THE UNIVERSITY OF

ALABAMA®



GRADUATE RESEARCH OPPORTUNITIES

Styslinger
College of Engineering
Department of Chemical and
Biological Engineering

THE UNIVERSITY OF ALABAMA® | Styslinger College of Engineering
Department of Chemical and Biological Engineering

Research Overview

Bioengineering / Biotechnology

BAO – KIM – RAO – SUMMERS – ZHAO

Catalysis / Electrocatalysis

HARRIS – HUANG – KIANI – LYU – RITCHIE – SHEEHAN – SUN – SZILVÁSI – TURNER – WANG

Computational / Thermodynamics

BARA – ESFAHANI – HENDERSON – SHEEHAN – SZILVÁSI – TURNER – ZHAO

Electronic Materials / Electronic Devices

BOUDOURIS – HENDERSON – HUANG – KOH

Energy / Environmental / Water

BARA – BOUDOURIS – ESFAHANI – KIANI – KOH – LYU – RITCHIE – SHEEHAN – WEINMAN

Membranes / Polymers

BARA – BOUDOURIS – ESFAHANI – HENDERSON – KOH – RITCHIE – WANG – WEINMAN – ZHAO

Graduate Faculty

Yuping Bao, Ph.D., Washington

Jason E. Bara, Ph.D., Colorado

Bryan W. Boudouris, Ph.D., Minnesota

Milad R. Esfahani, Ph.D., Tenn Tech

James W. Harris, Ph.D., Purdue

Clifford L. Henderson, Ph.D., UT-Austin

Qiang Huang, Ph.D., LSU

Daniyal Kiani, Ph.D., Lehigh

Yonghyun (John) Kim, Ph.D., UMBC

Amanda Koh, Ph.D., Rensselaer

Zhiheng Lyu, Ph.D., Georgia Tech

Shreyas S. Rao, Ph.D., Ohio State

Stephen M. C. Ritchie, Ph.D., Kentucky

James D. Sheehan, Ph.D., Penn State

Ryan M. Summers, Ph.D., Iowa

H. Hohyun Sun, Ph.D., UT-Austin

Tibor Szilvási, Ph.D., BME, Hungary

C. Heath Turner, Ph.D., NC State

Zhongyang Wang, Ph.D., Wash U

Steven T. Weinman, Ph.D., Clemson

Mingfei Zhao, Ph.D., SUNY Binghamton

Associate Department Head for Graduate Programs

Yuping Bao, ybao@eng.ua.edu

WHERE LEGENDS ARE MADE®



The University of Alabama Research Ecosystem

Our research efforts make a real difference in the lives of the people we serve. Our world-class faculty, professional staff and students are leading the way as we develop new technologies, advance scientific discovery and harness the power of creative thought to fuel the economy of the future.

MEASURES OF EXCELLENCE

$270M
TOTAL SPONSORED AWARDS (FY24)

#2
FOR GROWTH RATE OF R&D EXPENDITURES AMONG ALL 146 R1 UNIVERSITIES

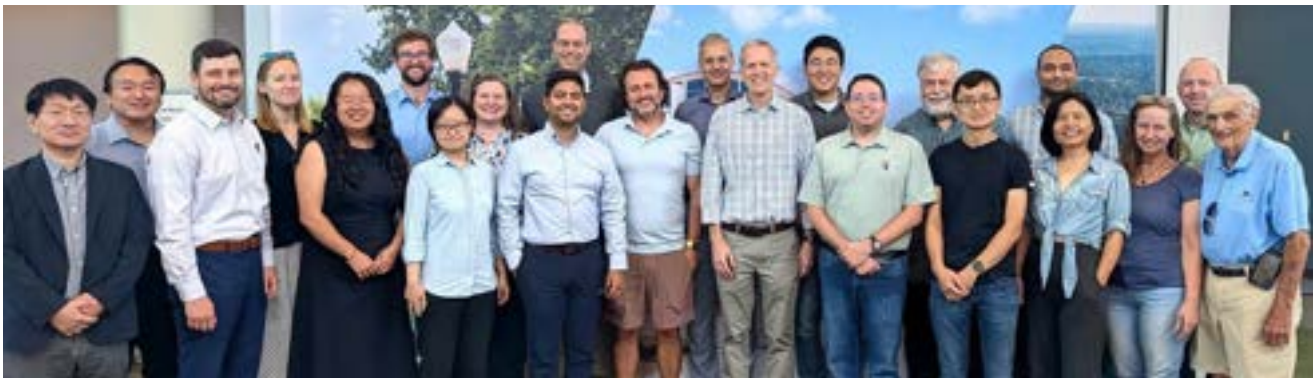
$3.4B
ECONOMIC IMPACT STATEWIDE (2025)

$221M
IN R&D EXPENDITURES (FY24)

207%
5-YR GROWTH RATE FOR 2018-2024 (NSF HERD SURVEY)

#1
NSF-FUNDED ACADEMIC INSTITUTION IN THE STATE OF ALABAMA

THE UNIVERSITY OF ALABAMA® | Styslinger College of Engineering
Department of Chemical and Biological Engineering



Program Highlights

Innovation, Entrepreneurship, and Creating New Opportunities

Our students and faculty are constantly exploring new ideas, venturing into new areas, and looking for solutions to society's most pressing challenges. Translating a theoretical concept into a tangible product is one of the most exciting aspects of our research portfolio, often leading to a patent, a new business venture, or a licensing opportunity. ***Did you know...****Prof. Huang currently holds 49 U.S. patents!*

Faculty Leadership and Student Mentoring

We strive to create a challenging and supportive research environment for our students, by providing opportunities to work side-by-side with some of the most creative and intellectually renowned researchers in the world. With publications in top journals and some of the most prestigious academic awards in the world, our students and faculty work together as a team. ***Did you know...****our faculty may have already contributed to your education with their textbooks (Fundamental Principles of Polymeric Materials, Prof. Brazel; Separation Process Essentials, Prof. Emeritus Lane) or mobile applications (Chemical Engineering App Suite for iPhone/iPad, Prof. Bara)!*

On-Campus Facilities and International Exposure

Our facilities have been transformed by a recent investment of $240 million to create the Science and Engineering Quad, with modern labs, environmental sustainability, and access to state-of-the-art analytical characterization tools. Our capabilities are leveraged to form international partnerships and research collaboration opportunities for our students and faculty around the globe. ***Did you know...****our students regularly receive international research recognition, and our faculty have won some of the most prestigious international awards (Fulbright Distinguished Scholar, Profs. Brazel and Kim)!*

Tuscaloosa, AL: The University of Alabama is located in the heart of Tuscaloosa (https://visittuscaloosa.com), home to one of the most beautiful campuses in the nation, along with a very mild climate and a low cost of living. It is about a 4-hour drive to the Gulf Coast where you will find some of the most breathtaking beaches in the world (https://www.gulfshores.com/). Birmingham is the largest neighboring city (1-hour drive), with a population of approximately 1 million residents. If you need more information about The University of Alabama and life on our campus, please visit: https://www.ua.edu/about/

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Styslinger College of Engineering

Department of Chemical and Biological Engineering



Research Support

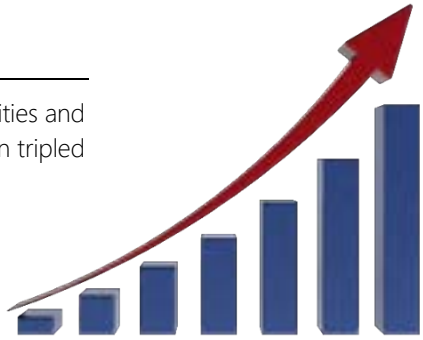
Funding the Best and Brightest Ideas

About 30% of the faculty have received NSF-CAREER Awards (NSF's most prestigious award in support of early-career faculty), as well as other national recognition of research and teaching excellence.

Over 35% annual growth rate!

A Period of Unprecedented Growth

Research funding has been growing at a rapid pace, creating new opportunities and increasing the impact of our work. ChemE research expenditures more than tripled from FY2020 to FY2024 (NSF HERD), a 35% compound annual growth rate.



Broad Research Support

Research Funding

Research projects are sponsored by a wide variety of state, regional, and federal agencies, as well as private companies. Whether you are interested in working with a federal agency, a private company, a government laboratory, or ultimately pursuing a career in academics, we can help pave the way.

NSF · DOE · DOD · NIH National Institutes of Health · DOE · USDA · NASA · arpa·e · U.S. Department of the Interior Bureau of Reclamation · ECS · ACS PRF · NOAA · ONR

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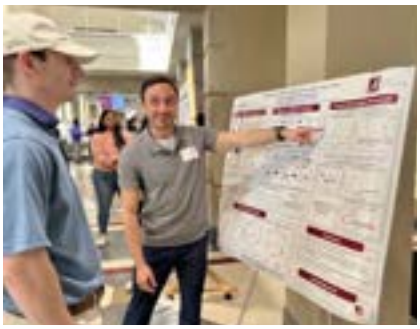
Professional Development

Networking Opportunities

Our research success is driven by passionate faculty, graduate students, and postdoctoral researchers, and we are all stronger together. Throughout the year, we provide multiple opportunities to connect and collaborate, including seminar visits from external distinguished researchers, Meet Your Neighbor lunches, our Annual ChBE Research Symposium, Peer Mentoring, and even an International Food Festival!

Presentation and Communication Experience

One of the most valuable skills in a research career is the ability to deliver a clear and impactful presentation. Our students are given frequent opportunities to participate in regional and on-campus events, as well as the ability to travel to national and international conference venues to present their research.



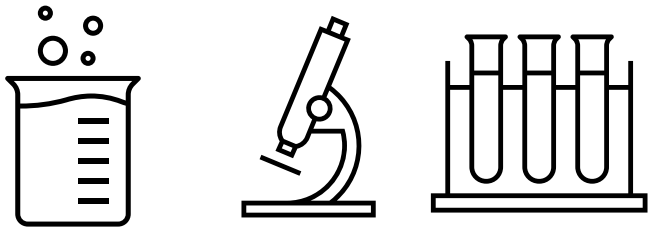
Outreach and Community Engagement

If you want to make a real impact in the lives of others, a graduate degree in chemical engineering can provide many opportunities. Our research projects extend far beyond the benchtop, including work with local schools, public utilities, and hands-on science museums.



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Department of Chemical and Biological Engineering

Affiliated Research Centers

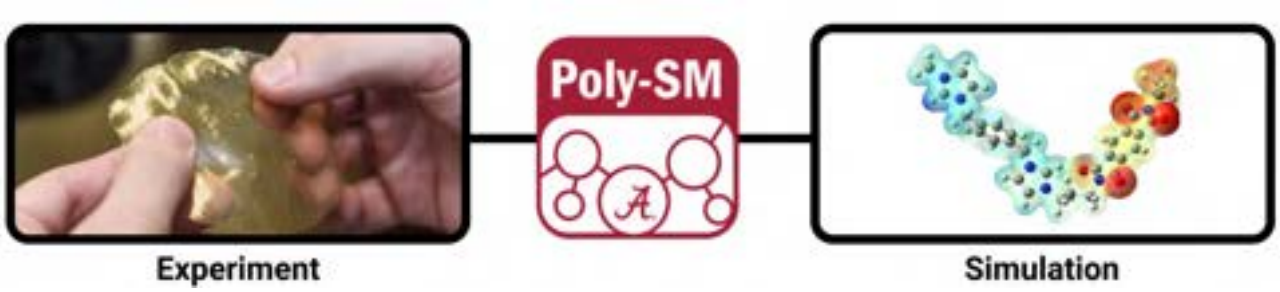


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Polymers and Soft Materials Research Center

Polymers and Soft Materials (Poly-SM) Research Center





Dr. C. Heath Turner
Professor and Poly-SM Director
hturner@eng.ua.edu



Prof. Jason E. Bara
Professor and Poly-SM Co-Director
jbara@eng.ua.edu

https://poly-sm.ua.edu/

The **Polymers and Soft Materials (Poly-SM) Research Center** is a collaborative effort to strengthen the multidisciplinary research on The University of Alabama campus in the field of polymers and soft materials. This includes investigations of fundamental chemical, mechanical, and biological materials, and processes, as well as applied technologies of industrial significance. In order to stimulate research and innovation within the Poly-SM area, we provide financial support for invited seminar speakers, we provide supplemental travel funding for our members, and we operate a shared experimental laboratory for soft material synthesis and characterization.

Industrial Interaction Opportunities

Advanced characterization capabilities for polymer materials

Bioderived solvent design

Advanced polymer recycling strategies

Research Examples

- Polymeric and ionic liquid (IL) materials for gas separation and processing
- Polymeric and IL materials for liquid and water/wastewater purification
- Polymers and soft materials for stretchable electronics and flexible robotics
- Gels and ILs for advanced solvent design and chemical processing
- Advanced plastics recycling, upcycling, and depolymerization
- Formulation of polymeric materials for additive manufacturing

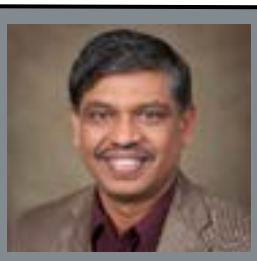
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Styslinger College of Engineering

Alabama Water Institute

Center for Water Quality Research (CWQR)





Prof. Prabhakar Clement

Professor and CWQR Director

pclement@ua.edu

https://cwqr.ua.edu/

CWQR's mission is to create new knowledge by challenging the status quo and utilizing the knowledge to develop practical solutions for solving water quality problems. The center's areas of research include water treatment, wastewater treatment, groundwater management, engineered porous material interfaces, membrane processes, and remediation design.

Vision

CWQR will be the leading research center in the Southeastern region for managing water resources by solving various types of water quality problems. Our long-term vision is to become a national center for solving national/global scale water quality problems.

Mission

- CWQR will support analytical facilities, field laboratories, and computer modeling capabilities to conduct water quality and groundwater management research.
- CWQR researchers will use their scientific knowledge and laboratory resources to develop novel technologies and best practices to provide public access to a sufficient amount of clean water.
- CWQR will have all necessary resources for addressing natural and anthropogenic environmental events that impact the quality of water stored in surface and groundwater systems.
- CWQR researchers will be engaged in educational and outreach activities that will benefit STEM researchers, policymakers, and the general public.

THE UNIVERSITY OF ALABAMA® | Division for Research

Center for Convergent Bioscience & Medicine (CCBM)







Dr. M. N. V. Ravi Kumar
University Distinguished Research Professor and CCBM Director
ccbm@ua.edu

https://ccbm.ua.edu

CCBM is dedicated to the convergence of bioscience and medicine with chemical, biological, physical, mathematical, and engineering disciplines that will not only allow us to identify the problems, but also establish approaches to overcome obstacles in drug development to avoid the valley of death across the preclinical and clinical divide.

Vision

The Center for Convergent Bioscience and Medicine (CCBM) will be a leading academic research center that advances entrepreneurial thinking, dedicated to promoting innovation and translational life science research, for a wide variety of audiences and stakeholders within the UA community, and across state, national, and international arenas.

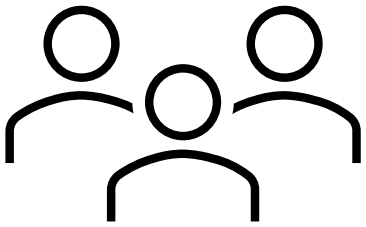
Goals

CCBM's mission to meet the current and the near future needs will be accomplished by adopting an "openness to emerging paradigms" in the life/translational sciences, so that UA and the Alabama Life Research Institute's (ALRI) strategic goals are best met in a timely, efficient and effective manner. The mission will be accomplished through the following:

- **Partnership**: seeking, establishing, and developing long-term research relationships within UA, and externally.
- **Research Excellence**: fostering a thriving scientific community, adhering to the highest ethical standards and professional best practices.
- **Re-envisioning Translation**: pursuing a multi-pronged approach encompassing drug discovery and repurposing, underpinned by state-of-the-art delivery technologies, to demonstrate preclinical proof of concept in human and animal diseases.
- **Multidisciplinary Research Training**: providing a unique environment to train the next generation of scientists within a multi-disciplinary setting to meet the changing paradigms in an evolving pharmaceutical industry.

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Department of Chemical and Biological Engineering

Faculty Research Profiles



Yuping Bao

Nano-Bio Interface Laboratory - Multifunctional Nanostructures for Imaging-guided Drug Delivery and Drug Discovery



Yuping Bao
Associate Professor
Ph.D. Materials Science and Engineering and Nanotech.
Univ. Washington, 2006

Recent Publications

Guerrero, M.; Braden, C.; Bao, Y. Applications of Isothermal Titration Calorimetry in Studying Biomimetic Nanocarriers, *Biomolecules*, 15(10), 1349. (**2025**)

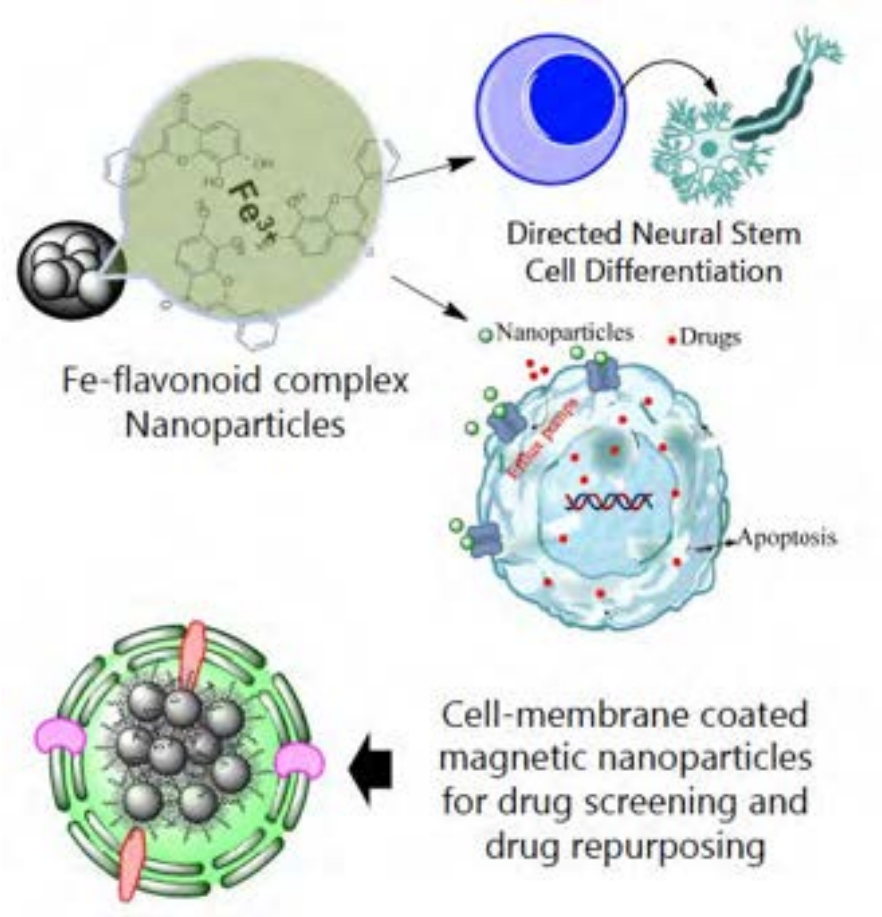
Kowkabany, G.; **Bao, Y.** Nanoparticle Tracking Analysis: An Effective Tool to Characterize Extracellular Vesicles, *Molecules*, 29, 4672. (**2024**)

Nguyen, D.D.; Mansur, S.; Ciesla, L.; Gray, N.E.; Zhao, S.; **Bao, Y.** A Combined Computational and Experimental Approach to Studying Tropomyosin Kinase Receptor B Binders for Potential Treatment of Neurodegenerative Diseases. *Molecules.* 29, 17. (**2024**)

Dr. Bao's group focuses on designing novel multifunctional nanosystems for drug delivery and drug discovery.

Much of Dr. Bao's work is related to the design of nanocarriers for targeted drug delivery, including multifunctional nanocarriers for overcoming drug resistance and directed stem cell differentiation. One of the unique aspects of the nanocarrier design is the use of natural products, such as flavonoids. In addition, the use of an Fe complex allows for MRI tracking.

The Bao group is also heavily working on the development of a drug screening platform for drug repurposing and new drug development. The designed drug screening platform has two distinct benefits: (1) screening against transmembrane receptors, and (2) ability to screen mixtures, eliminating the need to analyze each compound.



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Jason E. Bara

Molecular Design of Advanced Polymers, Gas Separation Membranes, "Green" Chemistry, Ionic Liquids, 3D Printing, Polymer Upcycling and Depolymerization, Chemical Engineering Mobile Apps



Jason E. Bara
University Distinguished Research Professor &
Co-Director POLY-SM Center;
Ph.D. Chemical Engineering
University of Colorado at Boulder, 2007

Dr. Bara's research group is focused on upcycling and depolymerization of plastic wastes; molecular design of membranes, sorbents and solvents; green chemicals; 3D printing of self-healing and stimuli-responsive polymers; scientific and educational apps for iPhones and iPads.

Dr. Bara is a recognized leader in the molecular design of polymers and composites, especially those based on ionic liquids and imidazoles. The highly tunable chemical and physical properties of these materials enable applications including gas separation membranes; superabsorbent materials for organic solvents; and stimuli-responsive, shape-memory, and self-healing polymers that can be 3D printed. Dr. Bara's group is also very active in the synthesis and study of new "green" solvents derived from glycerol. He is also pioneering research in plastic waste upcycling and depolymerization, with a particular emphasis on PVC.





Recent Publications

Pour, Z. S.; Shinde, P. S.; Wang, J.; Woods, C.; Taylor, S.; Chatterjee, S.; **Bara, J. E.** "1,3-Diether-2-Methacrylates with Glycerol Skeletons: Tunable Resins for Stereolithography 3D Printing." *Polym. Chem.* 16, 2840-2850. (**2025**)

Alshaikh, A. A.; Choi, J.; Olowookere, F. V.; Lubic, O.; Shinde, P. S.; Turner, C. H.; **Bara, J. E.** "Tuning Solvent Strength Can Fractionate PVC into Ultra-Low Molecular Weight Distributions with Low Dispersities." *RSC Appl. Polym.* 3, 336-346. (**2025**)

jbara@eng.ua.edu ◦ https://jbara.eng.ua.edu ◦ (205) 348-6836

Bryan W. Boudouris

Polymer Science & Engineering, Organic Electronic & Spintronic Materials, Water Purification, and Materials for National Security



Bryan W. Boudouris
Professor and Vice President for Research & Economic Development
Ph.D. Chemical Engineering
University of Minnesota, 2009

Recent Publications

H. Noh, T.H. Lee, S.H. Ahn, J.T. Davis, D. Jeong, R. Gounder, Z.P. Smith, **B.W. Boudouris,** B.M. Tackett, B. M. " Structural Tuning of Self-Conductive Polymer as Gas Diffusion Layer for Electrocatalytic Reactions at High Current." *Adv. Energy Mater.* 16(1) e02788 (**2026**)

H.Yeo, C.C. Sorensen, H. Tahir, A. Marquardt, Y.-F. Yang, N. Legaux, B.M. Savoie, F.A. Leibfarth, **B.W. Boudouris** "Stereoregular Radical Polymers Enable Selective Spin Transfer," *Sci. Adv.* 11, eadr4004. (**2025**)

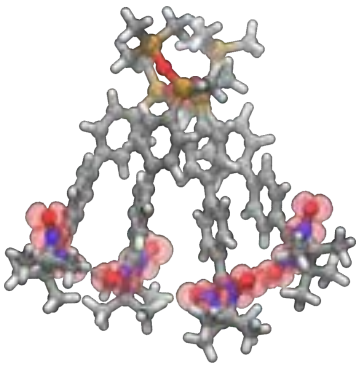
H. Tahir, K. Liu, Y.-F. Yang, B.M. Savoie, **B.W. Boudouris,** "Verdazyl Radical Polymers for Advanced Organic Spintronics," *Nat. Commun.* 16, 652. (**2025**)

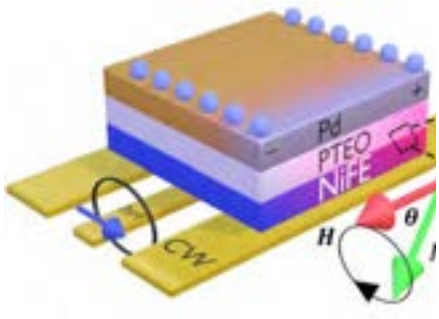
Dr. Boudouris' research interests focus on materials science with an emphasis on polymer chemistry and polymer physics. The application spaces touched by these fundamental efforts span from those associated with next-generation quantum materials through water purification and to materials for national security arenas.

From food packaging to large electronic displays, macromolecular materials have transformed modern society; however, many foundational principles associated with polymers are still not fully resolved. The Boudouris group designs, synthesizes, characterizes, and implements polymers for multiple end-use, next-generation applications.

For instance, the Boudouris Group has been a world-leading team in the design and application of radical polymers in solid-state organic electronic (i.e., charge-conducting) and spintronic (i.e., spin-conducting) devices. By connecting molecular-scale features with macroscopic properties, they have pushed the bounds of how the community considers transport in these advanced materials. In this way, they have paved new avenues in terms of bioelectronic sensors and quantum information systems.

Moreover, the Boudouris Group collaborates with multiple teams to better design materials for: (1) advanced gas sensors (e.g., for hydrogen detection); (2) water purification membranes (e.g., membrane adsorbers for heavy metal removal); and (3) advanced energetic materials systems. These applications are crucial to environmental security, water security, and national security. Thus, the Boudouris Group prides itself on connecting atomic design features to practical applications in a robust manner.





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Milad Rabbani Esfahani

Functionalized Membranes for Water Purification & Desalination, Metal Organic Framework, Adsorption, Wastewater Treatment



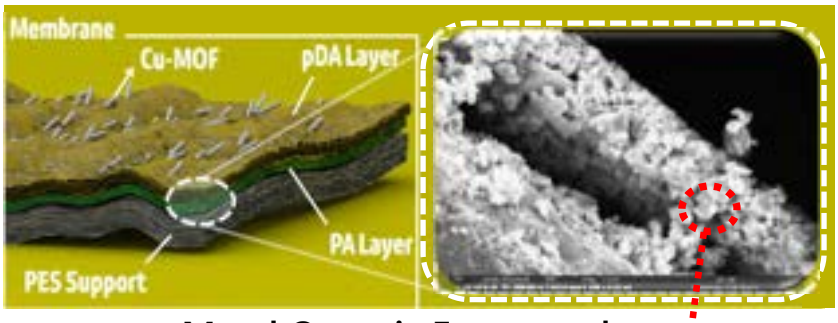
Milad R. Esfahani
Associate Professor
Ph.D. Chemical Engineering
Tenn. Tech. University, 2015

Dr. Esfahani's group uses a multidisciplinary approach to develop novel functionalized membranes and metal organic frameworks (MOFs) with the ultimate goal of water and wastewater treatment.

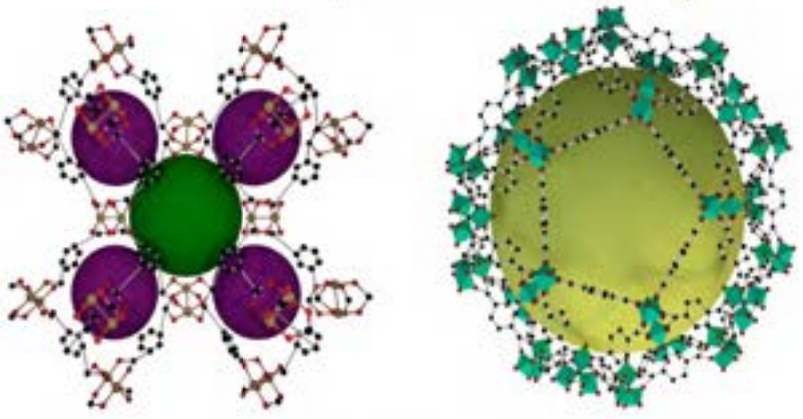
The Esfahani Research Group focuses on membrane functionalization and synthesizing novel adsorbents for water/wastewater treatment and desalination.

We develop strategies to functionalize different polymeric membranes, including thin-film composite nanofiltration and reverse osmosis membranes, for enhanced selectivity, permeability, and antifouling. Esfahani Research Group synthesizes a variety of metal organic frameworks (MOFs) as the new adsorbents or develops MOF-functionalized membranes for the selective removal of emerging contaminants such as PFAS and micro-nano plastics from water.

MOF- Functionalized Membrane



Metal Organic Frameworks



Recent Publications

A. U. Razzaq, **M. R. Esfahani**, Upcycled PVC support layer from waste PVC pipe for thin film composite nanofiltration membranes, *Sep. Purif. Technol.*, 340, 126747 (**2024**).

T. Le, **M. R. Esfahani**, Thin-film nanocomposite membranes functionalized with Fe-based metal–organic frameworks for enhanced removal of urea from water, *ACS EST Water*, 4, 2064 (**2024**).

mesfahani@eng.ua.edu ◦ http://mesfahani.people.ua.edu ◦ (205) 348-8836
Twitter: @EsfahaniMilad

James W. Harris

Synthesis and Characterization of Inorganic Solids, *In Situ* Spectroscopy, Chemical Reaction Engineering, Chemical Kinetics



James W. Harris
Associate Professor
Ph.D. Chemical Engineering
Purdue University, 2017

Recent Publications

Minne, A.P.; Garton, T.D.; Iaia, E.P.; Stavitski, S; **Harris, J.W.** "Promoting the Oxidative Coupling of Methanol and Dimethylamine using Group 1 Alkali Metals on Palladium-Gold Nanoparticles." *Appl. Catal. B*, 378, 125533 (**2025**).

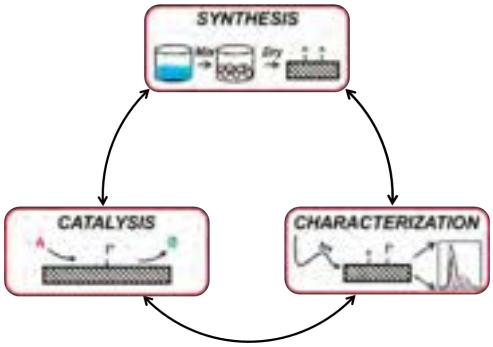
Iaia, E.P.; Miller, M.G.; Soyemi, A.; Bakker, M.G.; Szilvási, T.; **Harris, J.W.** "Kinetic and Mechanistic Studies of Cyclohexane Oxidation with tert-Butylhydroperoxide over M-N4 Catalysts." *React. Chem. Eng.*, 10, 1647-1664 (**2025**).

Borate, S; Samad, N; ... **Harris, J.W.** "Quantification of Active Sites in Yttrium Containing Dealuminated Beta Zeolites During Conversion of Ethanol and Acetaldehyde to Butadiene." *J. Catal.*, 433, 115468 (**2024**)

Dr. Harris's group studies chemical reactions occurring at solid surfaces in order to develop environmentally friendly catalytic routes to fuels and chemicals.

Catalysts provide energetically feasible pathways for chemical reactions to occur. The Harris group works to understand these materials as they exist during reaction in order to develop processes to upgrade abundant feedstocks to desirable chemicals. We synthesize catalysts, including supported metal nanoparticles and crystalline microporous solids, and characterize their physical and chemical characteristics at the molecular level. These materials are used for studies of the kinetics and mechanisms of chemical reactions, with aid from *in situ* spectroscopic tools, to develop improved processes that reduce the environmental impacts of the production of fuels and chemicals.

Research in our group includes efforts to transform shale gas to useful chemicals. Abundant reserves of shale gas in the United States have provided a surplus of light alkanes and provided an opportunity to develop new catalytic processes to transform these feedstocks into useful chemicals and fuels instead of flaring these gases at geographically isolated shale gas wells. Emerging classes of catalysts have demonstrated exciting prospects for the selective transformation of these light alkanes into liquid chemicals that are more easily transported.



A second area of research involves upgrading of oxygenates derived from biomass. These highly-functionalized molecules can act as platform molecules for production of fuels, polymer precursors, solvents, flavorings, perfumes, and pharmaceutical precursors. Production of these high-value chemicals currently requires non-renewable feedstocks and often generates toxic by-products, leading to opportunities to explore selective catalytic transformations that alleviate existing environmental impacts while producing renewable specialty chemicals.

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Twitter: @JWHarrisCatal

Clifford L. Henderson

Functional Polymers and Organic Nanotechnology Lab



Clifford L. Henderson
Dean and Professor
Ph.D. Chemical Engineering
University of Texas at Austin, 1998

Recent Publications

J.B. Delony, P.J. Ludovice, and **C.L. Henderson**, Block copolymer directed self-assembly defect modes induced by localized errors in chemoepitaxial guiding underlayers: A molecular simulation study. *J. Vac. Sci. Technol. B* 38, 032604 (**2020**).

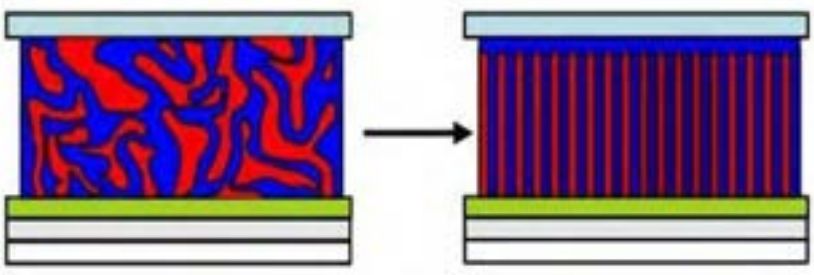
B.L. Sharp, H.L. Narcross, P. Ludovice, L.M. Tolbert, **C.L. Henderson**, Structural effects on the performance of epoxide-based negative-tone molecular resists. *J. Vac. Sci. Technol. B* 37, 011604 (**2019**).

Dr. Henderson's work intersects a variety of topics including polymer science, thin film science and technology, organic chemistry, nanoscience & nanotechnology, nanomanufacturing, molecular modeling and molecular dynamics, and electronic and optical materials and devices.

Our research focus broadly lies at the intersection of chemical engineering, chemistry, and materials science, where in many cases the general goals of our work are: (1) to understand the connections between chemical structure, material processing, and properties in advanced materials, (2) to develop materials and processes that allow for high definition patterning of materials and formation of nanostructured materials that enhance their function, and (3) to use these materials and processes to fabricate novel devices and structures for a variety of applications.

Examples of current projects include: (1) design of new block copolymers and processes for the directed self assembly (DSA) and fabrication of nanostructures, (2) modeling and simulation of block copolymer phase separation using advanced and novel molecular dynamics techniques, (3) design of new photoresist materials and processes for sub-20nm patterning, (4) studies of the physicochemical property behavior of polymer ultra-thin films, and (5) directed synthesis of graphene.

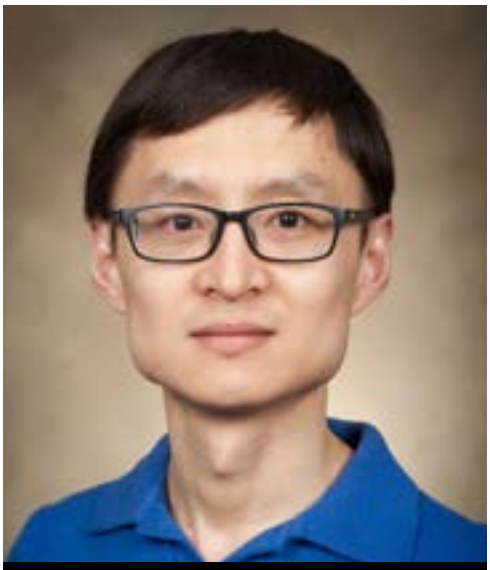
Organic Photovoltaic (OPV) systems are being engineered to capture sunlight more efficiently by using block copolymers to produce ordered materials with feature length scales commensurate with exciton charge pair separation distances.



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Qiang Huang

Electrochemical Engineering for Nanomaterials, Nanostructures and Nanodevices



Qiang Huang
Associate Professor
Ph.D. Chemical Engineering
Louisiana State University, 2004

Recent Publications

Q. Huang, Superconducting Damascene Interconnects from Electrodeposition and Solid State Metal Exchange, J. Electrochem. Soc., 173 (**2026**).

Z. Ma, J. Manzi, L. Tsui, J. Lavin, & **Q. Huang**, Bench-top Scale-up Electrodeposition of Superconducting Quantum Interconnectors, J. Appl. Electrochem., 56, 219 (**2026**).

Q. Liu, & **Q. Huang**, ReMo alloy Films with Enhanced Superconductivity and Thermal Stability, J. Solid State Electrochem. 30, 1075 (**2026**).

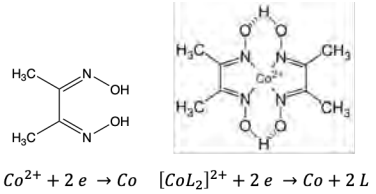
A. Fryer, & **Q. Huang**, Effects of Surfactants on Electrodeposition of Tin, J. Electrochem. Soc., 172, 072501, (**2025**).

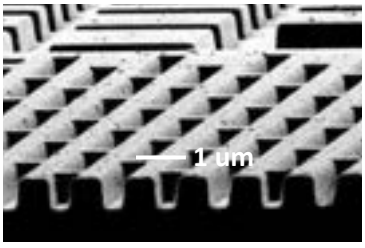
Dr. Huang's group focuses on developing electrochemical technologies to fabricate new materials and structures for applications in microelectronics, renewable energy, and quantum devices.

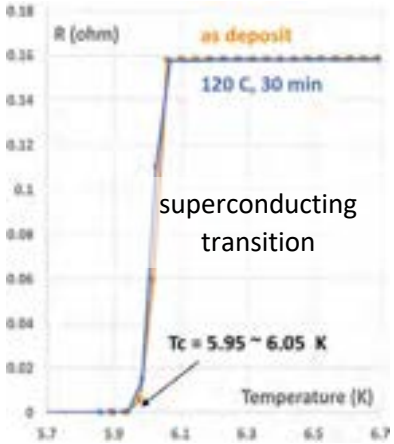
Electrochemical reactions are chemical reactions that involve electron transfer. Dr. Huang's current research focuses on such reactions in conjunction with materials science, investigating the impacts of the chemistry and process on the material structure and properties. Two example applications are for microelectronic and quantum devices.

Microelectronic and semiconductor devices form the cornerstone of our modern society. Interconnect is a nanometer-sized network of metal wires in integrated circuits, enabling the communication between semiconductor devices (transistors). We are exploring the electrochemistry and electrodeposition process for the fabrication of new interconnects, which are much needed to enable the further advancement of semiconductor technology, as well as our laptops, cell phones, and supercomputers. (Figure on the left)

Quantum computing is believed to represent a completely new paradigm, where the data are no longer zeros and ones but rather can be any values in between. We are developing new electrochemical methods to make superconducting films and superconductor-based quantum junction devices. Such films allow the passage of electrons without any resistance, avoiding electrical heating and temperature perturbation on the cryogenic quantum computer. (Figure on the right)







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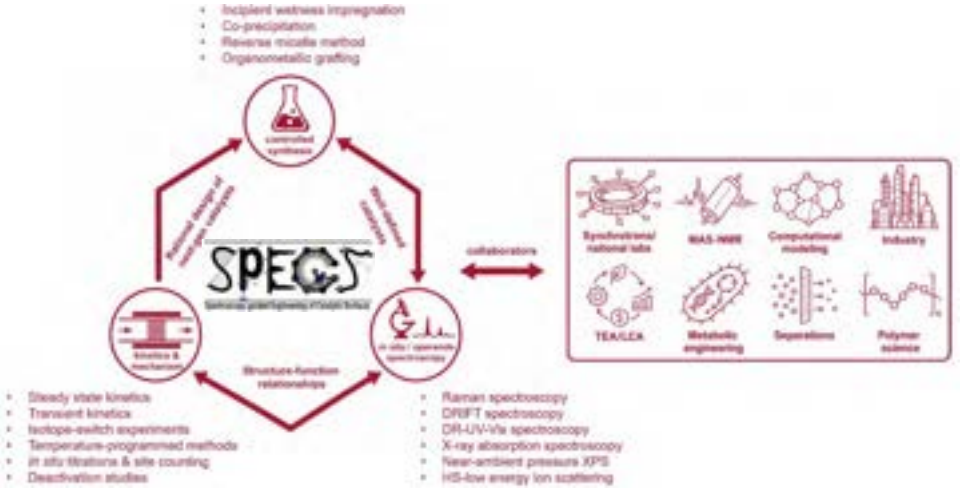
Daniyal Kiani

In situ & _operando_ molecular spectroscopies, heterogeneous catalysis, oxide surface chemistry, chemical kinetics



Daniyal Kiani
Assistant Professor
Ph.D. Chemical Engineering
Lehigh University, 2021

Dr. Kiani's group investigates the structural dynamics of oxide catalysts to understand how active sites, spectator sites, and pore environments form, function, restructure, and deactivate under reaction conditions, and how we can deliberately tune them to increase catalytic activity, selectivity, and stability.



At the SPECS lab, we use a balanced research approach, which integrates:

- **Precise synthesis** of earth-abundant catalysts, primarily supported oxides, bulk oxides, and mixed metal oxides.
- ***In situ* & *operando* molecular spectroscopies** including Raman, diffuse reflectance FT-IR, and diffuse reflectance UV-Vis spectroscopies in modulated and steady modes.
- **Kinetics & mechanistic studies** including steady-state and transient kinetics, isotope-switch experiments, and temperature-programmed methods.
- **Reactor engineering** through development of custom spectroscopic reaction cells capable of probing multiphase reactions under external stimuli.

We will also collaborate closely with groups specializing in computational catalysis, advanced characterization, metabolic engineering, polymer chemistry, separations, and systems-level analysis to expand the scope and practical impact of our research endeavors.

Recent Publications

Kiani, D.; Bozkurt, O. et al. Metal oxide-promoted calcium cuprate catalysts for diol oxidative dehydrocyclization to lactones. *Chem Catalysis,* 101777, (**2026**)

Kiani, D.; Rosetto, G. et al. Solventless, ambient-pressure production of bio-based lactones over earth-abundant mixed metal oxide catalysts. *Nature Communications*, 17, 2804 (**2026**)

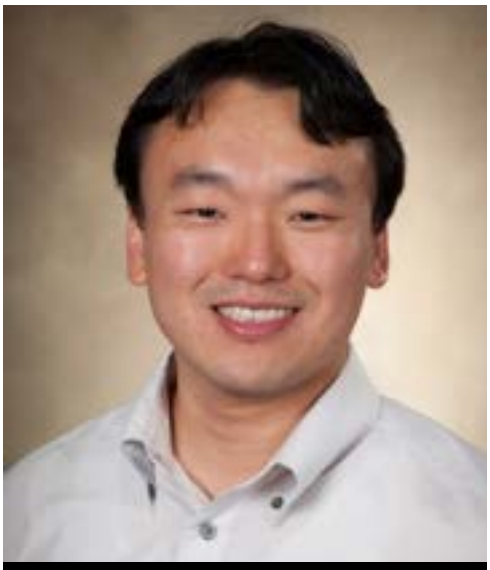
Kiani, D.; Eaglesfield, et al. Production of bio-based lactones as monomers for a circular polymer economy. *Nature Reviews Chemistry,* 9, 749–765 (**2025**)

Kiani, D.; Wachs, I. E. The conundrum of "pair sites" in Langmuir-Hinshelwood mechanism in heterogeneous catalysis, *ACS Catalysis*, 14,10260–10270 (**2024**)

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Yonghyun (John) Kim

Bioengineering, Oncology, Translational Medicine



Yonghyun (John) Kim
Associate Professor
Ph.D. Chemical Engineering
Univ. Maryland Baltimore County (UMBC), 2008

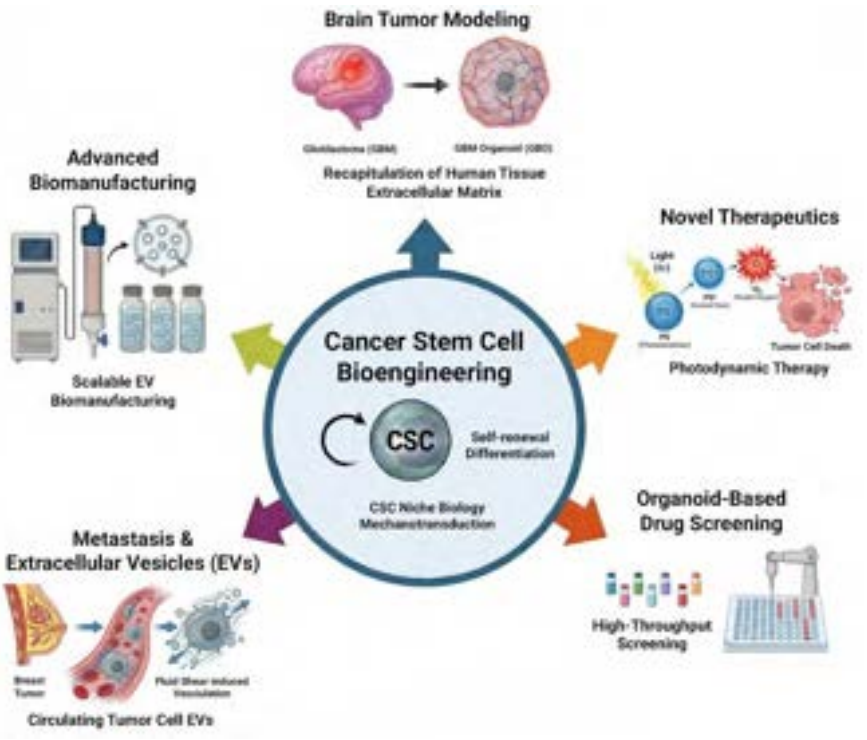
Recent Publications

A.D. Avera, T.N. Schnorbus, **Y. Kim**, Exogenous matrix-free biomanufacturing of glioblastoma organoids enables autonomous assembly of neurovascular-like structures and extracellular matrix, *Bioeng Transl Med*, e70166 (**2026**).

A.D. Avera, **Y. Kim**, Bioengineering Stem Cell-Derived Glioblastoma Organoids, *Pharmaceuticals,* 18(12), 1830 (**2025**)

A.D. Avera, D.J. Gibson, M.L. Birge, T.N. Schnorbus, I.M. Concannon, **Y. Kim**, Characterization of Native Extracellular Matrix of Patient-Derived Glioblastoma Multiforme Organoids, *Tissue Eng Part A,* 31(17-18):1144-1155 (**2025**)

Dr. Kim's group bioengineers cancer stem cells (CSCs) and their niche to drive advancements in translational medicine.



CSCs are recognized as the primary drivers of cancer relapse, yet traditional drug development relies on decades-old cell lines that fail to capture their complexity. We bridge oncology and engineering by investigating mechanotransduction and signaling pathways to develop highly accurate disease models.

Our multidisciplinary research includes:

- 3D glioblastoma organoid modeling with extracellular matrix recapitulation
- scalable biomanufacturing of extracellular vesicles (EVs) and spatially organized tumor microenvironments
- fluid shear stress studies of metastasis and circulating tumor cells
- targeted photodynamic therapies using ruthenium-based complexes; and
- high-throughput organoid drug screening platforms designed to overcome clinical resistance, identify new therapeutics, and improve patient outcomes.

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Amanda Koh

Functional Material Interfaces for Soft Robotics, Stretchable Electronics, Sensing, and Environmental Remediation



Amanda Koh
Associate Professor
Ph.D. Chemical Engineering
Rensselaer Polytechnic Institute; 2016

Recent Publications

Hoang, A.; Grasinger, M.; Papon, E. A.; **Koh, A.** Exploring the complex deformation behavior of liquid metal polymer composites through experimental and novel computational approaches. *Comp. Part B: Eng.* 296, 112257. (**2025**).

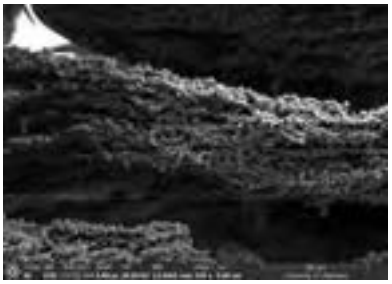
Hoang, A.; Faruqe, O.; Bury, E.; Park, C.; **Koh, A.** Homogeneity of liquid metal polymer composites: impact on mechanical, electrical, and sensing behavior. *Soft Matter* 19 (37), 7202-7215. (**2023**)

Bury, E.; Thiagarajan, S.; Lazarus, N.; **Koh, A.** Ferrofluid high internal phase emulsion polymer foams for soft, magnetic materials. *J. Magn. Magn. Mater.* 563, 169921. (**2022**)

Dr. Koh's group focuses on engineering multifunctional materials through the intentional design of interfaces. Current research focuses on materials for soft robotics, stretchable electronics, smart materials, and environmental remediation.

As devices become more advanced in the fields of defense, health, and manufacturing, it is no longer enough for materials to have a single function or be useful to only a single application. Materials that are responsive and multifunctional are key to creating robust, practical, and adaptive systems. The Koh lab seeks to develop these materials through the engineering of internal and composite interfaces either through the manipulation of existing chemistry or the addition of novel components.

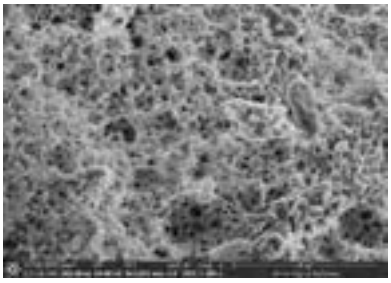
Much of the current work in Dr. Koh's lab focuses on developing soft materials which are both deformable and have electronic, magnetic, or sensing capabilities. Applications of these materials include stretchable electronics (ex. wearables and health monitoring), soft robotics (ex. human-machine interfaces and manned-unmanned teaming), and environmental contaminant remediation and sensing (ex. Harmful algal bloom toxins, chemical warfare agents, plastic byproducts).



Magnetically aligned magnetorheological fluid chain



Liquid metal in PDMS dielectric dispersions



High internal phase emulsion polymer foam

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Zhiheng Lyu

Nanomaterials, Electrocatalysis, Electron Microscopy



Zhiheng Lyu
Assistant Professor
Ph.D. Georgia Institute of Technology, 2020

Recent Publications

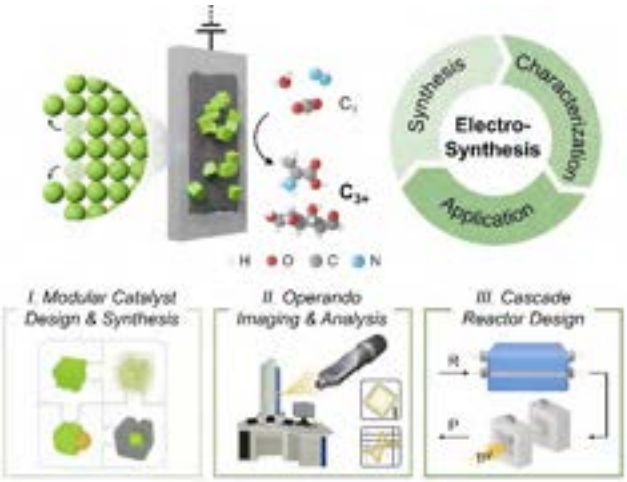
Z. Lyu, S. Shrivastav, J. Li, C. Qian, L. Yao, N. Shah, M. Eslami, C. Liu, S. Ismail, J. Shabaker, E. Doskocil, D. V. Krogstad, J. A. Krogstad, Q. Chen, Nanoscopic Imaging of Biogenic Feedstocks Induced Corrosion in Model Petroleum Infrastructure. *ACS Nano*, 19, 28315–28325 (**2025**).

Z. Lyu, L. Yao, W. Chen, F. C. Kalutantirige, Q. Chen, Electron Microscopy Studies of Soft Nanomaterials. *Chem. Rev.* 123, 4051–4145 (**2023**).

Y. Shi, **Z. Lyu**, R. Chen, M. Zhao, Y. Xia, Noble-Metal Nanocrystals with Controlled Shapes: A New Platform for Catalytic and Electrocatalytic Applications. *Chem. Rev.* 121, 649–735 (**2021**).

Dr. Lyu's Group focuses on the modular design of catalysts for electrochemical conversion of small molecules, assisted by mechanistic insights from *in situ* characterization.

Multi-carbon compounds, particularly C_{3+} chemicals such as propanol and butadiene, are essential as fuels, solvents, lubricants, and reaction intermediates. Their industrial production mainly comes from steam cracking, followed by high-temperature treatment, raising concerns in product purity and separation, energy consumption, and carbon emission. Electrochemical coupling of C1 feedstocks, such as CO_2, offers a scalable, low-emission pathway with minimal hazardous byproducts, providing supplements and alternatives to current petrochemical routes. However, electrochemically converting C1 feedstocks to C3+ species with practical efficiency is still challenging due to high energy barriers, complex reaction pathways, and lack of effective catalysts.



The Lyu group focuses on enhancing catalyst functionality and advancing technological viability of green chemical synthesis. Our research includes: (i) modular design of multi-functional catalysts, coupled with mechanistic understanding of their active sites and cooperative effects, (ii) *operando* imaging with product analysis to resolve structure-performance relationship of catalysts across multiple scales under reaction conditions, and (iii) electrochemical synthesis of value-added organic compounds from small molecules. Our research contributes to both fundamental and applied research in catalysis, aiming to create new synthetic pathways for diverse chemical products and fostering environmentally sustainable chemical processes.

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Shreyas Rao

Biomaterials, Cell-Material Interactions, Tumor Microenvironment, Drug Resistance



Shreyas Rao
Associate Professor
Ph.D., Chemical Engineering
The Ohio State University, 2012

Recent Publications

S. K. Gurung, K. Berger, **S.S. Rao**, Cancer Cell-Monocyte Co-Culture Spheroids Recapitulate Pro-tumorigenic, Immunosuppressive, and Drug-Resistant Micro-environments in Brain Metastatic Breast Cancer. *npj Breast Cancer*, 11, 136 **(2025)**.

P. Sarker, L.A. Shevde, **S.S. Rao**, An *In Vitro* Hydrogel-Based Model to Study Dormancy Associated Drug Resistance in Metastatic Breast Cancer Spheroids. *npj Biomed. Innov.*, 2, 39 **(2025)**.

S.N. Luna[$], V. Yakati[$], L.A. Shevde, **S. S. Rao.** Glucocorticoid receptor signaling mediates resistance to therapy in matrix rigidity-induced dormant brain metastatic breast cancer spheroids. *ACS Biomater. Sci. Eng.* (**2025**)

The Rao Laboratory is developing engineering tools to unravel the mechanisms associated with the role of the microenvironment in cancer progression, therapeutic response and resistance.

The oncogenic progression of cancer from the primary to the metastatic setting is the critical event that defines stage IV disease, no longer considered curable. Despite some success in developing a suite of therapies, a key challenge that continues to hamper cancer treatment is the frequent development of drug resistance, particularly in the metastatic setting, resulting in disease relapse and often mortality. Most existing experimental models to investigate tumor cell responses to therapeutic treatments and examine mechanisms of drug resistance utilize two dimensional (2D) substrates (e.g., plastic, glass) that largely fail to recapitulate the complex *in vivo* environment.

Our research group is designing three dimensional (3D) biomaterial scaffolds (e.g., hydrogel scaffolds, and porous scaffolds) as tools to mimic features of tissues that could serve as platforms for elucidating physiologically relevant cellular behaviors, drug screening and discovery, as well as mechanisms of drug resistance in the context of cancer therapeutics *in vitro* and *in vivo.* In addition, we are developing biomaterial tools that could be employed for sensing and modulation of drug resistance. We are also applying systems biology approaches to understand the underlying mechanisms of therapeutic resistance in physiologically relevant 3D microenvironments. This knowledge could be subsequently utilized to devise strategies that can reprogram the microenvironment to halt disease progression. Given that drug resistance is a major issue noted across multiple types of cancers, this work would have far-reaching implications in drug discovery and development, thereby transforming current treatment strategies.

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Stephen Ritchie

Functionalized Materials for Separations, Catalysis, and Solid-phase Antimicrobials



Stephen Ritchie
Associate Professor
Ph.D. Chemical Engineering
University of Kentucky, 2001

Dr. Ritchie's laboratory focuses on the addition of active properties to passive materials. This work has resulted in adsorptive membranes for antibody purification, highly charged membranes for protein separation and concentration, membrane catalysts, and anti-microbial surfaces. Commercial production of functionalized membranes and scale-up are also of interest.

The group's interest in adsorptive membranes has been focused on antibody purification. The work is continuing and evolving to include other biomolecules and more complex adsorption sites. Adsorptive membranes are fully synthetic and high capacity, and are capable of achieving similar selectivity to affinity resins.

We also have a strong interest in commercial production techniques and applications for functionalized membranes. Currently, work is focused on high volume systems containing proteins and other biomolecules. The goal is to concentrate proteins similar to conventional microfiltration and ultrafiltration processes, but at much higher flux through a combination of separation mechanisms beyond size exclusion.

The group's interest in acid catalysis has been on low temperature reactions where the competing solid-phase catalyst is strong acid ion exchange resin. Our current interest is adapting membranes for long-term operation in industrial systems. We are targeting applications where reactive distillation is currently employed.

We have also been active in synthesis of anti-microbial materials for application to dairy systems. Components of spiral-wound membrane elements can be modified to include anti-microbial surfaces. The particular application of interest is for *Listeria monocytogenes* reduction in milk processing.

We have a new area of research on particle separation using non-woven materials formed from recycled plastics. Our focus will be on synthesis of fibers used in the application, as well as construction of composite materials that can provide similar performance to commercial filters applied to indoor air filtration.

Recent Publications

M. I. Hossain, A. Udoh, B. E. Grabicka, K. S. Walton, **S. M. C. Ritchie,** T. G. Glover, Membrane-Coated UiO-66 MOF Adsorbents, *Industrial & Engineering Chemistry Research* 58, 1352 (**2019**).

S. M. C. Ritchie, M. Costa-Teixeira, and R. M. Summers, Functional Surfaces in Food Processing, *Chemical Engineering Progress*, 52-55, **(May 2019**).

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James D. Sheehan

Chemical Valorization of Biomass and Waste Plastics, Reaction Engineering of Thermocatalytic Processes, Reaction Kinetic Modeling



James D. Sheehan
Assistant Professor
Ph.D. Chemical Engineering
Pennsylvania State University, 2019

Dr. Sheehan's group uses experimental and modeling approaches to evaluate reaction kinetics and transport phenomena governing the chemical deconstruction of biomass and waste feedstocks. Their research develops sustainable processes for synthesizing commodity and fine chemicals.

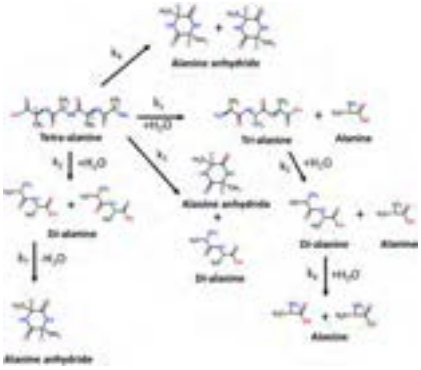
The research objective of the Sheehan group is to develop reactive processes that valorize abundant molecular feedstocks into value-added chemicals and support the expansion of a sustainable, chemical economy. To this end, the Sheehan Group investigates the reaction engineering of processes that valorize renewable and waste feedstocks (e.g., lignocellulosic biomass, organic waste, plastics) into value-added chemicals and materials. Investigations focus on evaluating thermochemical, catalytic, and supercritical fluid processes to chemically deconstruct and fractionate macromolecular feedstocks into small molecules. A combination of experimental and computational modeling tools are applied to evaluate the underlying transport phenomena and reaction kinetics governing these chemical fractionation processes.

Research Examples

Catalytic Fractionation of Biomass
Deconstruction and Derivatization of Lignins into Eco-friendly Polymers



Chemical Kinetics
Base-Catalyzed Hydrolysis of Peptides in Hot, Compressed Water



Recent Publications

D. W. Ball, O. E. Muojama, K. S. Hall, B. Hutton-Prager, **J. D. Sheehan,** Supercritical Fluid Assisted Impregnation Directs Solid-State Organization, Additive Localization, and Release Kinetics in Cellulose Matrices. *Langmuir*, 42, 21797–21811 **(2026).**

B. C. Ekeoma, J. E. Bara, **J. D. Sheehan,** Synergizing Catalyst and H-Donor Design for Selective H2-Free Reductive Catalytic Fractionation Using Glycerol-Derived Ethers. *ACS Sustainable Chem. Eng.*, 14, 1312–1330 **(2026).**

O. E. Muojama, B. Hutton-Prager, **J. D. Sheehan**, Supercritical Fluid Impregnation Enables Rapid Sorption of Hydrophobic Additives into Cellulose for Fabricating Sustainable Packaging Substrates. *Ind. Eng. Chem. Res.*, 64, 14122–14133 **(2025)**.

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Ryan M. Summers

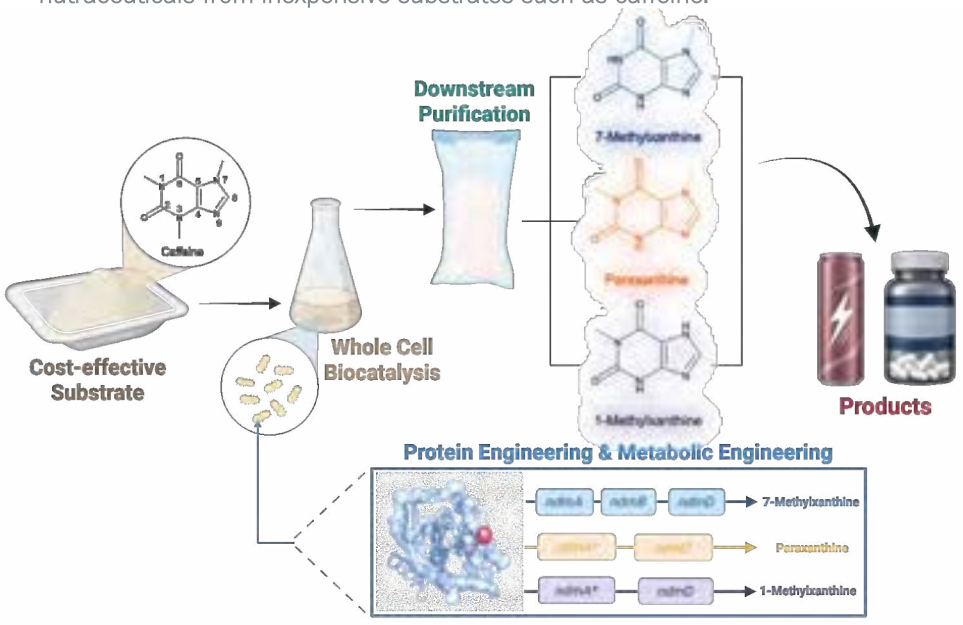
Metabolic Engineering, Synthetic Biology, Biochemical Engineering for Production of Chemicals, Fuels, and Pharmaceuticals



Ryan Summers
Associate Professor
Ph.D. Chem. and Bio. Engr.
University of Iowa, 2011

The Summers lab is working to metabolically engineer bacteria and yeast cells to produce chemicals, fuels, and pharmaceuticals. Specifically, the group focuses on engineering enzymes, gene networks, and genetic regulatory elements in microbial cells.

As society moves away from use of petroleum resources for production of fuels and chemicals, their replacements must come from natural, renewable resources. To meet this need, the Summers lab seeks to engineer bacteria and yeast cells to produce bulk and fine chemicals from biomass. In addition to these chemicals, the group is looking at production of pharmaceuticals and nutraceuticals in metabolically engineered microbial cells. Through a combination of systems biology, protein engineering, and molecular biology, we are engineering bacteria and yeast cells to produce high-value chemicals for food and nutraceuticals from inexpensive substrates such as caffeine.



Other projects in the Summers lab include metabolic engineering of probiotic bacteria for *in situ* delivery of amino acids, characterization of genetic regulatory elements in probiotic bacteria, design of modular plasmids for metabolic engineering of *E. coli*, *Saccharomyces cerevisiae*, and other microbial strains, and construction of novel riboswitches that recognize small molecules.

Recent Publications

M.B. Mock, **R. M. Summers**, *et al.*, Production of 1-methylxanthine via biodegradation of theophylline by an optimized *Escherichia coli* strain, *J. Biotechnol.* 379, 25-32 (**2024**).

M.B. Mock, **R. M. Summers**, *et al.*, Mixed culture biocatalytic production of the high-value biochemical 7-methylxanthine, *J. Biol. Eng. 17*, 2 (**2023**).

M.B. Mock, **R. M. Summers**, *et al.*, Biocatalytic production and purification of the high-value biochemical paraxanthine, *Biotechnol. Bioproc. Eng. 27*, 640-651 (**2022**).

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H. Hohyun Sun

Battery Materials for Electric Transport, Co-precipitation Reactions, Layered Oxide Cathodes, Functional Electrolytes



H. Hohyun Sun

Assistant Professor
Ph.D. The University of Texas at Austin, 2020

Recent Publications

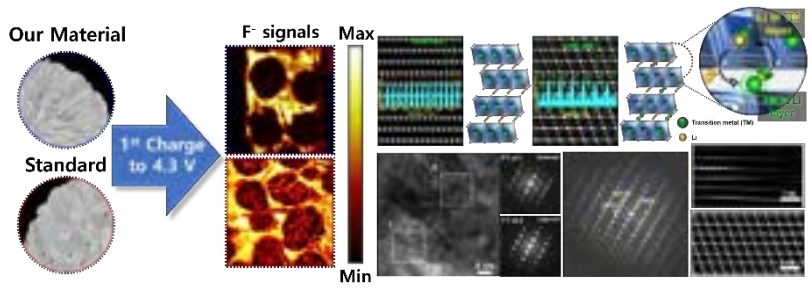
H. H. Sun, T. Pollard, O. Borodin, K. Xu, J. L. Allen, Degradation of High Nickel Li-ion Cathode Materials Induced by Exposure to Fully-Charged State and Its Mitigation, *Adv. Energy Mater.* 13, 2204360 (**2023**).

G.-T. Park, **H. H. Sun**, T.-C. Noh, F. Maglia, S.-J. Kim, P. Lamp, Y.-K. Sun, Nanostructured Co-Free Layered Oxide Cathode that Affords Fast-Charging Lithium-Ion Batteries for Electric Vehicles, *Adv. Energy Mater.* 12, 220719 (**2022**).

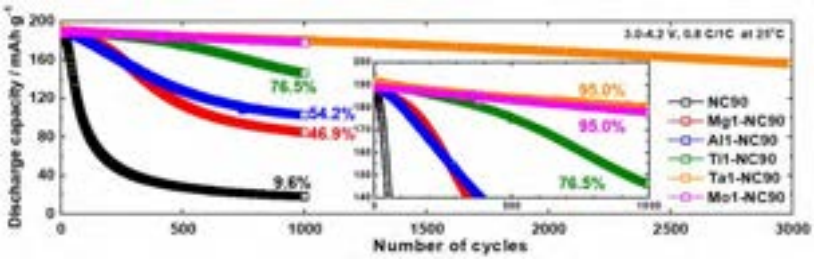
Dr. Sun's research group explores molecular phenomena and charge transport processes for the development of innovative energy materials for safer and sustainable energy storage applications.

Batteries are instrumental in supporting the energy transformation from fossil-fuel to sustainable energies, with applications ranging from portable electronics to larger grid energy storage and electric transport. This has been challenging though as batteries suffer from rising prices, cycling instabilities, and safety hazards especially at highly charged states, which in turn restrict the state-of-charge and, therefore, the energy density.

Our group is committed to enhancing the mechanical and chemical stabilities of next-generation energy materials to alleviate uncertainties and enable successful integration of batteries into our future energy systems. Specifically, the group engineers the micro- and nano-structures of material to bypass the inherent degradation pathway of battery materials to enable significantly increased cycling stabilities, even in strenuous conditions. These materials can be easily scaled-up from laboratory scale to larger pilot scale through batch type reactor synthesis to address the needs of industry. In addition, the group designs stable and conductive electrode-electrolyte interfaces through compositional engineering of electrolytes that facilitates smooth ion diffusion processes.



Micro- and nano-structure modifications



Cycling performance of engineered cathodes

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Tibor Szilvási

Computational Catalysis, Computational Materials Design, Energy Storage, Interfacial Phenomena, Surface Science

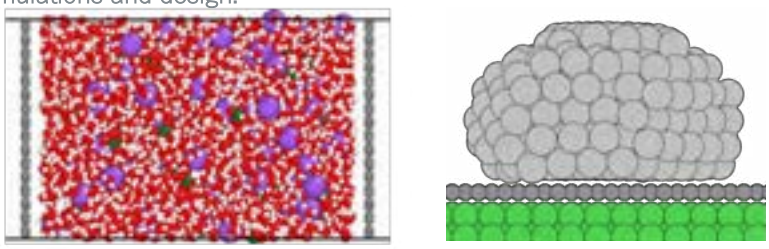


Tibor Szilvási
Associate Professor
Ph.D. Budapest University of Technology, 2016

Dr. Szilvási's research group focuses on designing functional materials with well-tailored specific properties by applying computational methods.

Societal needs require the development of efficient and cheap functional materials for various technologies. Our group is committed to accelerating the development of new materials by using fast and accurate computational methods to screen potential candidates and pinpoint materials with desired properties. Using computational methods, we can potentially save millions of dollars and years of tedious experimental efforts and therefore can provide solutions for pressing problems in time.

Dr. Szilvási's research group aims to focus on engineering interfaces and molecular materials. Specifically, the group intends (i) to understand and improve catalytic reactions, (ii) to identify functional materials, (iii) to design complex interfaces for energy and sensor applications. To achieve our goals, Dr. Szilvási's research group develops computational workflows that provide more accurate predictions for materials simulations and design.



Representative solid-liquid and solid-gas interfaces



Background of Dr. Szilvási's research group

Recent Publications

T. Maxson and **T. Szilvási**, Self-consistent DFT+ U for CO adsorption on transition metal surfaces: a practical correction and benchmark, *J. Catal.*, 458, 116875 (**2026**).

T. Maxson and **T. Szilvási**, Metal-Support Interactions Reshape Nanoparticle Catalyst Surfaces, *Angew. Chem. Novit.* 1, e70008 (**2025**).

T. Maxson and **T. Szilvási**, Transferable Water Potentials Using Equivariant Neural Networks, *J. Phys. Chem. Lett.* 15, 3740 (**2024**).

A. Soyemi and **T. Szilvási**, Calculated Physicochemical Properties of Glycerol-Derived Solvents to Drive Plastic Waste Recycling, *Ind. Eng. Chem. Res.* 62, 6322 (**2023**).

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C. Heath Turner

Computational Screening of Solvents, Desalination Technologies, Interfacial Phenomena, and AI-Driven Autonomous Computations



C. Heath Turner
Associate Dean for Research
Ph.D. Chemical Engineering
North Carolina State University, 2002

Dr. Turner's group uses computer simulations to investigate adsorption, interfacial phenomena, and environmental technologies. Their work helps guide the synthesis of new nanomaterials, identify new processes for environmental applications, and design new molecules for air and water purification. Many of the projects use novel AI/ML approaches for automating the material discovery process.

The Turner group uses molecular simulations and quantum mechanical calculations to screen new materials for a variety of clean energy technologies. In the field of catalysis, we are using kinetic Monte Carlo simulations to help identify environmentally-benign routes for synthesizing large-scale commodity chemicals. Also, we are using molecular simulation tools to screen solvents for purifying wastewater and industrial gas emissions. In all projects, we work closely with experimental collaborators, in order to regularly benchmark our models and develop reliable predictions. Through this research, students acquire excellent analytical and computational skills, especially involving programming AI/ML workflows, that can be applied to many different career fields after graduation.

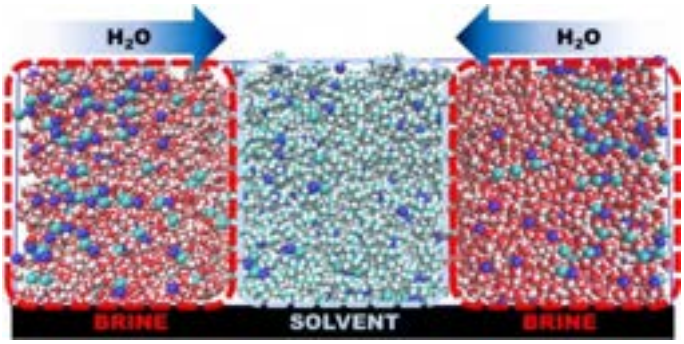
Recent Publications

I. S. Ibeto, A. T. Camba, J. E. Bara, and **C. H. Turner**, Molecular-Level Insights into the Influence of Ionic Liquids on the Structure and Dynamics of Neutral and Charged Polyimides, *Macromolecules* 59, 8073 (**2026**).

F. V. Olowookere, X. Teng, and **C. H. Turner**, A Molecular Dynamics Study of Aqueous Na^{+}/Mg^{2+} Intercalation Behavior in Vanadium Oxide Nanopores, *Langmuir* 42, 21163 (**2026**).

F. V. Olowookere and **C. H. Turner**, Improving Aqueous Metal Salt Interactions Using Machine Learned Interatomic Potentials, *Journal of Physical Chemistry B* 129, 10407 (**2025**).

Solvent Development for Brine Treatment and Nutrient Recovery



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Zhongyang Wang

Engineering Nanostructured Soft Materials for Energy and Sustainability



Zhongyang Wang
Assistant Professor
Ph.D. Energy, Environmental & Chemical Engineering
Washington University in Saint Louis, 2019

Dr. Wang's group leverages the self-assembly of functional soft materials (block copolymers and liquid crystals) to design next-generation polymer electrolytes for energy conversion and storage.

Polymer electrolytes are at the heart of many electrochemical systems such as fuel cells, electrolyzers, and batteries. In addition, they are the key components for sustainable technologies such as electrodialysis for seawater desalination and the chloralkali process. One of the main drivers that will advance the commercialization of these sustainable processes is the development of mechanically robust, highly ion conductive, ion selective, and chemically resistive polymer electrolytes.

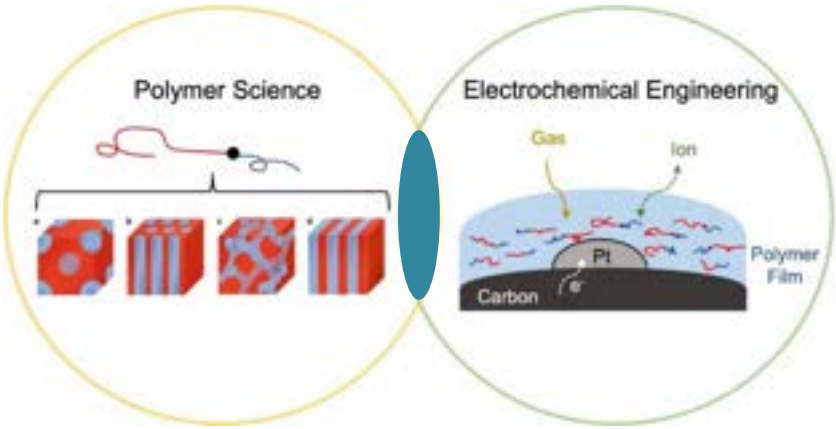
The Wang group aims to empower high-performance electrochemical systems and sustainable technologies by solving fundamental problems at the interface of polymer science and electrochemical engineering. The group focuses on three distinct areas: (1) understanding ion/electron transport in nanostructured block copolymers and liquid crystals, (2) developing efficient pH-gradient-enabled microscale bipolar interfaces for water and CO_2 electrolysis, and (3) engineering sub-2 nm structured liquid crystals for efficient water treatment and energy storage.

Recent Publications

M. Kim, G. Sun, Z. Yi, M. Mandal, R. Dong, K. Wang, P. A. Kohl, **Z. Wang,** C. G. Arges, S. N. Patel, J. J. de Pablo, and P. F. Nealey, Origins of Enhanced Ion Transport in Nanostructured Anion-Conducting Polyelectrolytes. *J. Am. Chem. Soc.,* 148, 24260–24273 **(2026)**.

Z. Wang, G. Sun, N. H. C. Lewis, M. Mandal, A. Sharma, M. Kim, J. M. Montes de Oca, K. Wang, A. Taggart, A.B. Martinson, P. A. Kohl, A. Tokmakoff, S.N. Patel, P.F. Nealey, J.J. de Pablo, Water-Mediated Ion Transport in an Anion Exchange Membrane. *Nat. Commun.*, 16, 1099 **(2025)**.

Overall research interest



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Steven Weinman

Membranes for Water Purification, Surface Science, Solvent Desalination, Water and Wastewater Treatment



Steven T. Weinman
Associate Professor
Ph.D. Chemical Engineering
Clemson University, 2018

Recent Publications

H. Rouhi and **S.T. Weinman**, Primary, secondary, tertiary, and quaternary Alkyl amine-functionalized PVDF membranes for DBSA removal, *Front. Membr. Sci. Technol.* 5, 1892716 (**2026**).

H. Rouhi, R.D. Copeland, R.M. Summers, **S.T. Weinman**, Biocatalytic membrane for the degradation of diisononyl phthalate, *Surf. Interfaces* 80, 108285 (**2026**).

L.M. Ward, S.K. Jarrell, E.B. Monti, G.D. Barbosa, J.T. Danner, J.E. Bara, C.H. Turner, **S.T. Weinman**, Substituent Effects on the Desalination Performance of Six-Carbon Amines in Temperature Swing Solvent Extraction, *Ind. Eng. Chem. Res.* 64, 24, 12173 (**2025**).

Dr. Weinman's group focuses on functionalizing and synthesizing membranes and new solvents to improve current water treatment technologies.

Membranes are semi-permeable barriers that separate substances when a driving force is applied across the membrane. The Weinman group works to provide solutions to current environmental challenges by developing new membrane and solvent technologies.

The Weinman Group focuses on synthesizing and studying the fundamental properties of membranes for microfiltration, ultrafiltration, nanofiltration, and reverse osmosis applications. This will allow us to better understand what factor(s) influence membrane properties and utilize this understanding to enable new separations.

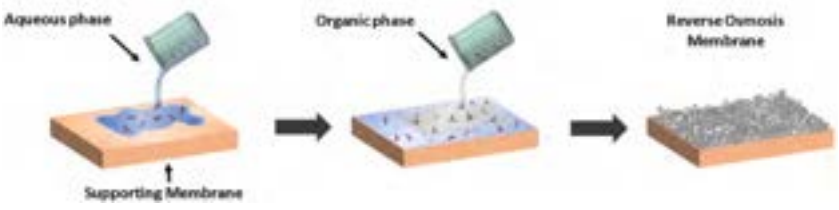
Progressive decline in water permeability due to fouling is one of the largest costs associated with membrane processes in water treatment. My research focuses on surface modifying membranes to reduce various types of fouling (oil, biological, scaling, etc.).

Another area of interest is creating membrane adsorbers and solvents to capture compounds of interest. There is a need to selectively remove persistent pollutants and high value products from numerous water sources.

Lastly, the Weinman Group is exploring new solvents for brine desalination where membranes cannot be used.







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Mingfei Zhao

Multiscale Modeling of Nanomaterials, Rational Design of Functional Biomaterials, Self-Assembly, Interfacial Phenomena, Fluid Dynamics



Mingfei Zhao

Assistant Professor
Ph.D. Mechanical Engineering
SUNY at Binghamton, 2019

Recent Publications

A. A. Onomah, K. L. Bicker, **M. Zhao**, Sequence Patterning Governs Lipid-Selective Insertion and Membrane Perturbation of Antimicrobial Peptoids. *Langmuir*, 42, 21085–21100 **(2026)**.

J. Wang, Z. Yu, **M. Zhao**, Extending the MARTINI 3 Coarse-Grained Force Field to Polypeptoids. *J. Chem. Theory Comput.*, 22, 6961–6975 **(2026)**.

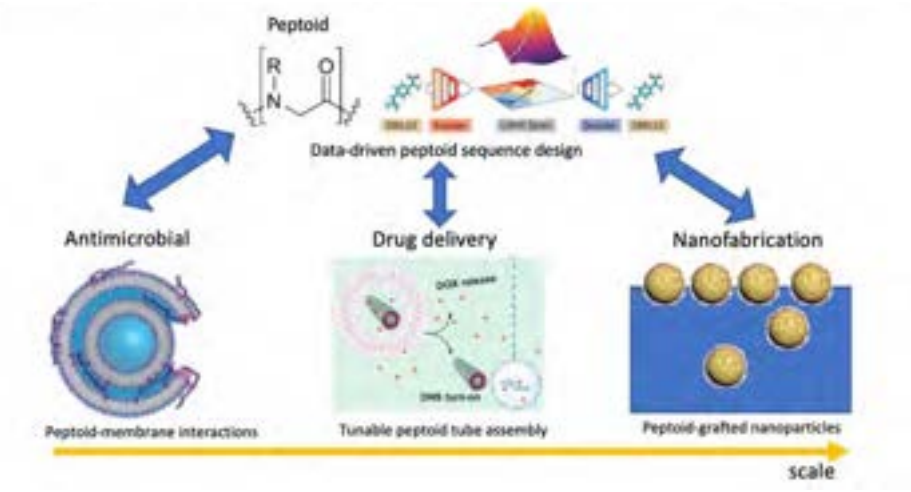
R. Zheng, **M. Zhao**, J. S. Du, T. R. Sudarshan, Y. Zhou, A. K. Paravastu, ... and C. L. Chen, Assembly of short amphiphilic peptoids into nanohelices with controllable supramolecular chirality. *Nat. Commun.* 15, 3264 (**2024**).

Dr. Zhao's group is interested in utilizing multiscale modeling techniques to understand and manipulate biomolecule and particle self-assembly towards a diverse spectrum of applications.

Hierarchical self-assembly offers a pathway for the bottom-up creation of nanomaterials, granting specific structures and functions not easily achievable through top-down methods. Employing multiscale computational modeling proves to be an influential tool in comprehending and managing the intricate assembly processes across varying length and time scales. Dr. Zhao's group aims to develop and use computational modeling tools in comprehending and steering self-assembly dynamics for rational design of advanced functional biomaterials.

Peptoids, recognized for their exceptional biocompatibility and stability, present promising avenues for applications in antimicrobials, drugs, and catalysts. Pioneering simulation endeavors from Dr. Zhao's group have unveiled critical understandings of the structures and properties of peptoid-based nanomaterials. Some examples of current projects include: (1) molecular modeling of peptoid assembly for drug discovery and delivery, (2) mesoscale modeling of peptoid-grafted nanoparticle assembly for advanced nanofabrication, and (3) data-driven molecular design of functional biopolymers.

Research Overview



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