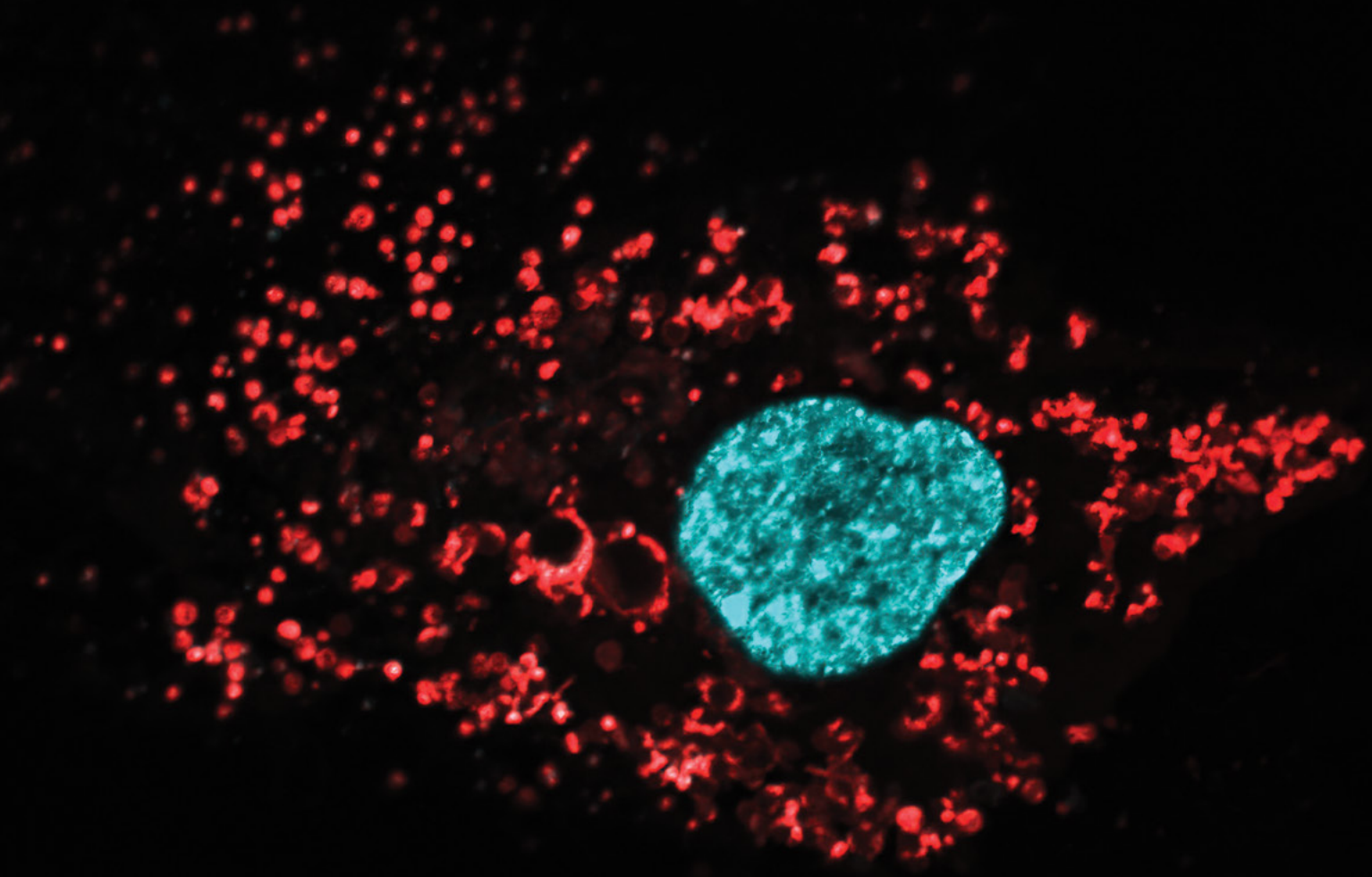
CATALYST

BREAKTHROUGH COLLABORATIONS IN HEALTH, ENERGY, AND THE ENVIRONMENT

Advancing science, supporting business, and improving people's lives.



University at Buffalo
Department of Chemical and Biological Engineering
School of Engineering and Applied Sciences

CHAIR'S **WELCOME**

Dear UB CBE Community,

I am writing these lines on the first day of classes for the 2022-23 academic year, which is an exciting time for CBE at UB. Last week, I met a fresh batch of incoming graduate students, eager to start the next phase of their academic journey. Today, we welcome back our undergraduate students and are reminded of the tremendous energy they bring to the campus and the department. The past year has been one of great success for the department, in terms of research grants, faculty and student awards, and a return to our annual Graduate Research Symposium in the fall and Ruckenstein Lecture in the spring.

With the launch of the Thomas Weber Outstanding Dissertation Award (see p. 20, back cover) the faculty had occasion to review the dissertations of the twenty PhD students who graduated from spring 2021 through winter 2022 and appreciate the tremendous depth and breadth of graduate research in the department. These students are not only generating new knowledge but are addressing some of the most pressing problems facing our planet. Their contributions range from medical advances like synthetic vascular grafts and reversal of cellular senescence (aging) to technologies to capture CO_2, generate and utilize H_2, and address challenges of plastic recycling and behavior of "forever chemicals" in our environment. Please take a moment to learn about the highlights of some of these students' work on pp. 10-16 of this newsletter.

Meanwhile, our faculty members are on a roll, winning awards and bringing in new grants, including a $4.5 million plastics recycling research center (see p. 6) and multiple new grants from the National Institutes of Health, Department of Energy, National Science Foundation, and others. While several notable grants are mentioned throughout this newsletter, we cannot describe them all – more than twenty have been awarded in just the past 6 months. Of course, we do not seek these grants for their own sake. Rather, they allow us to generate the kinds of scientific and technological advances you will find in the pages of this newsletter, and in the scores of original research articles we publish each year. More important, these funds support the growth and development of the outstanding student researchers and alumni who are the ultimate measure of our department's success.

Congratulations to our entire community on the successes of the past year and the tremendous momentum that we have as we begin this new year. Thank you for your continued interest in and support of our department. We have exciting days ahead!

Cheers,

Mark T. Swihart
Chair, SUNY Distinguished Professor and Empire Innovation Professor

Cover Image: *Accumulation of lysosomes (red) in a senescent (aged) skeletal muscle cell; the cell nucleus is shown in blue, courtesy of the Stelios Andreadis lab.*

$10+ MILLION
in annual research expenditures

More than
180 PUBLICATIONS PER YEAR
nearly all with graduate students as first authors *(see pg 10)*

6
SUNY Distinguished Professors

150
Graduate Students in 2022

FACULTY AWARDS & HONORS

AMIT GOYAL, SUNY Distinguished Professor and Empire Innovation Professor in the Department of Chemical and Biological Engineering, has been named Director of the new UB Plastics Recycling Research Center. The center is funded by a $4.5 million New York Department of Environmental Conservation (DEC) grant and includes a multidisciplinary team of university researchers and senior scientists, as well as recycling industry experts and DEC employees *(see p. 6 to read more)*. He was also awarded a U.S Department of Defense (DoD) grant to develop high performance superconducting wires with the goal of revolutionizing the electric grid.

ASHLEE FORD VERSYPT, Associate Professor, was selected for the American Institute of Chemical Engineers (AIChE) 2022 David Himmelblau Award for Innovations in Computer-Based Chemical Engineering Education. She was also named a 2021 Influential Researcher by *Industrial & Engineering Chemistry Research,* an American Chemical Society publication *(see p. 8 to read more).*

MIAO YU, Empire Innovation Professor in the UB RENEW Institute, is the recipient of the 2022 Separations Division FRI/Neil Yeoman Innovation Award from the American Institute of Chemical Engineers (AIChE). The award recognizes outstanding contributions to scientific, technological, or industrial areas involving separations technologies. Selection criteria include development and implementation of significant discoveries, creative research, or new processes and/or products. He has recently been awarded two substantial grants from the DOE, and is part of the largest Advanced Research Project Agency-Energy (ARPA-E) grant awarded, with approximately $1.5 million funded to UB *(see p. 9 to read more).*

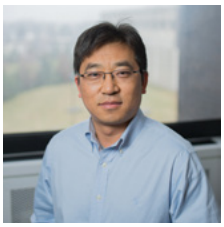
FACULTY AWARDS & HONORS

MARK SWIHART was named a SUNY Distinguished Professor. He is also chair of the Department of Chemical and Biological Engineering, and Empire Innovation Professor in the UB RENEW Institute. He is recognized globally for developing new nanoscale materials, engineering practical processes for producing unique materials, and generating fundamental understanding of those processes. His research group has developed methods and materials that have been adopted by researchers and industry worldwide. He was also part of a team of researchers that was recently awarded $7.5 million for an Air Force Office of Scientific Research Multidisciplinary University Research Initiative (MURI) program to improve computer chip reliability and security via revolutionary testing advancements.

SRIRAM NEELAMEGHAM has been designated a UB Distinguished Professor for his immense contributions to the University at Buffalo and the Department of Chemical and Biological Engineering. Neelamegham was instrumental in developing the department's current level of excellence in bioengineering. He has built a nationally and internationally recognized research program at the interface of engineering and medicine, addressing important challenges in inflammation, thrombosis, and cancer biology. Neelamegham has published more than 125 refereed journal papers and has several issued patents. His group has created widely used open-access software packages and toolboxes related to glycobiology. Nationally, he leads development of the Symbol Nomenclature for Glycans (SNFG) standards that have been adopted by many journals and other resources. He was previously honored with a National Heart, Lung, and Blood Institute (NHLBI) Independent Scientist Award, Jacob F. Schoellkopf Medal from the WNY American Chemical Society, and multiple SUNY and UB awards. He serves as an associate editor of several top-tier journals and on a key NIH study section.

STELIOS ANDREADIS, SUNY Distinguished Professor, has been elected a Fellow of the AIChE for his contributions to the area of biotechnology and bioengineering and in particular tissue engineering and regenerative medicine. He was recently named Director of UB's new Cell, Gene, and Tissue Engineering Center (CGTE) *(see p. 7 to read more).*

HAIQING LIN, Professor, has received the 2022 SUNY Chancellor's Award for his work in developing high-performance materials for various separation technologies, involving both gases and liquids. Much of his research is directed at capturing carbon dioxide. Lin has garnered 23 grants totaling $12 million, including support from the National Science Foundation (NSF), the U.S. Department of Energy (DOE), and the U.S. Department of the Interior. He has published more than 100 peer-reviewed papers, including 80 in just the past eight years. He is a co-inventor on 10 patents and patent applications.



GANG WU, Professor, has been named a Highly Cited Researcher for the fifth consecutive year by Clarivate Analytics. He also recently published a paper in *Nature Energy,* describing how iron can be combined with nitrogen and carbon to produce a catalyst that is efficient, durable and inexpensive – the three main objectives the U.S. DOE has identified for fuel cell research. The breakthrough will help unleash the full potential of hydrogen fuel cells.

PASCHALIS ALEXANDRIDIS, UB Distinguished Professor, was quoted in *The Wall Street Journal* in a story about a new DOE report showing that the U.S. recycles only 5% of its plastic waste. "The past couple of years included major disruptions due to China's National Sword program and due to COVID," Alexandridis said. Plastic use, overall, has grown exponentially and has become essential in many industries. "Plastic foams are thermal insulators, and lightweight engineering plastics contribute to significant energy savings and reduced CO_2 emissions," said Alexandridis. Alexandridis' research revealing how molecules of GenX, a fluorinated surfactant, and water intermingle to form complex structures called micelles and the potential hazards of GenX was quoted in multiple publications including the *Journal of Hazardous Materials, Plant Treatment Operator,* and *Phys.org.* The project is supported by an award from the National Science Foundation.

JOHANNES NITSCHE, SUNY Distinguished Teaching Professor, was featured in *Mirage News* and *AAAS Eurekalert!* under the heading "Does what goes on your skin get through?" His work, in collaboration with Professor Gerald Kasting of the University of Cincinnati and industrial partner Proctor & Gamble, explores ways to make products such as anti-aging and skin lightening creams, lotions, and gels more effective, while building fundamentally-based quantitative models of transport across the skin.

ELENI KYRIAKIDOU, Assistant Professor, received the UB School of Engineering and Applied Sciences Early Career Researcher Award for her achievements in advances in catalysis of carbon-hydrogen bond activation and related emissions reduction technologies with both fundamental scientific impact and important practical implications for controlling vehicle emissions. She has also been selected for the UB Exceptional Scholar Early Career award.

UB CBE Plays Leadership Role in Plastics Recycling

Researchers in the Chemical and Biological Engineering Department at the University at Buffalo are uniquely positioned to address plastics pollution, and are developing innovative solutions for recycling, outreach, and educational programs. They are also examining what happens when chemicals from plastic packaging interact with our water supply.

This spring, the New York State Department of Environmental Conservation awarded **$4.5 million** to create the New York State Center for Plastic Recycling Research and Innovation at UB.

The center expands upon a partnership between the DEC and UB that focuses on reducing plastic waste, while also improving the environment and fighting climate change in New York and beyond.

Researchers will study how to develop secondary markets to reduce the costs currently borne by municipal recycling programs, as well as best practices for streamlining the recycling process, especially with certain types of lower-grade plastics. Additionally, the center will:

- **Map** the reverse supply chain for plastics in New York State and conduct a deep dive into the structure of the collection, disposal, and recycling industries.
- **Improve** the efficiency of businesses involved in collecting and processing plastics in New York.
- **Research** plastics in natural environments.
- **Research** plastics in New York agriculture/food and medical industries.
- **Develop** understanding of public knowledge of and attitudes toward recycling.
- **Advance** high-speed plastic sorting by infrared imaging.
- **Undertake** several innovative academic- and community-based transformative seed projects.

AMIT GOYAL, SUNY Distinguished Professor and Empire Innovation Professor, serves as the project's principal investigator and the center director.

> *"Plastics are the single-biggest problem humanity faces, because we can't live without them... Their usage is increasing and not decreasing."*
>
> *—Amit Goyal*

PASCHALIS ALEXANDRIDIS, UB Distinguished Professor, is also leading a project to improve recycling of plastic packaging by deconstructing the materials and finding secondary uses for them. Nearly 50% of the world's plastic waste comes from packaging, and within that waste stream, about 50% consists of polymer-based, multilayer packaging. The major component of these thin layers of plastic is polyolefins. Cling wrap is a common example.

Researchers will investigate how to separate polyolefins and other plastics from additives or impurities using advanced solvents. The goal is to render the polyolefins suitable for reuse in new products, such as milk jugs and detergent bottles.

Information sourced from reporting from Nealon, Cory. "DEC awards UB $4.5 million to create plastics recycling research center." UB Now, April 26, 2022, and "UB-led team receives $555,000 grant to improve recycling of plastic packaging." UB Now, May 19, 2021

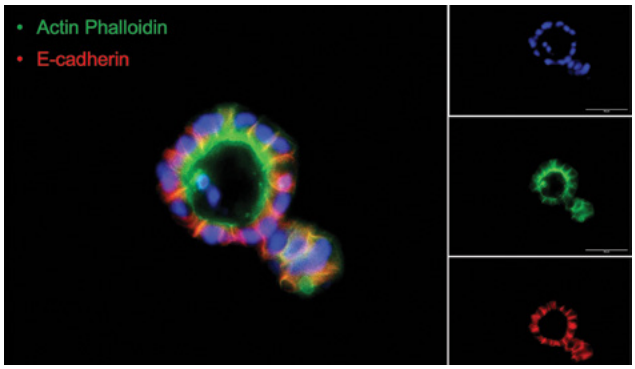
Engineering Health at CGTE

Last year, the University at Buffalo School of Engineering and Applied Sciences (SEAS) announced the launch of the new Cell, Gene and Tissue Engineering (CGTE) Center. The Center will further enhance existing cutting-edge research in the broad area of cell, gene, and tissue engineering; develop innovative engineering technologies for regenerative medicine; and educate the next generation of scientists and engineers to prepare them to be future leaders in the field.

The CGTE is directed by SUNY Distinguished Professor **STELIOS T. ANDREADIS** and is already investing in high-end technologies to enhance its research infrastructure, bringing together talented researchers from the UB School of Engineering, the Jacobs School of Medicine and Biomedical Sciences, the School of Pharmaceutical Sciences, and the School of Dental Medicine to promote innovation via interdisciplinary collaborations and make UB one of the leading institutions in this research area.

Recently, CGTE acquired several new instruments to facilitate research by our faculty. These include a state-of-the-art confocal microscope (Leica Stellaris 5), a quantitative live cell imaging and analysis system (Incucyte SX5), a Seahorse XFe96 metabolic analyzer, and a Zetasizer Ultra Red that provides accurate size and charge measurements of nanoparticles. These add to existing flow cytometry and mass spectrometry facilities that are used heavily by our faculty and students to enhance their research, scholarship, and grant seeking efforts.

Notably this past year, CGTE faculty published 110 papers and were awarded multiple grants. **JONATHAN LOVELL,** Empire Innovation Professor, Biomedical Engineering, recently received a new R33/R61 grant to develop new vaccine formulations for tuberculosis, based on multivalent antigen display on immunogenic liposomes, in collaboration with researchers from Roswell Park Comprehensive Cancer Center. **YUN WU,** Associate Professor of Biomedical Engineering, received two grants, one R01 and one R21, from the National Cancer Institute. The R01 project aims to develop an exosome-based liquid biopsy assay (i.e., Exo-PROS assay) for lung cancer early detection, and the prediction and monitoring of treatment responses to immune checkpoint inhibitors. The R21 project aims to develop exosome Thomsen-Friedenreich glycoantigen as a new biomarker for lung cancer screening and early detection. **SRIRAM NEELAMEGHAM,** UB Distinguished Professor in the Department of Chemical and Biological Engineering, and colleagues including **RUDIYANTO GUNAWAN,**



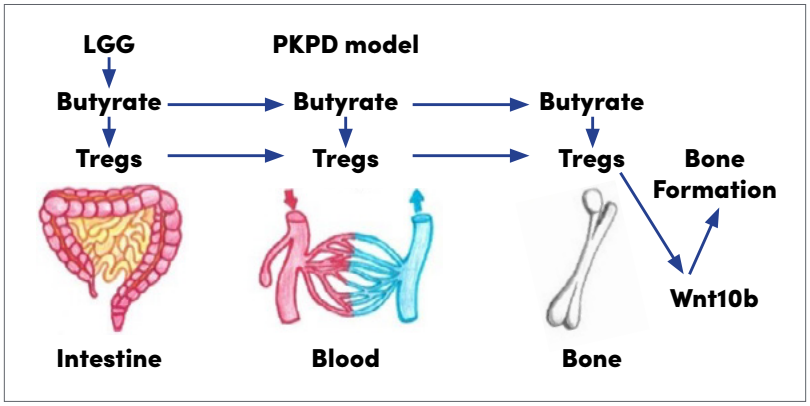
Luminal organoid from induced pluripotent stem cell derived gland progenitor cells. ***Photo courtesy of Ronel Z. Samuel from Stelios Andreadis group.***

CBE Associate Professor, renewed their NIH (National Institute of Health) grant on Systems Biology of Glycosylation to continue their work on high-throughput experimental and bioinformatic approaches to understand glycosylation in the context of various diseases such as cancer. The **BLAINE PFEIFER** group will be working with UB collaborators in the medical school on a new pneumococcal disease vaccine designed specifically for aged subjects. The work builds on Dr. Pfeifer's prior research devoted to vaccine design and delivery in using carrier systems to prompt a more comprehensive immune response, especially in those elderly patients who are more prone to pneumococcal disease (leading to pneumonia). **ELSA BOU GHANEM,** Assistant Professor, from the UB Department of Microbiology and Immunology is the co-investigator on this project. **LAERTIS IKONOMOU,** Associate Professor, UB Oral Biology secured a NIH R01 grant to study gene regulatory networks in early lung epithelial cell fate decisions. In collaboration with **OLGA BAKER** from the University of Missouri, **STELIOS ANDREADIS** received a R01 grant from the National Institute of Dental and Craniofacial Research (NIDCR), to develop novel approaches to enhance salivary gland regeneration in cancer patients receiving radiation therapy or patients with Sjogren's syndrome.

The UB Center for Cell, Gene, and Tissue Engineering publishes a monthly newsletter with updates about new research facilities, a monthly seminar series, and future events.

Integration of Research, Teaching, and Service Earns Himmelblau Award

The AIChE Computing and Systems Technology Division has recently recognized UB CBE Associate Professor **ASHLEE N. FORD VERSYPT** with the 2022 Himmelblau Award for Innovations in Computer-Based Chemical Engineering Education. Her innovative educational activities and related publications and software products have led to this and many other recent awards.



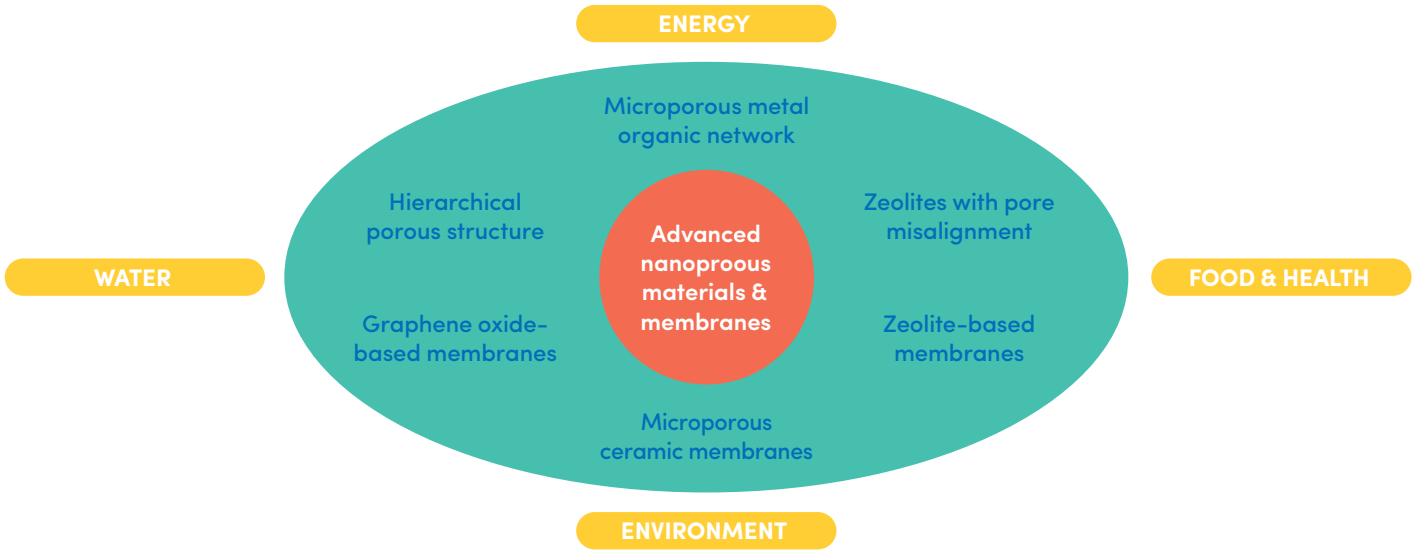
The National Science Foundation (NSF) emphasizes the integration of research and education through its Faculty Early Career Development Program (CAREER Award), which Ford Versypt received in 2019. The grant enabled the Ford Versypt group to develop computational models for kidney damage due to diabetes and create related educational activities, including one that trains undergraduate students to use tools from mathematical biology and chemical engineering to simulate human diseases; 11 undergraduate students have participated in this training in 2021-2022. Her group also led high school students in a hands-on drug dosing design simulation activity for the UB Chemical Engineering High School Summer Camp.

Additionally, Ford Versypt, masters student Austin Johns, and collaborators developed a 90-minute workshop on teaching with computational tools for the American Society for Engineering Education (ASEE)/American Institute of Chemical Engineers (AIChE) Summer School for Chemical Engineering Faculty. At UB, Ford Versypt has taught Principles of Chemical Engineering, Undergraduate Research, and Chemical Engineering Mathematics and Computation, in which she introduces chemical engineering through materials and energy balances, develops professional skills in undergraduate researchers, and trains graduate students in mathematical and computational methods.

She also serves as a trustee for the non-profit Computer Aids for Chemical Engineering. These educational and service activities are strategically integrated with the mathematical and computational techniques and applications studied by Ford Versypt's Systems Biomedicine and Pharmaceutics Laboratory to understand the mechanisms governing tissue remodeling and damage as a result of diseases and infections, and to simulate the treatment of those conditions to improve human health. Two of the lab's recent publications on modeling the effects of nutritional supplements on bone health have been invited and featured in the 2021 Class of Influential Researchers special issue of the *Industrial & Engineering Chemistry Research* journal and the 2022 Futures Issue of *AIChE Journal*. These and other publications have led to invited conference talks and seminars. Additional recent recognitions include the 2022 Young Alumni Achievement Award from the University of Illinois Urbana-Champaign Department of Chemical and Biomolecular Engineering, the 2021 Ernest W. Thiele Lectureship from the University of Notre Dame Department of Chemical and Biomolecular Engineering, and the 2022 AIChE Gary Leach Recognition Award for the AIChE Education Division Virtual Communities of Practice (for facilitating a virtual group of faculty shifting to online teaching of process control and chemical reaction engineering in response to the COVID-19 pandemic).

Image: Butyrate, a gut metabolite, influences the immune system through regulatory T cells (Tregs) in the gut–bone axis and promotes bone-forming activity. The Ford Versypt research group developed mathematical models for tracking butyrate throughout the body and its influence on Tregs and for simulating the consequences on bone metabolism. These models are detailed in two recent publications in Industrial & Engineering Chemistry Research *and the* AIChE Journal.

CO_2 Capture Research Earns **Miao Yu** the AIChE Neil Yeoman Award



PROFESSOR MIAO YU recently received the Neil Yeoman Innovation Award from the AIChE for his outstanding contributions to solving energy and environmental problems using nanoporous materials. The emission of carbon dioxide (CO_2), mainly caused by the combustion of fossil fuels, has increased sharply since the 1900s, and is the most significant driver of global warming, ocean acidification, and climate change. Targeting efficient CO_2 capture from both point sources and the atmosphere, Yu's group **is engineering various nanoporous materials as the basic building blocks to design and generate unique advanced nanostructures to either selectively adsorb CO_2 (by adsorbents) or allow selective permeation of CO_2 (by membranes).**

In addition to CO_2 capture/removal, Yu's group is developing carbon conversion technologies to transform CO_2 into valuable products in an efficient, economical, and environmentally friendly manner. Specifically, Yu's group is focused on membrane reactor (MR) technology to efficiently convert CO_2 into methanol, dimethyl carbonate, and dimethyl ether, which can be used directly as fuels or as fuel additives. **The core of the Yu group's MR technology is a microporous inorganic membrane, which allows permeation of small polar molecules, such as water (H_2O) and ammonia (NH_3), while blocking molecules as small as hydrogen (H_2).** Adoption of this highly selective membrane in the reaction system was found to boost CO_2 conversion by 2–3 times.

Finally, Yu's group is researching renewable NH_3 synthesis and H_2 production from NH_3 decomposition. Although H_2 is a clean and high energy density fuel, its transportation and storage are costly. NH_3 is a highly effective chemical carrier for H_2 that can drastically lower the cost of H_2 transportation and storage. Yu's group is focused on modular MR technology to achieve a high reaction rate and conversion at moderate temperature and pressure in a compact system, which will enable easy adoption in renewable H_2 production sites at different scales. Once NH_3 is produced, transported, and stored on site, one way of using it is to convert it back to H_2. **The group is therefore also working on H_2 production by NH_3 decomposition. They will design, fabricate, and test a 5 kg H_2/day scale prototype and demonstrate its use in vehicles.**

Other research directions in Yu's group include crude oil separation, organic solvent nanofiltration, gas mixture separation (air separation, natural gas purification, etc.), bioseparation, and water purification.

UB CBE GRADUATE RESEARCH

Metabolic Rewiring of Aged Myoblasts Restores Strength of Aged Skeletel Muscle

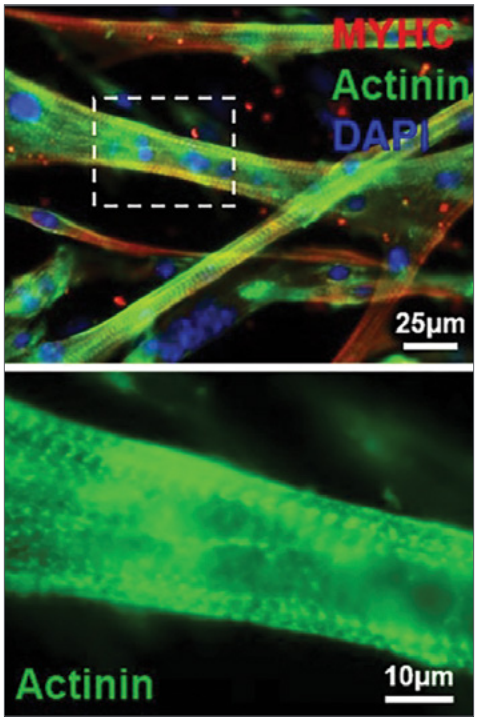


Image of a myotube, i.e., muscle fiber made in the lab.

Nika Rajabian is a PhD student in the Department of Chemical and Biological Engineering. Her advisor is **STELIOS ANDREADIS,** SUNY Distinguished Professor. She has been awarded the UB Excellence in Research, Scholarship and Creativity Award for 2022, and also the SEAS Dean's Achievement Award 2022.

Rajabian came to UB in 2016, and started her research in the field of stem cells, tissue engineering, and regenerative medicine with the purpose of reversing the effects of aging on stem cells. She is planning to continue her research on gene editing technologies and discovering novel therapeutic compounds to improve the function of old stem cells and extend people's healthy lives.

Skeletal muscle comprises approximately 40% of total body mass and plays essential physiologic functions such as enabling movement and regulating metabolism. Age-related muscle loss is a major medical problem facing the elderly and correlates with cranial fractures, type II diabetes, and cardiac insufficiency. Rajabian and her lab group conducted a study that improved muscle health and increased muscle strength during aging. In this work, she showed that aged skeletal muscle cells manipulate their bioenergetics from using glucose to methionine as a way to maintain or even increase adenosine triphosphate (ATP) levels necessary for survival. Notably, a gene that is expressed in the early stages of embryonic development, NANOG, could reverse these effects and restore the regenerative capacity of skeletal muscle, providing possible solutions for addressing skeletal muscle atrophy, one of the most important causes of functional decline in older adults. Rajabian's studies also revealed that NANOG works at least in part by inhibiting methionine metabolism, which she discovered causes insulin resistance, suggesting a possible mechanism in development of type II diabetes observed in older adults. These findings are novel and explain previous work linking methionine to inflammation and decreased lifespan, and others that touted the benefits of methionine restriction for geriatric subjects.

UB's Three Minute Thesis Finalists

Neurodegenerative diseases, reducing multiple surgeries, and vehicle emissions are some of the big problems that CBE's doctoral students addressed at The University at Buffalo 2022 3MT Competition.

Student: Bita Nasiri

Title: Say Farewell to Multiple Surgeries: Artificial Vessel that Grows with the Patient

Bita Nasiri came to UB in 2016 from Iran's Sharif University of Technology and will complete her PhD in fall 2022. Her advisor is **STELIOS ANDREADIS,** SUNY Distinguished Professor. Nasiri's research studies the production of cell-free vascular grafts that grow with the host to avoid multiple surgeries in pediatric applications. Congenital heart disease affects nearly 40,000 newborns annually in the United States, and requires surgical intervention to replace defective vessels with artificial ones that cannot grow with an infant into adulthood. Repeated surgeries are required to replace the artificial vessels with larger ones. To avoid repetitive surgeries, small diameter tissue-engineered vessels were developed from natural biomaterials, functionalized with heparin and vascular endothelial cell growth factor (VEGF) and implanted into the carotid artery of neonatal lambs for three months and six months. Blood cells called monocytes were recruited to the vessel surface by VEGF and turned into endothelial cells that maintained patency. Most important, the vessels also grew in size with the host and developed contractile function. The results suggest that these grafts are a strong candidate for treatment of congenital heart disease because they can grow with the host and serve as a permanent replacement, eliminating the need for repeated surgical procedures in babies while they grow.

Student: Chih-Han Liu

Title: Clean Cars: Novel Configured Catalysts for Catalytic Converters

Originally from Tainan, Taiwan, **Chih-Han (Judy) Liu** recently completed her PhD in the research group of Assistant Professor **ELENI A. KYRIAKIDOU.**

Her PhD research targeted improving gasoline and diesel vehicle catalytic converter efficiencies by developing uniquely structured catalysts with enhanced durability and low-temperature activity for emission remediation. The goal of Liu's research is to advance methods to eliminate 90% of vehicle exhaust pollutants at 150 °C, thus meeting strict emissions standards introduced by the Environmental Protection Agency. During her PhD, Liu published two first-authored articles in *Fuel and Chemical Engineering Journal.*

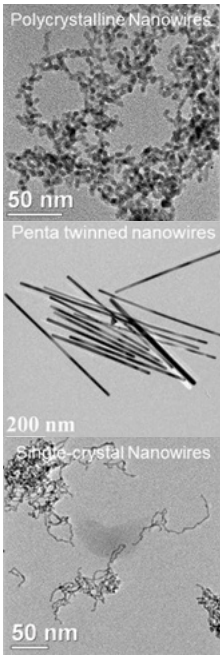
After graduation, Liu joined Alkegen (formerly Unifrax) in a new position as a development engineer in Flexcat for catalyst development. In this position, she will continue her journey of gasoline and diesel vehicle catalyst research. She is also expanding her expertise to other catalysts that could be highly valuable in industry.

Student: Mahasweta Bhattacharya

Title: Decrypting Your Brain: The Quest for Smarter Machines

Mahasweta Bhattacharya is a PhD candidate in the Department of Biomedical Engineering. She is originally from Kolkata, India, and is advised by **RUDIYANTO GUNAWAN,** Associate Professor in the Department of Chemical and Biological Engineering.

Her PhD project seeks to understand how neuronal activity of the brain changes when animals learn a new task, to leverage this understanding in hopes of developing efficient brain-machine interfaces for treatment of neurodegenerative diseases, and to formulate new computing and memory paradigms for solving the bottlenecks of current computer architectures. To this end, she employs a data science approach that combines statistical modeling of the brain's connectome with deep learning. She applies this strategy to analyze large datasets of neuronal activity in awake animals during learning and characterize learning-associated rewiring of the brain's connectome. In a recent publication, Bhattacharya and another PhD student in the laboratory (Saber Meamardoost) reported a new method, called FARCI (Fast and Robust Connectome Inference), that provides an accurate, efficient, and robust reconstruction of the brain's functional connectome from neuronal firing data, superior to existing methods. Applying this method to neuronal activity in the motor cortex of mice engaging in lever press task learning provides insights into the dynamics and operational principle of the brain's connectome rewiring during learning. The results show that functional connectomes in the motor cortex rewire in a biphasic manner by increasing connectivity among neurons in the first days of learning, followed by pruning of neuronal connectivity to return to a homeostatic level over weeks. Interestingly, motor performance improves significantly with the initial increase of connectivity (first phase), and it remains relatively stable during connectome pruning (second phase). Thus, motor skill learning rewires the functional connectome in the motor cortex to achieve not only good motor performance, but also an efficient connectome.



Shape-Controlled Synthesis and Applications of One-Dimensional Palladium Nanostructures

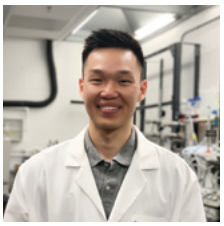
Abhishek Kumar recently earned his PhD in the Department of Chemical and Biological Engineering. His advisor was **MARK SWIHART,** SUNY Distinguished Professor and Department Chair. He has been awarded the first annual Professor Thomas Weber Best Dissertation award, endowed by Ranjit Chakravorti (see story back cover). He is currently a postdoctoral researcher at Pacific Northwest National Laboratory.

Kumar's PhD research focused on palladium-based nanowire synthesis for H_2 sensing and separation applications. Hydrogen (H_2) has great potential as an emission-free energy carrier to replace fossil fuels. Its usage, however, is limited by the current high cost of pure hydrogen production and storage and safety concerns arising from its flammability and lower explosion limit (4%). H_2 is produced in large quantities from fossil fuel with CO_2 as a byproduct. Palladium (Pd) has been widely investigated for H_2 selective separation and sensing due to its unique ability to form hydride phases (PdH_x) in the presence of H_2, and its large H_2 sorption capacity. Among the different Pd nanostructures, one-dimensional nanomaterials are of interest due to their high surface-to-volume ratio and effective electron and hydrogen transport pathways, which are advantageous in sensing and separations, respectively. Pd nanowires dispersed in polymeric membranes could provide an effective means of hydrogen separation. The change in electrical resistance of Pd nanowires upon hydride formation makes them useful in H_2 sensors.

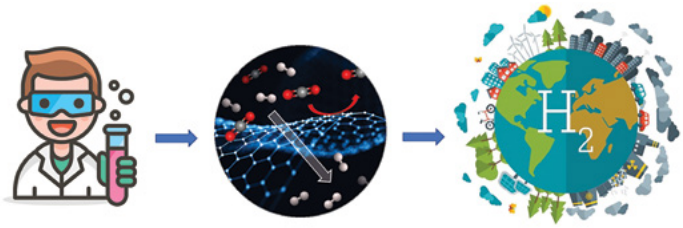
Key contributions of Kumar's dissertation include low-cost, paper-based sensors using Pd nanostructures that could advance the safety of hydrogen production, distribution, and emerging applications.

In addition to his work on Pd-based materials, during the early months of the COVID pandemic, Kumar developed copper nanowire-based materials and demonstrated their ability to impart antimicrobial activity to filtration media like that used in N95 masks. That work appeared in *Advanced Functional Materials* in 2020.

Image: Transmission electron microscopy images of three types of palladium nanowires.



Developing Membrane Materials for the Transition to a Hydrogen Economy

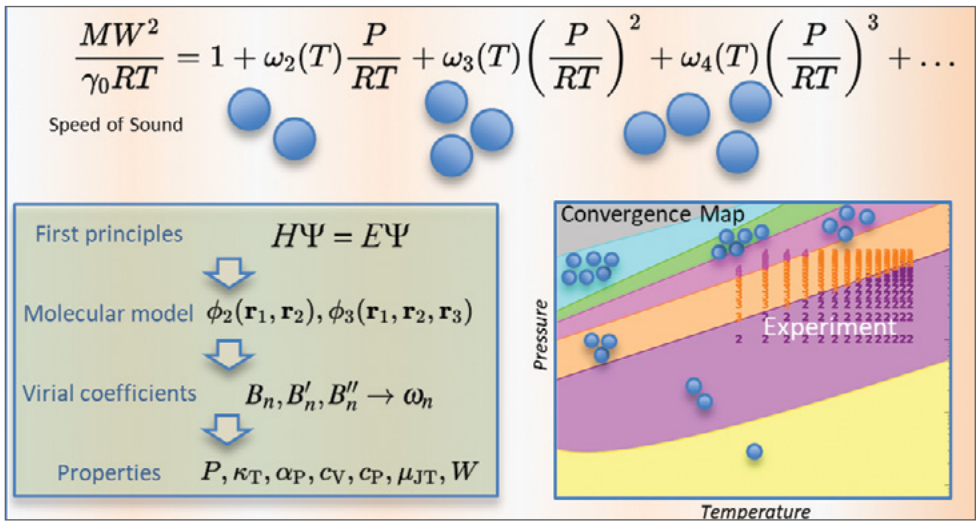


Vinh Bui is a PhD student in the Department of Chemical and Biological Engineering from Professor **HAIQING LIN'S** research group. At the North American Membrane Society 2022 conference, he presented his work on Plasma-Induced Organosilica Membrane for Hydrogen Purification, which won him second place for best poster presentation. Vinh earned his undergraduate degree in chemical engineering at UB and started his research career as a junior. "I fell in love with research, so I came back for a PhD...doing research is fun. It is full of surprises!" Bui said enthusiastically to explain why he's pursuing a a doctorate. Bui, a SEAS Schomburg Fellow, is now a third-year PhD student and a co-author of five publications in high impact journals such as *Science Advances, Journal of Material Chemistry A* and *Small*. He hopes to become a research scientist in industry after graduation.

With zero carbon emission upon combustion or reaction in a fuel cell, hydrogen is an important energy carrier for a carbon neutral society. However, current hydrogen purification technology consumes up to 20% of the energy generated and involves hazardous chemicals. Under Professor Lin's guidance, Bui is developing membrane materials for environmentally friendly hydrogen purification processes with low energy requirements. Their successful development can help lower hydrogen production costs, pushing the transition from a fossil fuel economy to a sustainable hydrogen economy.

Accurate Thermodynamic Models of Fluids from the Virial Equation of State

Navneeth Gokul recently earned his PhD in Chemical Engineering from UB CBE. His advisor was **DAVID KOFKE,** SUNY Distinguished Professor and Walter E. Schmid Chair. Gokul was a nominee for the UB CBE Outstanding Dissertation award for his research on Accurate Thermodynamic Models of Fluids from Molecular Models using the Virial Equation of State. He also received the student speaker award at the 2020 CBE Graduate Symposium. Born in India, he completed his bachelor's degree in Chemical Engineering at Vishwakarma Institute of Technology, Pune, India. He then moved to the United States to pursue his master's degree in Chemical Engineering at the University of Florida. He is currently working as a software development engineer at Intel and plans to continue working in scientific software development. His hobbies include reading, listening to and playing music, playing video games, and going on hikes.



Thermodynamic properties like the pressure, specific heat, isothermal compressibility, speed of sound, and Joule-Thomson coefficient are necessary for the design, optimization, and control of various engineering equipment. These properties can be measured experimentally, or extracted from molecular simulations. However, both experiments and molecular simulations are expensive and can only yield one state point at a time. An alternate approach involves using equations of state (EOS). EOS are inexpensive to evaluate and can typically be applied over a range of conditions. They can also yield multiple thermodynamic properties through thermodynamic identities. The virial equation of state (VEOS) is unique because it is the only EOS that rigorously relates molecular interactions to bulk thermodynamic properties. For this reason, Gokul's research focused on using the VEOS to compute thermodynamic properties of fluids for various molecular models.

In his doctoral research, he worked on three distinct projects. The first involved modifying the algorithm used to evaluate virial coefficients. His approach accounts for multibody intermolecular interactions and yields temperature derivatives of virial coefficients, which are needed for computing thermal properties. The second project generated an equation of state for multicomponent mixtures with an exact description of composition dependence. The third project examined the accuracy of ab initio virial coefficients for helium, which are based on first principles potentials.

Overall, the work focused on assessing and improving the accuracy and precision of the virial equation of state for various molecular models. These EOS are not only relevant to industries like petroleum, fertilizers, and carbon dioxide sequestration, but are also used in metrology and to evaluate universal constants, particularly the Boltzmann constant.

Elucidating Interactions of Persistent Pollutants

Samhitha Kancharla recently earned her PhD in the Department of Chemical and Biological Engineering under the joint advisement of **PASCHALIS ALEXANDRIDIS,** UB Distinguished Professor, and **MARINA TSIANOU,** Associate Professor. She was awarded an Outstanding Dissertation award from the department for her research on fluorinated surfactant self-organization and binding in aqueous media. She joined UB in the fall of 2016. During her PhD, Kancharla developed expertise on the structure and properties of nanomaterials and complex fluids formed by molecular organization of amphiphilic molecules. She applied this knowledge toward the solution of a vexing environmental problem, the sequestration from aqueous media of persistent pollutants known as "Forever Chemicals." Her PhD research was reported in ten first-author journal publications. She was a featured speaker at the CBE Graduate Research Symposium in 2021 and received a Mark Diamond Research Foundation Grant. Upon graduation, she joined Intel in Hillsboro, OR, where she works as a process engineer in dry etch module, developing recipes for new modifications in the chip manufacturing process, and sustaining the chip manufacturing process.

Kancharla's research focused on surfactants that comprise fluorinated hydrophobic chains and hydrophilic headgroups and are members of the per- and polyfluorinated alkyl substances (PFAS) family. Due to their unique properties, PFAS surfactants are used in many applications, including consumer products, cosmetics, and fire suppressants. However, they are extremely resistant to degradation, accumulate in the environment, and have long half-lives in humans. Thus, their presence in the environment is of great concern. The removal of PFAS from water presents a challenge. Meeting increasingly stringent regulations requires new PFAS-selective adsorbent materials. Molecular and supramolecular-level understanding of how PFAS molecules behave in solution and on surfaces is essential for designing new adsorbents. To address this need, Kancharla investigated PFAS molecular association in solution and binding to polymers. Among others, she published the first study on aqueous solution properties of the GenX PFAS surfactant, and the first report on the structure of PFAS surfactants bound to polymers.

Catalysts for a Sustainable Future

Junjie Chen recently completed his PhD in the Department of Chemical and Biological Engineering. His advisor was **ELENI KYRIAKIDOU,** UB Assistant Professor. He was awarded the Outstanding Dissertation award from the department for his research on engineering cost-effective metal/metal oxide-based catalysts with enhanced activity for low-temperature emissions control. He was also selected as a recipient of a SEAS Dean's Graduate Achievement Award, which honors exceptional graduate students who have distinguished themselves through excellence in research and related technical presentations/publications.

Chen grew up in the small town of Zhejiang, China, is a first-generation college student, and the first PhD in his family. He is currently a postdoctoral scholar at Stanford University, and he plans to pursue a research career in catalysis for creating a more sustainable environment.

Chen's PhD research, in collaboration with researchers from Oak Ridge National Laboratory, explored the underlying mechanism of methane activation over Ni/CeO_2-based catalysts for natural gas vehicle emissions control (CH_4 oxidation). The findings indicated that the oxygen storage capacity of the catalytic supports affect the catalytic performance. Chen improved the performance of these catalysts by controlling the CeO_2 support morphology. He also developed a bimetallic PdCo catalyst that showed 77% higher CH_4 oxidation reaction rates than Pd-only catalysts, even with lower Pd usage. Apart from the CH_4 oxidation catalysts, he also studied catalysts for diesel and gasoline vehicles and propane dehydrogenation reactions. The Pt-only three-way catalysts he developed showed activity and durability comparable to state-of-the-art Rh-based catalysts, but with much lower cost. This work was published in *ACS Catalysis, ChemCatChem, and Chemical Communications.*

Earth-abundant Materials Show Promise to Realize the Implementation of Hydrogen Fuel Cell Vehicles

Mengjie Chen recently completed his PhD in the Department of Chemical and Biological Engineering. His advisor was **GANG WU,** Professor. He was a nominee for the UB CBE Outstanding Dissertation award for his research on Engineering Nanostructures and Morphologies of PGM-free Cathode Catalysts for Enhanced Fuel Cell Performance and Durability. His research interests include nanomaterials and electrodes for energy conversion technologies. He is working as a research scientist at Fortescue Future Industries, which focuses on green hydrogen production.

Substantial attention has been paid to development of efficient energy conversion technologies that can meet rising energy demands while reducing environmental impact. Among others, electrochemical energy systems, especially hydrogen fuel cells, have been studied intensively worldwide. Production and utilization of hydrogen allow long-term chemical storage of energy from intermittent renewable sources (e.g., solar and wind) to improve energy sustainability. Hydrogen fuel cells can be used in fuel cell vehicles (FCVs), which are much more efficient than traditional combustion vehicles powered by gasoline. FCVs are powered by hydrogen, which produces only water as a product, with zero carbon emissions.

Electrocatalytic reactions involving oxygen play a crucial role in energy conversion, especially the oxygen reduction reaction (ORR), which occurs at the cathode in hydrogen fuel cells. At present, platinum (Pt) catalysts represent the state of the art in ORR electrocatalysis. However, the scarcity and cost of Pt have hindered widespread implementation in fuel cells.

To reduce the cost of the catalyst, Chen's PhD research focused mainly on platinum-free catalysts, which are particularly promising candidates to replace Pt catalysts because of the abundance and low cost of their component elements, as well as their high intrinsic ORR activity. This new type of catalyst has potential to eventually replace Pt catalysts in fuel cell vehicles and dramatically reduce their cost.

In these projects, the challenge is to develop atomically dispersed metal catalysts. Chen developed multiple methods to synthesize atomically dispersed metal catalysts and characterized their electrochemical and physical properties. The first was a self-assembly method to prepare a highly active atomically dispersed iron catalyst via a benign aqueous synthesis. The resulting catalyst exhibited homogeneous iron (Fe) active sites in a popcorn-like graphitic carbon matrix with excellent performance. However, it still suffered from insufficient durability. To address this issue, more stable manganese catalysts were designed and synthesized. Ultimately, a two-step doping-adsorption method was developed to increase the density of Mn active sites without clustering or agglomeration. This atomically dispersed manganese (Mn) catalyst achieved promising activity and excellent stability for the ORR. These new materials may make H_2 fuel cells much more affordable for widespread commercial application.

Left to Right: Vaishali Maheshkar, Yaoli Zhao, Patatri Chakraborty

Three UB PhD Students Chosen as Finalists in the Keysight Innovation Challenge

UB CBE PhD students Patatri Chakraborty and Yaoli Zhao, along with UB Computer Science and Engineering student Vaishali Maheshkar were selected as one of the top six finalist teams in the Keysight Innovation Challenge. Their project is entitled "Piezo-Cantilever Sensor for Real-time Monitoring of Eight Greenhouse Gases with LoRa Communication."

Teams of up to six students—with a female team leader and at least half female membership—were invited to participate by Keysight Technologies. **Teams submitted details about an Internet of Things (IoT) innovation that provides carbon neutrality, corporate site monitoring, multi-site monitoring, or community monitoring.** The proposed device must communicate wirelessly, be easy to deploy by a non-expert in a secure fashion, and must handle sensitive data. Designs were judged on sensor effectiveness, AI capabilities, and cybersecurity resilience. In the initial round, 52 teams submitted their entries with participants from over 106 countries. As finalists, the team will receive $2500 to further develop their proposed idea and present it in a final showcase in September 2022. Patrati is a student in SUNY Distinguished Professor **AMIT GOYAL'S** lab and Zhao is advised by Professor **THOMAS THUNDAT.**

UB CBE GRADUATE EVENTS

Top - Graduate Research Symposium participants; Bottom - Sharon Glotzer and Eli Ruckenstein.

» Over 200 people participated in the 2021 UB CBE Graduate Research Symposium, held on Friday, October 29, 2021. The event featured 30 posters, two lectures from senior graduate students, and a keynote lecture from Donald P. Visco Jr., University of Akron Professor, UB CBE Advisory Board Member, and PhD 1999, BS 1992. A video of his lecture "The Academic Pathway – Perspectives Along My Journey" can be found on UB CBE's YouTube Channel.

» The annual Ruckenstein Lecture, held each spring, honors the late Eli Ruckenstein, a prolific researcher who has made contributions in almost every subfield of chemical engineering. Each year, the series brings to our campus a distinguished scholar in chemical engineering to speak about research activities in his or her laboratory, trends in the field, and larger problems in society that chemical engineers can address. Sharon C. Glotzer, Anthony C. Lembke Department Chair of Chemical Engineering at The University of Michigan, Ann Arbor, delivered the 2022 Ruckenstein Lecture on "Bonding Through Entropy."

» ***Save the Date:*** *UB CBE's 25th Annual Graduate Research Symposium will take place in the UB Center for the Arts on* ***Friday, November 4,*** *and feature UB CBE alumna Maria Koutsona, PhD 2002, Research Guidance and Valuation Senior Advisor at Exxon Mobil Corporation in Spring, Texas.*

» ***Save the Date:*** *UB CBE will expand its annual Ruckenstein Lecture to create a day-long memorial symposium in Professor Ruckenstein's honor, tentatively scheduled for the week of* ***May 22-26, 2023.***

UNDERGRADUATE PROGRAM AWARDS

The CBE Department is very proud of the quality and capabilities of the students in our undergraduate program, and we want to see them succeed in every way. One measure of success is their advancement toward the degree. We also hope that the education they receive from us prepares them to be successful in their careers. But we can help them to achieve in other ways as well.

We think it helps our students, and the recognition of our program, to have students earning awards and scholarships that acknowledge their accomplishments and potential. The awards described on this page are one step in this direction, but we think we can do more. **Numerous prior UB CBE students have won major national awards, such as the Marshall Scholarship, Goldwater Scholarship, NSF Fellowship, and more.** We think we can grow the number of students garnering these recognitions by encouraging them to compete, and by coaching and mentoring them so that they can make a successful application.

Alumni and friends of the department can help with this effort. If you know of worthwhile awards suitable for our students, drop us a line and tell us about them. If you have experience with any of these award programs, we welcome your input, or perhaps you'd like to mentor a student toward a successful application; we can connect you. If you have other ideas, share how you think we can do more. **Our students are world-class, and we'd like to let the world know about them!**

David A. Kofke,
Walter E. Schmid Chair, SUNY Distinguished Professor,
Director of Undergraduate Studies

- **Professor Thomas W. Weber Undergraduate Excellence Award**
  Daniel Petrov and Caroline Schnabel
- **AIChE WNY Local Section Outstanding Senior Award**
  Thomas Rennells
- **AIChE WNY Local Section Outstanding Junior Award**
  Scott Coia
- **CBE Senior Academic Excellence Award**
  Jesse Canavan, Dylan Davignon, Madison Richardson
- **CBE Senior Leadership Award**
  Kathryn Birkholz, Michael Cueter, Jacob Freehart
- **CBE Junior Academic Excellence Award**
  Anish Avasthi, Joel Mercado, Bryson Shunk
- **WNY-ACS Distinguished Student Award**
  Elizabeth Haddad
- **Award for Student Achievement in Sexual Violence Prevention**
  Jennifer Elliott and Shanita Glover-Mangam
- **Chuang Family Scholarship**
  Dylan Davignon
- **Gregory B. Jarvis Scholarship Fund**
  Chintan Jayesh Shah
- **Issac Waugh Memorial Scholarship**
  Sarah Hamdan
- **Samuel R. McLernon and Nancy McLernon Memorial Scholarships**
  Russell Close
- **Barbara and Jack Davis Engineering Education Endowment Fund**
  Parker Catalano

ALUMNI SECTION

UB CBE Alumnus Jayant Singh, MS 2002, PhD 2005 Awarded the Herdillia Award for "Excellence in Basic Research in Chemical Engineering"

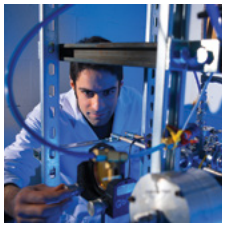
UB CBE alumnus **Jayant Singh,** MS 2002, PhD 2005 has been awarded the Herdillia Award for "Excellence in Basic Research in Chemical Engineering" by the Indian Institute of Chemical Engineers (IIChE). He has also been elected as a Fellow of the National Academy of Sciences, India (NASI). NASI is the oldest science academy of India.

While at UB in SUNY Distinguished Professor **DAVID KOFKE'S** research group, he focused on studying the effects of molecular association on the properties of fluid interfaces and developing new methods to calculate interfacial properties more accurately. He also undertook a problem on virial coefficient calculation using molecular simulations, which led to the development of an innovative technique, Mayer Sampling.

Jayant continues to study molecular behavior at the nanoscale, building upon his work at UB. More recently, he has revealed a universal nucleation behavior under shear flow which was published in the journal *Physical Review Letters* (Phys. Rev. Lett. 126, 195702, 2021). More details of recent contributions are at cnislab.com.

Meet Alumnus Matt Kahn

Matt Kahn, BS 1998, is co-founder of Buffalo's own Big Ditch Brewing Company. After graduating from UB CBE, he worked in the consumer products and pharmaceutical/biotech industries, until starting his own business with co-founder Corey Catalano. In 2011, Catalano suggested using a plastic bucket as a fermenter and the pair began brewing beer in his garage. Big Ditch opened for business in October of 2014 and the beer is now available throughout Western New York. As a way of giving back for the education he received at UB CBE, Kahn and Big Ditch host an annual alumni happy hour with food, and of course beer, for all our guests.



Clever Energy Solution Earns Parham Rohani DOE Grant

Parham Rohani, PhD 2018, MS 2013, recently landed a phase 1 Small Business Innovation Research (SBIR) grant from the Department of Energy (DOE) for his startup company, NanoHydroChem, LLC, co-founded with his PhD advisor, SUNY Distinguished Professor **MARK SWIHART.** NanoHydroChem is working to commercialize next-generation materials for lithium ion batteries based on research that Rohani began during his PhD studies. NanoHydroChem has licensed related patent-pending technology from UB and continues to collaborate with the Swihart group to advance it. Prior support for NanoHydroChem has come from the Buffalo Innovation Accelerator Fund and the New York State Energy Research and Development Authority.

Panagiotis Mistriotis Receives the Career Development Award from the American Heart Association

UB CBE alumnus **Panagiotis Mistriotis,** PhD 2016, has received a Career Development Award from the American Heart Association (AHA), to study vascular cell behavior within pathophysiologically-relevant confined microenvironments. The award spans three years, totals $231,000, and supports highly promising healthcare and academic professionals in the early years of their first professional appointment, to explore innovative questions or pilot studies that will provide preliminary data and training necessary to assure the applicant's future success as a researcher.

Dr. Mistriotis is a former member of SUNY Distinguished Professor **STELIOS ANDREADIS'** research group, and according to Professor Andreadis: "Panos' work on stem cell senescence was first-rate. He discovered that the hair follicle contains mesenchymal stem cells that were as multipotent as those from bone marrow. He also discovered that senescent stem cells can be rejuvenated, restoring their ability to differentiate into functional, force-generating muscle cells. His work set the stage for understanding molecular mechanisms of aging and rejuvenation that may ultimately lead to the development of anti-aging therapies."

Currently, Mistriotis is an Assistant Professor of chemical engineering at Auburn University and his research lies at the interface of engineering, biophysics, cell and molecular biology, and biochemistry. His research group is exploring how biochemical and biomechanical cues alter fundamental cellular processes such as migration, differentiation, and gene expression to develop novel therapeutic interventions against the initiation and progression of cardiovascular diseases, aging, and cancer.

Chemical Engineering Alumnus Recognized with Samuel Rosen Memorial Award from AOCS

Prabodh Varanasi (PhD '84) received the Samuel Rosen Memorial Award from the American Oil Chemists Society's (AOCS) Surfactants and Detergents division. The award recognizes an individual who has made a significant advancement, cumulative advancements, or application of surfactant chemistry principles. Varanasi has developed several new products in hair care, insect control, and home cleaning, along with materials to provide enhanced anti-staining properties to tooth surfaces in oral care applications.

Varanasi's breakthroughs extend to products associated with his other research interests such as interfacial and transport phenomena, or what occurs when two different phases (solid, liquid, or gas) come together. Additionally, he has significant achievements in rheology of emulsions and dispersions for applications in consumer products and industrial processes. Varanasi's work in this area led to several new and innovative products.

Varanasi chose to attend UB on a scholarship provided by SUNY Distinguished Professor and U.S. National Medal of Science awardee **ELI RUCKENSTEIN.** Shortly after earning his PhD, Varanasi began his career in the corporate research labs of S.C. Johnson & Son, Inc. His work there was recognized with 14 worldwide research and development technical merit awards.

Varanasi continued to develop innovative materials for different companies throughout his career, including SPX corporation, and BASF, a chemicals company, where he currently serves as the head of development for home, personal, and oral businesses, and is associated with BASF's industrial formulators business. His research has led to over 100 patents and publications.

Stella Alimperti Appointed Assistant Professor

Stella Alimperti, PhD 2014 and a former member of the Stelios Andreadis research group, has been appointed as Assistant Professor at Georgetown University. She previously served as principal investigator at NIST (National Institute of Standards and Technology) in Washington, D.C., and will retain an associate researcher title there. Alimperti's postdoctoral training was at Wyss Institute for Biologically Inspired Engineering.

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Ranjit Chakravorti Has Established the "Professor Thomas W. Weber Best Dissertation Award in Chemical and Biological Engineering" endowment

Ranjit and Sunanda Chakravorti

UB CBE is delighted to announce that alumnus Ranjit Chakravorti has generously established the "Professor Thomas W. Weber Best Dissertation Award in Chemical and Biological Engineering" endowment to recognize one PhD graduate each year who is selected by a faculty committee as having produced the best dissertation in that year. Congratulations to Abhishek Kumar, who is the inaugural recipient of this award *(see p. 12 to read more)*. Professor Weber, Dr. Chakravorti's PhD advisor, had a lasting impact on UB CBE, spending his entire academic career in the department, from 1963 to his retirement in 2000, including multiple terms as chair.