period (time between two consecutive bursts) between 0.1ms-1ms. Stark broadening of H $\alpha$  at 656.3 nm, N2(C-B) band at 337 nm and Boltzmann plot using Ar (I) lines were used to estimate the electron density, gas temperature and electron temperature respectively. The electron density varied between  $1.73 \times 10^{17}$  -  $5.96 \times 10^{15}$  cm<sup>-3</sup>,  $7.10 \times 10^{15}$  -  $7.78 \times 10^{15}$  cm<sup>-3</sup>, and  $1.63 \times 10^{16}$  -  $7.79 \times 10^{15}$  cm<sup>-3</sup> when N-cycles, burst period and internal frequency were varied.

### Selected Publications and Presentations

Mital A.; Locke B.R.; Bulusu R. Effect of burst mode on electron density and temperature in a continuous flowing gas-liquid nonthermal plasma reactor. Presented at the 67th Annual Meeting of the APS Division of Plasma Physics, Long Beach, CA, November 17, 2025.



## Nat Torres

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**Research Interests:** Rheology, Polymer Science, Vitrimers, Covalently Adaptable Networks

**Advisor:** Ralm Ricarte, Ph.D.

**Presentation:** Poster

### Personal Statement

For the past two years, I have conducted research in Dr. Ricarte's polymer laboratory. My first project, which began as my undergraduate honors thesis, focused on exploring vitrimer chemistry as a strategy for improving polymer blend miscibility and resulted in my first first-author publication in *Macromolecules*. My current research centers on analyzing the bulk dynamics of PVA-borax hydrogels using rheological characterization, including small-amplitude oscillatory shear measurements. Next year, I will begin my Ph.D. in chemical engineering with the long-term goal of becoming a professor

## Polydimethylsiloxane/Polybutadiene Vitrimer Blends: Morphology and Rheology

This study utilizes vitrimer chemistry, covalently cross-linked networks undergoing molecular rearrangement, to enhance miscibility in incompatible polymer blends of polydimethylsiloxane (PDMS) and polybutadiene (PB). Using photo-initiated thiol-ene click chemistry, we synthesized blends containing dynamic dioxaborolane cross-links with varying PB weight percent and cross-link density, alongside a permanently cross-linked control. Scanning electron microscopy indicated that cross-link chemistry does not significantly impact droplet size; rather, final morphology is predetermined by the initial solution state. Differential scanning calorimetry revealed that dynamic cross-linking exhibited improved mixing compared to permanent cross-linking. Small angle X-ray scattering identified that some vitrimer blends form cross-link aggregates. Linear viscoelasticity measurements revealed fast and slow relaxation regimes. The fast regime is associated with segmental motions, while the slow regime, independent of blend composition, follows time-temperature and time-composition superposition.

### Selected Publications and Presentations

Torres, N.; Barzycki, D.; Bauer, Z.; Duclos, C.; Ricarte, R. Immiscible Polydimethylsiloxane/Polybutadiene Vitrimer Blends. *Macromolecules* 2025, ASAP Article. DOI: 10.1021/acs.macromol.5c02945.



## Colin Waldie

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**Research Interests:** Magnetic field assisted separations, renewable energy, biomaterials and biodegradable materials

**Advisor:** Hadi Mohammadigoushki, Ph.D.

**Presentation:** Poster

### Personal Statement

I am from Pensacola, FL and I am currently in my last semester as a bachelor's level student in Chemical Engineering at the FAMU-FSU College of Engineering. Outside of research, I have spent a few years as a tour guide for Florida State University, and spent my summers as a Process Engineering Intern at a paper mill with International Paper. I like to spend my free time playing board games with friends, watching FSU athletics, making tea, and homebrewing.

## Modeling Bubble Dynamics under Magnetic Fields

The utilization of water electrolysis as a means of oxygen production in space has been used and improved for decades. However, the functionality of this method has been limited by the formation of gas bubbles without buoyancy forces. One potential solution is the use of magnetic fields and forces. While researchers are replicating microgravity conditions on Earth to better observe a bubble's trajectory when suspended in a liquid under a magnetic field, there is a gap in the literature for a validated numerical model to better understand the dynamics observed in this system. The primary goal of this research project is to develop a validated numerical model of the motion of a bubble suspended in liquid under the effects of a non-homogeneous magnetic field. Laboratory observations will be made to observe the effects of magnetic fields under full gravity conditions. A numerical model will be developed using COMSOL modeling software, and validated against laboratory collected data, providing a consistent mathematical prediction of suspended bubble trajectories under these conditions.



## Amaya Walker

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**Research Interests:** Currently focused on sustainable vitrimers, I aim to apply my material characterization expertise to innovate in cosmetics.

**Advisor:** Ralm Ricarte, Ph.D.

**Presentation:** Poster

### Personal Statement

As a scientist, my perspective is led by adaptability, a principle that has guided me in both my research in polymer chemistry as well as in my commitment to the STEM community. Growing up in a military household, I moved constantly, immersing myself in diverse cultures across the globe. This nomadic upbringing taught me that while traditions and languages may vary, science serves as a universal platform for a collective human effort to modernize our planet through the lens of sustainability. This passion for sustainable advancement led me to my current research on vitrimers, where I explore materials that embody the balance between durability and recyclability.

## Determining the Effects of Associative Crosslinks on Swollen Vitriemer Networks

Polymers are a class of materials commonly used due to their high resistance to deformation; however, they generally lack both strength and malleability. Vitrimers, a novel class of polymers, are an alternative because of their ability to associatively rearrange. This project investigates how dynamic crosslinks in vitriemer gels affect relaxation using various techniques, including dynamic light scattering (DLS) and diffusion ordered spectroscopy (DOSY). While creating vitriemer gels, some samples became turbid, raising the question: what occurs during rearrangement to cause macrophase separation? Dynamic and permanent gels were crafted via click chemistry and characterized in parallel across a range of parameters. The turbid gels were investigated using small-angle X-ray scattering to rule out microphase separation. Using DLS, scattering intensities were autocorrelated, indicating two relaxation modes responsible for (I) large clusters and (II) dimers. DOSY then measured the diffusion coefficients which support the DLS analysis, including that of pure uncrosslinked PDMS in toluene.



## Dana Wolfe

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**Research Interests:** Drug delivery systems, regenerative medicine, molecular and cellular engineering, engineering education

**Advisor:** Ayyalusamy Ramamoorthy, Ph.D.

**Presentation:** Poster

### Personal Statement

I am a biomedical engineering student at Florida State University specializing in cell & bioprocess engineering. My passion lies in understanding how cellular microenvironments contribute to early disease and how engineered systems might redirect those pathways. I pursue this through research at the National High Magnetic Field Laboratory, where I study amyloidogenic processes for therapeutic development in disease. I have experience in microscopy (TEM), spectroscopy (NMR, FTIR, CD), fluorescence assays, cell culture, and computational modeling, developed in both research and educational settings. Outside the lab, I'm committed to STEM education. I lead hands-on science programming at the Challenger Learning Center and serve as the departmental BMES tutoring coordinator.

## Dual Role of Copper Ions in Insulin-IAPP Interactions and $\beta$ -Cell Dysfunction in Type 2 Diabetes

Type 2 Diabetes (T2D) is a progressive metabolic disorder characterized by pancreatic  $\beta$ -cell dysfunction and insulin resistance. Islet amyloid deposits composed of islet amyloid polypeptide (IAPP) fibrils contribute to T2D pathogenesis. IAPP aggregation is regulated by the pancreatic microenvironment: insulin suppresses fibril formation by inhibiting early oligomerization, while copper(II) [Cu(II)] ions play a dual role by inhibiting fibrillation and stabilizing toxic oligomers. Despite extensive research of these factors individually, their combined influence remains unclear. This study examined the effects of Cu(II) and insulin on IAPP aggregation. Fluorescence assays indicated that Cu(II) altered aggregation kinetics and diverted IAPP away from fibrillar states. Biophysical and imaging analyses revealed Cu(II) induced changes in secondary structure and aggregate morphology. In vitro, Cu(II)-modulated aggregates increased cytotoxicity, partially attenuated by insulin. These results link metal ion dysfunction to  $\beta$ -cell failure in T2D and inform strategies to mitigate amyloid burden.

### Selected Publications and Presentations

McVay, B.; Wolfe, D.; Ramamoorthy, A. Functional Amyloids as Multifunctional Platforms for Targeted Drug Delivery and Immunotherapy. *Langmuir* 2025, 41 (38), 25849–25867. <https://doi.org/10.1021/acs.langmuir.5c03238>.





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The Joint College  
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and Florida State University*

One **college**,  
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The FAMU-FSU College of Engineering is the joint engineering institution for Florida A&M and Florida State universities, the only such shared college in the nation. We are located less than three miles from each campus. After satisfying prerequisites at their home university, students learn together at the central engineering campus with its adjacent, associated research centers and a national laboratory.