MASS Transfer

Fall/Winter 2022

CHEMICAL & BIOMOLECULAR ENGINEERING

Up-and-coming engineers

inspired by chemical engineering summer camp

Read more on page 20.

MASS Transfer

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About the cover:
Chemical and biomolecular engineering graduate students lead tenth- through twelfth-graders through hands-on experiments during an outreach summer camp that is part of The Grainger College of Engineering's Worldwide Youth in Science and Engineering Program.

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Letter from the Department Head

Greetings from Illinois!

It is a bittersweet feeling to be writing to you as I prepare to step down from my role as a department head on Nov. 15, a position I have held for over a decade. Next, I will serve as the director of the School of Chemical Sciences here at Illinois.


Paul Kenis

During my tenure as head, I have seen our department grow and prosper thanks to our community of faculty, staff, students, alumni, and friends. I look forward to passing the torch to another leader to usher in another era of growth and positive change. In the meantime, Reid T. Milner Professor **Deborah Leckband** has graciously stepped up to serve as our interim head.

Within these pages, you'll find countless examples of our department's prosperity—for instance, we have moved up into the **top five undergraduate chemical engineering programs** in the nation, according to U.S. News & World Report rankings.

This fall, we welcomed **Ryan Mullen** as a teaching assistant professor. Also, we look forward to assistant professor **Alexa Kuenstler** joining the department in January. In this edition, we showcase the work of Richard C. Alkire endowed Chair **Hong Yang** who has helped establish UIUC as a leader in nanotechnology and energy sustainability efforts.

At our annual alumni award event, we also celebrated another impressive cohort of alumni award winners who represent the best of what our graduates offer our industry and society—from prioritizing sustainability practices to leading diversity, equity, and inclusion efforts, and pursuing cutting-edge research.

Our students continue to excel, ranging from attaining competitive scholarships and fellowships to leading independent research efforts, many of which were showcased at our annual Graduate Research Symposium. A big thank you to our symposium judges: **Christopher Burcham** (BS '91), **Ashlee Ford Versypt** (MS '09, PhD '12), **Dale Kyser** (PhD '87), and professor **R. Mohan Sankaran**.

It has been a privilege to serve as the head and help shape the trajectory of Chemical Engineering at Illinois. Thank you for entrusting me to lead. I look forward to continuing to serve as a faculty member and director of the School of Chemical Sciences.

Yours sincerely,

Paul Kenis

Paul Kenis
Elio E. Tarika Chair in Chemical Engineering and Department Head

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Undergraduate program ranked No. 5 in the nation by U.S. News and World Report

The Department of Chemical and Biomolecular Engineering's undergraduate program moved up three spots to be ranked No. 5 nationwide by U.S. News & World Report.

"This recent ranking reflects our commitment to continually assess and improve our undergraduate program," said department head **Paul Kenis**, the Elio E. Tarika Endowed Chair. "Our faculty and staff are deeply invested in curriculum development, cross-curricular design, revitalizing lab-based learning experiences, and providing value-added student experiences to prepare chemical engineers who are capable and eager to tackle societal problems across many industries."

Specialized teaching faculty and tenure-track faculty work side-by-side to evaluate and improve the undergraduate chemical engineering curriculum. For example, by incorporating cross-curricular design assignments throughout the sophomore and junior level courses to ensure that students master the ability to address open-ended questions in collaborative teams—just like they will in the real world.

"During the pandemic, the university provided excellent online infrastructure, and our faculty embraced the opportunity to modernize their courses. We are working to maintain that momentum with new data science initiatives and a new laboratory fundamentals course," said director of undergraduate studies **Baron Peters**, William H. and Janet G. Lycan Professor. "Illinois has a long tradition of excellence in chemical engineering foundations. We want to maintain that while also emphasizing computation, probability, and data analytics to ensure that graduates from our program continue to excel in a changing industry."

Efforts are underway to realize a new $2.5 million, 3,000-square-foot laboratory space to house the undergraduate chemical engineering laboratory courses, including separate spaces for the specialized third- and fourth-year experimentation. The revitalized laboratory curriculum will include cutting-edge experiments relevant to current societal and industry needs, such as water purification, catalysis for sustainability, and food processing. The new laboratory will also house a new distributed control system to provide a hands-on facility for teaching process control.

Core required courses are offered in the fall and spring to help students who transition into the program from other disciplines or institutions and to allow students to pursue value-added experiences such as study abroad or six-month cooperative internships with industry partners.

Our program's dedicated career services team helps our students discover these opportunities and guides them through the process of arranging application materials and preparing for interviews.

Based on students' self-reports at graduation, 70% participate in an internship or co-op program, and 60% participate in undergraduate research or study abroad. More than 90% of our students report landing a job or acceptance into graduate school upon graduation.

"I am most proud of the community of chemical engineers we have created in Illinois," Kenis said. "What speaks volumes is the number of faculty and teaching and classroom assistants who have been ranked as excellent by our students. They add important context and dimension to the curriculum, but most of all, they are invested in student success."

Ryan Mullen joins ChBE's teaching faculty

The Department of Chemical and Biomolecular Engineering is excited to welcome **Ryan Mullen**.

Mullen joined the department as a teaching assistant professor in the Fall of 2022. He brings petroleum engineering experience from his time at ExxonMobil, a solid academic background in statistical mechanics from his graduate work at UC Santa Barbara, and a research background in molecular simulation from a postdoc and staff position at Lawrence Livermore National Laboratory.

"In each of my professional positions, I have found ways to work with students," Mullen said. "Whether as a summer mentor for an intern at ExxonMobil, a teaching assistant in grad school, or a classroom volunteer at the local grade school. My interactions with the students here at the University of Illinois have, so far, proven them eager to learn and to tackle the wide variety of problems faced by chemical engineers."

Mullen is a native of El Paso, Texas. His grandfather moved there in the 1960s for his work as a pipeline engineer with Chevron. "I remember Papa had a spare room full of computer parts in the early 90s. He loved building computers and tinkering with all kinds of machinery. I have a similar tinkering spirit, but with a focus on computer software and algorithms rather than hardware."

Mullen's love of engineering is rooted in high school, where he had excellent chemistry and calculus teachers. "Terry Peartree and Mary Kelly were both gifted at breaking down complex material in simple ways. When I began pursuing my chemical engineering degree in college, the demanding coursework didn't scare me because of the strong foundation they had given me."

He is teaching Process Design (CHBE 431) and will work with the faculty to develop the ChemE + Data Science certificate. "As a reservoir engineer at ExxonMobil, one of my responsibilities was to model the incremental revenue stream from the workovers and drillwells that my team proposed. In Process Design, the students learn to compute the same economic indicators we would use to rank our proposals."

"In each of my professional positions, I have found ways to work with students," Mullen said. "Whether as a summer mentor for an intern at ExxonMobil, a teaching assistant in grad school, or a classroom volunteer at the local grade school. My interactions with the students here at the University of Illinois have, so far, proven them eager to learn and to tackle the wide variety of problems faced by chemical engineers."

Ryan Mullen

Mullen also is committed to STEM outreach and has served as a Science Olympiad coach, presented Fun with Science to middle schoolers, volunteered for family science nights, and more. "I particularly love any excuse to develop video clips that show students how molecules behave in the same processes we observe with our eyes. After pouring liquid nitrogen on the floor for a class of fifth-graders—they ooh'd and ahh'd at the mist that formed. I made a clip that shows a ball of nitrogen molecules landing on an iron surface and instantly evaporating. I hope to use these skills to teach our students about abstract engineering concepts like internal energy and fugacity."

In his personal life, Mullen and his wife, Mary Karlee, have five kids who roll their eyes at how he laughs too loudly at Laffy Taffy jokes, sings off-key to rock songs and Broadway musicals, and gives "long science answers" to rhetorical questions.

If you'd like to connect with Dr. Mullen, he can be reached at rgmullen@illinois.edu.

Graduate and Alumni Awards Ceremony

The Department of Chemical and Biomolecular Engineering held its annual Graduate and Alumni Awards Ceremony on Oct. 14, 2022, to recognize Alumni Awards recipients, graduate student fellows, and the Graduate Research Symposium winners.

Department head **Paul Kenis**, the Elio E. Tarika Endowed Chair, said that one of the most rewarding aspects of serving as the head has been getting to know our accomplished and distinguished alumni, who inspired the department to launch the Alumni Awards program in 2019. "I am especially honored to help recognize several of these alumni whom I have come to know and respect for their dedication to pitch in to aid our department, our field, and even great issues such as fuel sustainability; water scarcity; diversity, equity, and inclusion; and more."

In her welcome remarks, **Venetria K. Patton**, the Harry E. Preble Dean of the College of Liberal Arts & Sciences, recognized the department's legacy of impactful research and teaching, as illustrated by the alumni and graduate students recognized during the ceremony. "With 37 academic units and 68 programs in all, no other dean on this campus has so many people and accomplishments to be proud of," Patton said. "The Department of Chemical and Biomolecular Engineering is one of the standard bearers in our college and across campus."

Venetria K. Patton, Dean of the College of Liberal Arts & Sciences

Since the inception of the Alumni Awards program in 2019, the department has recognized 36 Alumni Award winners, eight of whom were recognized at this year's event.

2022 Distinguished Alumni Achievement Award

Charles Damianides (MS '85, PhD '87)
Executive Director, Center for Sustainable Fuels and Chemicals, U.S. Department of Energy

Bob Dudley (BS '78)
Former Group Chief Executive Officer, bp

Chung Sul Youn "Sue" Kim (BS '55)
Innovator at Standard Oil of Ohio, Georgia Pacific, and Aerojet Corporation; professor, California State University, Sacramento

Kamalesh K. Sirkar (MS '66, PhD '69)
Distinguished Professor and Foundation Professor in Membrane Separations, New Jersey Institute of Technology

2022 Young Alumni Achievement Award

Ashlee N. Ford Versypt (MS '09, PhD '12)
Associate Professor, University at Buffalo, The State University of New York

Meagan E. Lewis (BS '08)
Regional General Manager, Honeywell Building Solutions

2021 Distinguished Alumni Achievement Award

Kathryn E. Gordon (BS '83)
Grassroots Ecology, Board Member

2019 Young Alumni Achievement Award

Jerrod A. Henderson (MS '07, PhD '10)
Assistant Professor, William A. Brookshire Department of Chemical and Biomolecular Engineering, University of Houston

Professor and director of graduate studies **Mary Kraft** recognized the fellowships awarded to the department's graduate students. "Each year, our graduate students are recognized for their achievements with various fellowships from the department, campus, national foundations, and corporate partners. These fellowships honor their scientific pursuits and academic accomplishments. We are very proud of our fellowship recipients and what these awards represent."

The ceremony concluded with two representatives from the Graduate Student Advisory Council (GSAC), **Sonji Lamichhane** and **Suchi Vijayaraghavan**, who recognized the Graduate Research Symposium judges, participants, and winners.

Read more about our Alumni Award recipients and submit your nomination at ***go.chbe.illinois.edu/AlumniAwards***. Nominations are accepted on a rolling basis with a deadline of July 1, 2023, to be considered for the 2023 Alumni Awards. Self-nominations are encouraged and all nominations are held for future consideration.

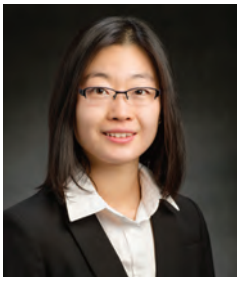
From left: GSAC first-year representative Huston Locht, department head Paul Kenis, internal vice president and co-organizer Suchi Vijayaraghavan, international chair and co-organizer Sonji Lamichhane, alumni judges Ashlee Ford Versypt and Dale Kyser, external vice president Rajarshi Samajdar, first-year representative Tony Pham, and president Destiny Collazo.

Alumni Awardees from left: Charles Damianides, Kamalesh Sirkar, Kathryn Gordon, Meagan Lewis, Ashlee Ford Versypt, Jerrod Henderson, and department head Paul Kenis.

Winners of the Graduate Research Symposium from left: Yash Laxman Kamble, Jarom Sederholm, Richa Ghosh, Melanie Brunet Torres, Susannah Miller and Ryan Miller.

Awards & Recognition

Diao chosen for Thiele Lectureship at Notre Dame



Associate professor **Ying Diao** was chosen to give the University of Notre Dame's Thiele Lectureship. The award was established in 1986 to honor Thiele's association with Notre Dame's Department of Chemical and Biomolecular Engineering. The annual lectureship recognizes outstanding research contributions by a younger member of the chemical engineering profession.

Diao's lecture was entitled "Printing Functional Polymers for Sustainable Earth and Habitable Mars." The abstract stated that printing technologies have the potential to revolutionize the manufacture of electronic and energy materials by drastically reducing energy costs and environmental footprint while increasing throughput and agility. Diao's research group is designing interfaces and fluid flow central to all printing processes by controlling chiral helical structures of semiconducting polymers. This approach enables precisely controlled charge transport and power generation properties of printed semiconducting polymers to help advance their commercial viability in solar cell devices.

Flaherty named College of LAS Dean's Distinguished Professorial Scholar

Professor **David Flaherty** is among four College of Liberal Arts & Sciences Dean's Distinguished Professorial Scholars who were recognized for their contributions to research and teaching. Launched in 2020, professorial scholars receive a stipend for teaching and research as they are promoted to full professors. Flaherty is the first recipient of this recognition in the department.

"This support will enable my students to seek training, attend conferences, and pursue other opportunities to advance their academic careers—I am grateful to be able to use this recognition to help the next generation of scholars," said Flaherty, who designs more reactive and selective catalysts to tackle challenges in environmental conservation and energy production.

Flaherty and Rogers honored with 2022 Campus Distinguished Promotion Awards

Professors **David Flaherty** and **Simon Rogers** are among 10 faculty members who received the 2022 Campus Distinguished Promotion Award in recognition of the scope, quality, and impact of their scholarship, teaching, service, and engagement efforts. The Campus Committee on Promotion and Tenure identifies particularly excellent cases, noting those scholars whose contributions are truly exceptional. The award includes a discretionary fund to support the recipient's scholarly activities.

"It is remarkable for two members from the same department to receive this recognition, which speaks to the excellence of our chemical and biomolecular engineering faculty," said department head **Paul Kenis**, the Elio E. Tarika Endowed Chair. "It is a privilege to work alongside Flaherty and Rogers who excel in teaching, research, and service. This honor is well deserved."

Rogers earns Metzner Early Career Award from The Society of Rheology

Associate professor **Simon Rogers** received the prestigious Arthur B. Metzner Early Career Award from the Society of Rheology in recognition of his distinguished rheological research. Rogers received this distinction "for developing fundamentally new experimental and analytical methods for linear and nonlinear transient rheology that have provided an improved understanding of complex flow phenomena in yield stress fluids, polymer solutions, and colloidal suspensions."

"It is an honor to be recognized by the society that is central to my research," Rogers said. "This recognition is the result of many collaborations, and I am grateful to my students, mentors, and colleagues who have supported our efforts to better understand how matter flows and deforms."

Rogers named I. C. Gunsalus Scholar by College of LAS

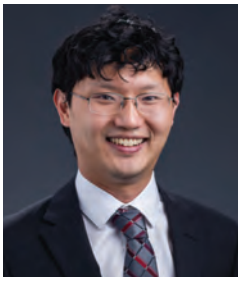
Associate professor **Simon Rogers** has been named a 2022-2023 I. C. Gunsalus Scholar by the College of Liberal Arts & Sciences. This named scholar position recognizes contributions to education and research at Illinois. The I. C. Gunsalus endowment supports the development of the scholarship and teaching of young faculty members in the physical and life sciences. The distinction includes using the title for the next academic year and a stipend to support research and teaching.

Shukla chosen for NAE's Frontiers of Engineering symposium

Associate professor **Diwakar Shukla** is among 84 highly accomplished early-career engineers selected to participate in The Grainger Foundation Frontiers of Engineering. Hosted by the National Academy of Engineering, this U.S.-based symposium brings together engineers performing exceptional research and technical work in various disciplines for the two-and-a-half-day event.

“It is a privilege to be chosen to discuss how best to harness engineering to benefit our society with so many distinguished early-career engineers,” said Shukla, whose work is focused on understanding complex biological processes using physics-based models and techniques.

Su elected to the Center for Advanced Study



Assistant professor **Xiao Su** is among the Center for Advanced Study’s newly elected fellows for 2022-2023. The CAS identifies the top scholars on campus and provides one semester of release time from teaching duties for fellows to concentrate on creative work.

Su’s research focuses on developing new materials and processes for advanced separations and intensification. His group leverages stimuli-responsive materials and redox-electrochemistry to achieve molecular selectivity and energy efficiency. He was elected based on his proposal, “Chiral Electrochemical Interfaces for Enantioselective Interactions,” which seeks to advance the fundamental design and study of enantioselective interactions at interfaces.

Zhao receives AIChE Food, Pharmaceutical and Bioengineering Division Award

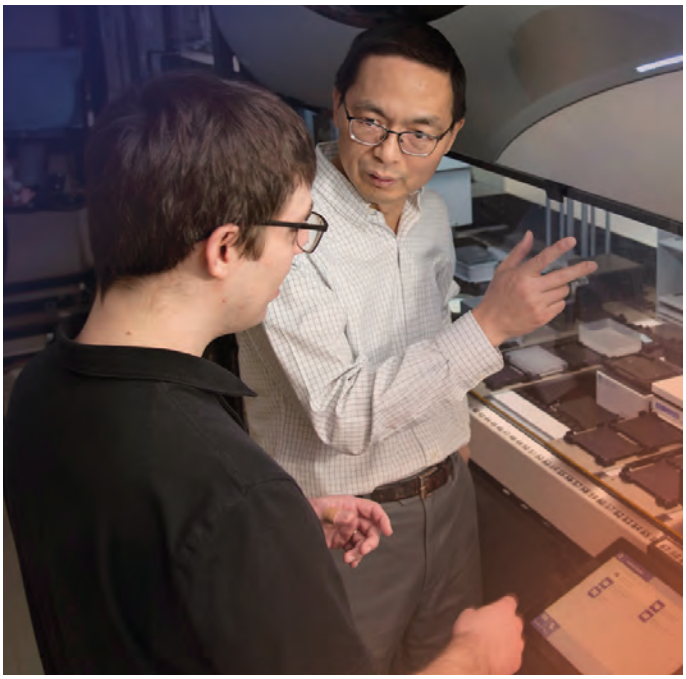
Professor **Huimin Zhao**, the Steven L. Miller Chair, has received the 2022 Food, Pharmaceutical and Bioengineering Division Award in Chemical Engineering from the American Institute of Chemical Engineers (AIChE). The Division Award recognizes an individual's outstanding chemical engineering contribution in the food, pharmaceutical, and/or bioengineering field, which is of a fundamental nature and/or of practical significance to industry and industrial practice.

“I am deeply honored and humbled to receive this award,” said Zhao, who develops and applies synthetic biology tools for industrial and medical applications and studies the fundamental aspects of enzyme catalysis, cell metabolism, and gene regulation.

Huimin Zhao to lead ACS Synthetic Biology as editor in chief

Huimin Zhao has been appointed editor in chief of ACS Synthetic Biology by the Publications Division of the American Chemical Society. Zhao previously served as a founding associate editor of ACS Catalysis, a position he held from 2011–2022.

“Advances in synthetic biology are needed more than ever as the world seeks solutions to improve human health, mitigate climate change, and reduce environmental waste,” Zhao said. “I am excited to lead the world-renowned journal ACS Synthetic Biology, particularly as the field enters an exponential growth phase that has attracted numerous researchers, government funding, and private sector interest.”



Research Highlights

Redox, reuse, recycle: Novel process extends life cycle of valuable catalysts

A team of researchers has developed an electrochemical technique for recycling highly valuable homogeneous catalysts, typically made of sparsely available platinum-group metals, in an effort to make the chemical manufacturing industry greener, more affordable, and more innovative.

"What makes homogeneous catalysts incredibly valuable is their unique ability to produce large volumes of value-added chemicals and commodities," said assistant professor **Xiao Su**, the senior investigator of the study published in Science Advances.

> "The cool part about our recycling method is that it's purely electrically driven. It's a step toward making the whole manufacturing process more sustainable and having electricity driving things instead of heat."
>
> **Xiao Su**

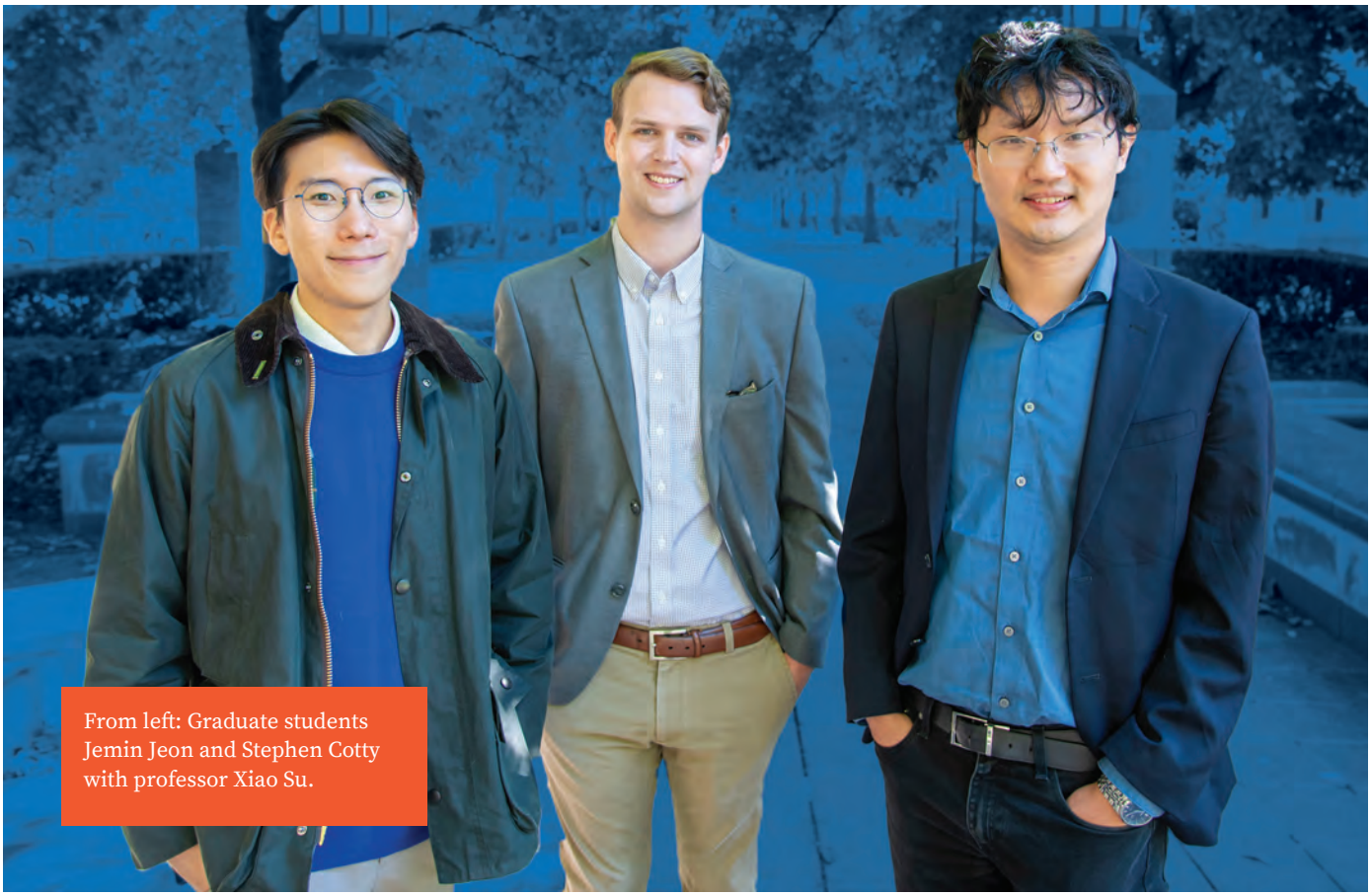
During chemical reactions, homogeneous catalysts often end up in complex chemical mixtures and are difficult to separate from other components. The few existing methods for recycling catalysts are energy-intensive, and their reliance on heat tends to destroy the catalyst structure itself while creating a large carbon footprint. Due to increased waste production, the cost of persistent mining is absorbed by manufacturing companies, end users, and the environment.

The researchers' proposed recycling method applies an electrical field to a uniquely tailored surface called a redox-electrode. The catalysts separate from the chemical mixture they are in and bind to the surface under the electrical field, removing them from the reaction they're in and recycling them. To reuse the catalyst, a chemist can apply the opposite electrical field to the redox-electrode surface to release the catalyst into a new solution.

Under the electrical process, catalysts can be reused for many cycles.

"The cool part about our recycling method is that it's purely electrically driven," Su said. "It's a step toward making the whole manufacturing process more sustainable and having electricity driving things instead of heat."

Read more: go.chbe.illinois.edu/ValuableCatalysts2022



From left: Graduate students Jemin Jeon and Stephen Cotty with professor Xiao Su.

Scientists crack upcycling plastics to reduce greenhouse gas emissions, advancing a recent Science study

A team of scientists have developed a breakthrough process to transform the most widely produced plastic—polyethylene (PE)—into the second-most widely produced plastic, polypropylene (PP), which could reduce greenhouse gas emissions.

"We started by conceptualizing this approach and demonstrated its promise first through theoretical modeling—now we have proved that it can be done experimentally in a way that is scalable and potentially applicable to current industry demands," said co-lead author and associate professor **Damien Guironnet**, who published the first study outlining the necessary catalytic reactions in 2020 with William H. and Janet G. Lycan Professor **Baron Peters**.

The new study published in the Journal of the American Chemical Society announces a series of coupled catalytic reactions that transform PE, which accounts for 29% of the world's plastic consumption, into the building block propylene that is the key ingredient to produce PP, which accounts for another 25% of global plastic.

The work presented in this publication complements a recent paper published in Science. Both groups used virgin plastics and similar chemistries. However, the Science team used a different process in an enclosed batch reactor, requiring much higher pressure—which is energy intensive—and the need to recycle more ethylene.

"If we are to upcycle a significant fraction of the over 100 million tons of plastic waste we generate each year, we need highly scalable solutions," Guironnet said. "Our team demonstrated the chemistry in a flow reactor we developed to produce propylene highly selectively and continuously. This is a key advance to address the immense volume of the problem that we are facing."

Read more: go.chbe.illinois.edu/UpcyclingPlastic2022

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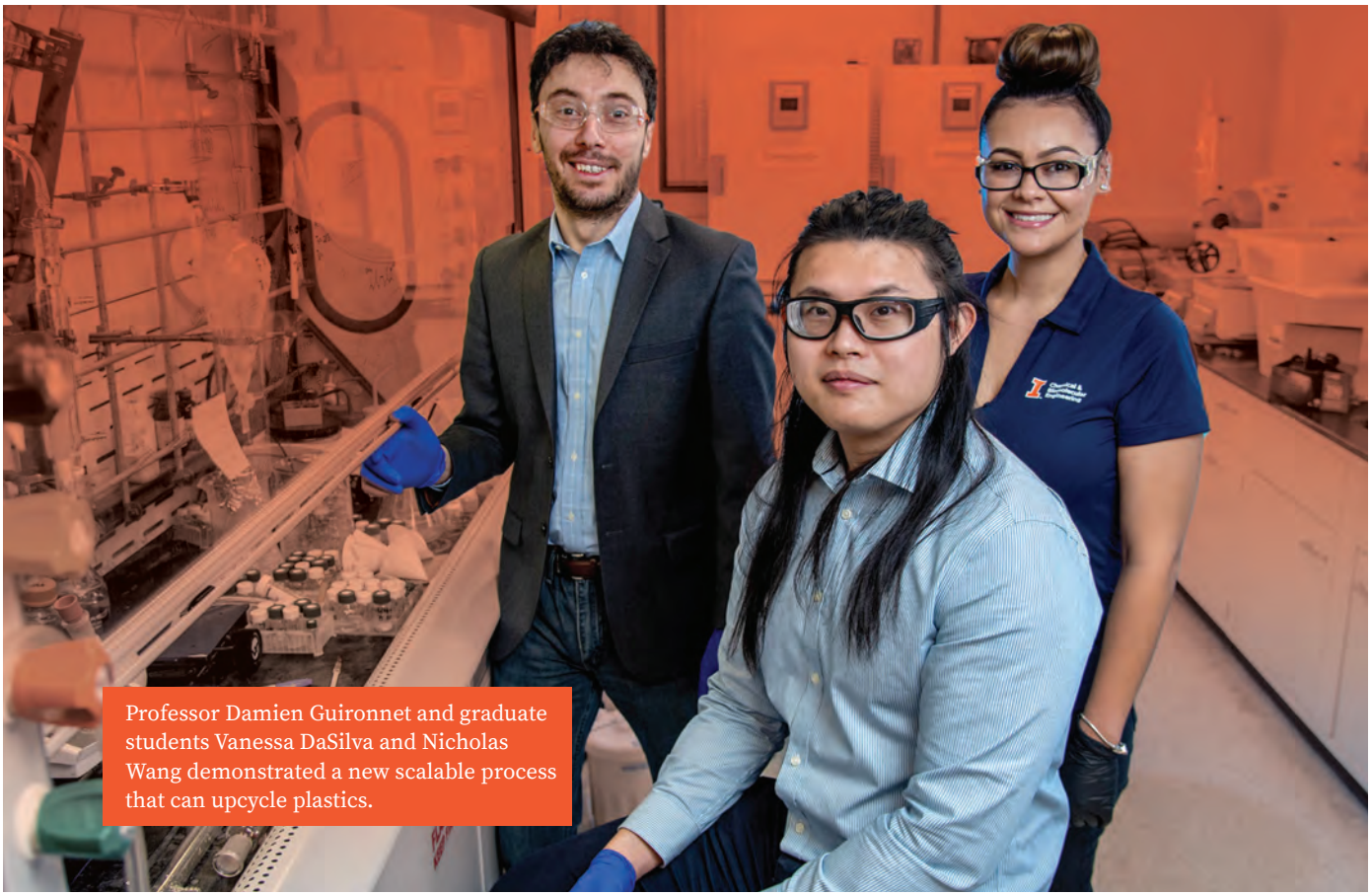

Professor Damien Guironnet and graduate students Vanessa DaSilva and Nicholas Wang demonstrated a new scalable process that can upcycle plastics.

New polymer property could give accessible solar power a boost

Lightweight as a window cling and replicable as a newspaper, organic solar cells are emerging as a viable solution for the nation's growing energy demand.

Associate professors **Ying Diao**, **Qian Chen**, and **Diwakar Shukla** and their researchers are the first to observe a biological property called chirality emerging in achiral conjugated polymers, which are used to design flexible solar cells. Their discovery, published in Nature Communications, could help enhance the cells' charge capacity and increase access to affordable renewable energy.

“Chirality is a fascinating biological property," said Diao, the study's principal investigator. "The function of many biomolecules is directly linked to their chirality. Take the protein complexes involved in photosynthesis. When electrons move through the proteins’ spiraled structures, an effective magnetic field is generated that helps separate bound charges created by light. This means that light can be converted into biochemicals more efficiently."

Diao and her colleagues observed that under the right conditions, achiral conjugated polymers can depart from the norm and assemble into chiral structures. Achiral is an object that is identical with (superimposable on) its mirror image whereas chiral objects are not identical or superimposable, like left and right hands.

This work introduces new opportunities for research at the convergence of biology and electronics. For the first time, scientists can apply chiral structure to the various materials that require achiral conjugated polymers to function.

“Now that we’ve unlocked the potential for chiral conjugated polymers, we can apply that biological property to solar cells and other electronics, learning how chirality enhances photosynthesis in nature,” Diao said. “With more efficient organic solar cells that can be manufactured so quickly, we can potentially generate gigawatts of energy daily to catch up with the rapidly increasing global energy demand.”

> “This remarkable emergence of chirality in conjugated polymers could open new avenues of applications beyond solar cells: polarization-sensitive imaging, smart machine vision, chirality-selective catalysis, and even the engineering of novel, lightweight topological mechanical metamaterials that can shield shock and minimize impact. Our work provides direct insight into how to make these applications happen.”
>
> **Qian Chen**

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Read more: go.chbe.illinois.edu/PolymerProperty2022

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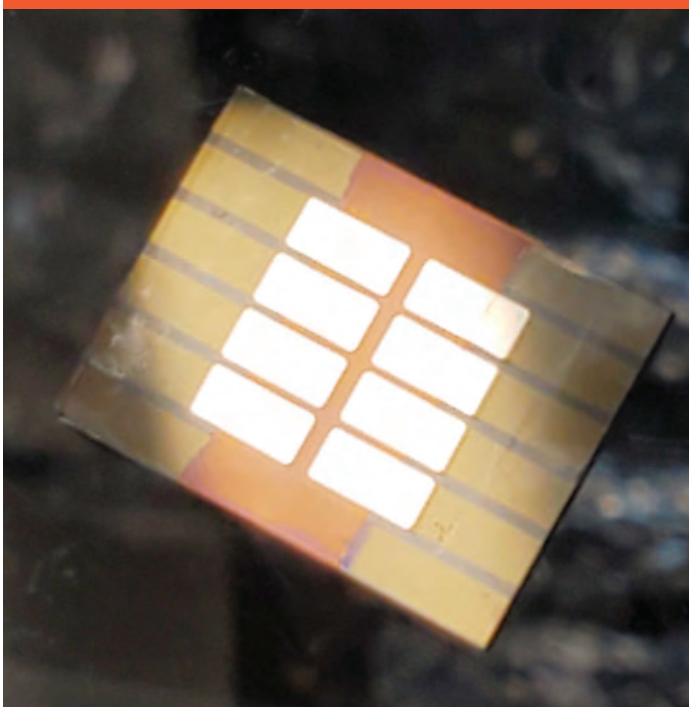
>
> **Ying Diao**

Organic solar cells like the one pictured are emerging as a viable solution to meet the nation's growing energy demand.



The Illinois Biological Foundry for Advanced Biomanufacturing (iBioFAB) supports the automated construction of plasmids through a new platform called PlasmidMaker.

Team develops automated platform for plasmid production

Plasmids have extensive use in basic and applied biology. Scientists use these small, circular DNA molecules to introduce new genes into a target organism. Well known for their applications in the production of therapeutic proteins like insulin, plasmids are broadly used in the large-scale production of many bioproducts.

However, designing and constructing plasmids remains one of the most time-consuming and labor-intensive steps in biology research.

iBioFAB is a fully integrated computational and physical infrastructure that supports rapid fabrication, quality control, and analysis of genetic constructs. It features a central robotic arm that transfers labware between instruments that perform distinct operations like pipetting, incubation, or thermocycling.

To address this, researchers led by Steven L. Miller Chair **Huimin Zhao** have developed a versatile and automated platform for plasmid design and construction called PlasmidMaker. Their work for the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI) was recently published in Nature Communications.

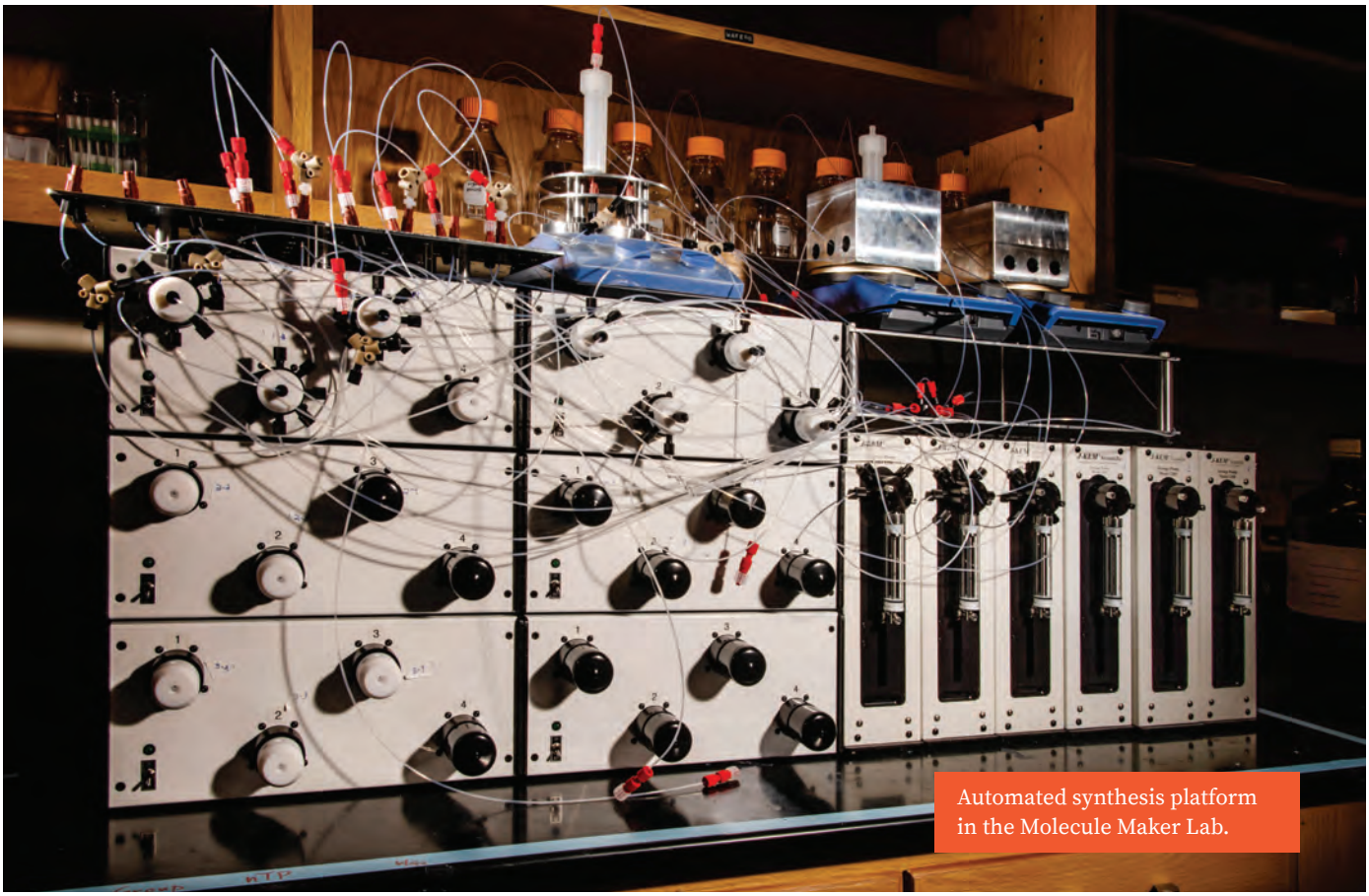
Creating a plasmid starts with design. To aid in this design process, PlasmidMaker has a user-friendly web interface with which researchers can intuitively visualize and assemble the perfect plasmid for their needs.

Once the plasmid has been designed, it is submitted to the PlasmidMaker team, and an order for the plasmid is placed at the Illinois Biological Foundry for Advanced Biomanufacturing (iBioFAB), where the plasmid will be built.

iBioFAB is a fully integrated computational and physical infrastructure that supports rapid fabrication, quality control, and analysis of genetic constructs. It features a central robotic arm that transfers labware between instruments that perform distinct operations like pipetting, incubation, or thermocycling.

“This tool will be available to CABBI researchers, and we want to eventually make it available to all researchers at the other three Bioenergy Research Centers,” Zhao said. “If things go well, we hope to make it available to all researchers everywhere.”

Read more: go.chbe.illinois.edu/PlasmidProduction2022



Automated synthesis platform in the Molecule Maker Lab.

Automated synthesis allows for discovery of unexpected charge transport behavior in organic molecules

A cross-disciplinary team has demonstrated a major breakthrough in using automated synthesis to discover new molecules for organic electronics applications.

The technology that enabled the discovery relies on an automated platform for rapid molecular synthesis at scale— which is a game-changer in the field of organic electronics and beyond. Using automated synthesis, the team was able to rapidly scan a library of molecules with precisely defined structures, thereby uncovering, via single-molecule characterization experiments, a new mechanism for high conductance.

The work was reported in Nature Communications and is the first major result to emerge from the Molecule Maker Lab, an AI Institute for Molecular Discovery, Synthesis Strategy, and Manufacturing supported by the National Science Foundation and led by Steven L. Miller Chair **Huimin Zhao**.

The unexpectedly high conductance was uncovered in experiments led by James Economy Professor **Charles Schroeder**. The project's goal was to seek out new molecules with strong conductivity that might be suitable for use in molecular electronics or organic electronics applications. The team's approach was to systematically append many different side chains to molecular backbones to understand how the side chains affected conductance.

"We observed that the side chains have a huge impact on how the molecule behaves and how this affects charge transport efficiency across the entire molecule," said co-author and graduate student **Jialing "Caroline" Li**.

Specifically, the team discovered that molecular junctions with long alkyl side chains have unexpectedly high conductance, which is dependent on concentration.

"Semiconductor-metal interfaces are ubiquitous in electronic devices," said co-author and associate professor **Ying Diao**. "The surprising find of a high conductance state induced by metallic interfaces can pave the way to new molecular design for highly efficient charge injection and collection across a wide range of electronic applications."

Schroeder believes that the Molecule Maker Lab facilities—which also offer artificial intelligence capabilities for predicting what molecules are likely to be worth making—will open up a new approach to research in that "you can start thinking about designing based on a function instead of a structure."

The intent is eventually to make the Molecule Maker Lab facilities available to researchers beyond campus.

Read more: go.chbe.illinois.edu/AutomatedSynthesis2022

Researchers develop powerful strategy for creating new-to-nature enzymes

A team of researchers, led by former postdoctoral researcher Xiaoqiang Huang and Steven L. Miller Chair **Huimin Zhao**, has developed a simple yet powerful strategy for creating new enzymes with novel reactivity that can produce valuable chemical compounds, building on their previous work using light to repurpose naturally occurring enzymes.

The study, conducted for the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI), was published in Nature Catalysis.

In the study, visible light was used to excite an engineered ketoreductase enzyme, enabling a new-to-nature biocatalytic reaction known as an asymmetric radical conjugate addition, which is extremely difficult to achieve by chemical catalysis.

In living organisms, protein molecules called enzymes catalyze reactions in a process called biocatalysis.

Scientists have begun using biocatalysis to synthesize valuable compounds, as its high selectivity allows them to deploy enzymes to act on specific substrates and create target products. Another advantage is that enzymatic reactions are highly sustainable. They are also relatively inexpensive, consume low levels of energy, and do minimal damage to the environment—as opposed to chemical catalysts, which typically require organic solvents, heat, and high pressure to function.

Zhao's lab has focused on steering biocatalysis with visible light (a process known as photobiocatalysis) to produce new enzyme reactivity.

The new study builds on previous work but uses photobiocatalysis on a different enzyme family (nicotamide-dependent ketoreductases produced by bacteria) and a different chemical mechanism to produce another type of chiral carbonyl compound known as α-chiral esters. Through the illumination and evolution of ketoreductase, the team achieved an enantioselective biocatalytic Giese-type radical conjugate addition to transform fatty acids to α-chiral esters, Zhao said.

The findings offer practical applications for CABBI's work to develop biofuels and biochemicals from crops like miscanthus, sorghum, and energycane instead of petroleum. The new biocatalytic transformation could use the fatty acids that CABBI is generating from those plants as starting materials to synthesize value-added bioproducts, such as ingredients for soaps or skin-care products, in an environmentally friendly way.

"One of the major scientific challenges in CABBI's Conversion research, or bioenergy research in general, is the lack of known enzymes with the desired activity and substrate specificity for the synthesis of target fuels and chemicals," Zhao said. "Therefore, there is an urgent need to develop new strategies to discover or engineer enzymes with desired activity or reactivity."

Read more: go.chbe.illinois.edu/NewEnzymes2022

> "One of the major scientific challenges in CABBI's Conversion research, or bioenergy research in general, is the lack of known enzymes with the desired activity and substrate specificity for the synthesis of target fuels and chemicals. Therefore, there is an urgent need to develop new strategies to discover or engineer enzymes with desired activity or reactivity."
>
> **Huimin Zhao**

Biomass that could be converted into biofuels more efficiently with the help of enzymes is harvested at the University of Illinois South Farms.

Shell sponsors CHBE 494 Process Safety course

The Department of Chemical and Biomolecular Engineering recently started offering the CHBE 494 Process Safety course, sponsored by Shell, and geared toward equipping students with the universal fundamentals needed to stay safe while working in the chemical process industry.

"Process safety is critical for ensuring safe production in the chemical industry," said **Raj Sengupta**, a mergers, acquisition, and divestment manager at Shell. "The CHBE 494 course teaches the importance of these issues to future graduates as part of our long-standing partnership with the department."

The class is taught by senior lecturer **Joachim Floess**, who formerly worked in industry and is sharing his expertise and preparing students to address the safety issues they may encounter in the workforce.

Early in his career, Floess worked at General Electric's research and development center in Schenectady, New York. He also spent time at the Cabot Corporation, a specialty chemicals and materials company in Tuscola, Illinois. Between these roles, he taught chemical engineering at the University of Illinois at Chicago and earned his doctorate in chemical engineering at the Massachusetts Institute of Technology.

"One of the most critical learning objectives revolves around what I like to call technical engineering," Floess said. "Essentially, applying engineering analysis and engineering design to properly deal with the flammability and toxicological characteristics of the numerous liquids, solids, and gasses that are encountered in the chemical industry."

Students with senior standing are encouraged to take this three credit elective course to expand their knowledge of chemical safety principles. The class will also address the interaction of chemicals with people and the role of toxicology and industrial hygiene in process safety the next time it is offered.

The critical examination of the current chemical process industry will allow students to learn to analyze a process for safety, considering the environmental compatibility of a process and how to have a more positive impact on the planet.

The course explores various topics through lectures, case studies, and guest speakers with support from Shell.

"Shell continues to be a valued corporate sponsor of the Department of Chemical and Biomolecular Engineering, for example, through our tutoring program and the process safety course," said department head **Paul Kenis**, the Elio E. Tarika Endowed Chair. "Their ongoing support of this course has helped several of our students to enter the industry as fully prepared, safety conscious-engineers."

Joey Greenberg named a Cargill Global Scholar

Chemical and biomolecular engineering undergraduate student Joey Greenberg earns one of the 10 United States spots in the Cargill Global Scholars Program (CGSP), due to his commitment to improving his understanding of chemistry, leadership skills, and business savvy.

CGSP is a two-year scholarship program designed to assist undergraduate students in Brazil, China, India, Indonesia, Russia, and the U.S. The benefits include financial assistance for educational expenses, mentorship from Cargill employees, networking with fellow global scholars, attending in-country and abroad Global Leadership Seminars, and more.

Greenberg's acceptance into this prestigious group is made possible by the impact he has had in numerous roles. Whether he's performing chemistry experiments for high schoolers, owning and operating a home services business, or becoming a lifeguard—his work ethic knows no bounds.

He first heard about the scholarship from a senior ChBE student who worked at Cargill through a co-op, a semester-long internship experience. Greenberg later recognized the opportunity in an email and decided to apply.

Greenberg said that it was a good choice so far. "Cargill is one of the companies that—even with such a large base of employees—still shows care for individuals," he said. "They spotlight the differences of individuals that make up and contribute to the company."

Greenberg said the scholarship program perfectly fits his aspirations as it focuses on leadership growth within the food processing industry.

"My long-term aspiration is to own a start-up working to make healthier genetically modified foods by pairing my chemical engineering background with my business acumen to offer meaningful solutions and impact the world," he said.

His cohort's first of two Leadership Seminars took place this summer. Held over three days in Minneapolis, Minnesota, the seminar took place at Cargill headquarters with visits to surrounding facilities. Scholars analyzed their leadership style via the Myers-Briggs test and heard from speakers discussing government relations, diversity and inclusion, and corporate responsibility topics. Scholars also volunteered at Second Harvest Heartland and ended every night with group activities that allowed for meaningful conversations and friendships to form.

Greenberg's devotion to excellence is evident, as is his humility in thanking others who helped him. Those names include Michael Faibishenko, associate project manager at the Plus Group; Nicole Nowbahar, the assistant director of the National and International Scholarships Programs; and Patricia Simpson, the director of Academic Advising and Career Services in the School of Chemical Sciences, which serves chemical engineering students.

For a closer look at what CGSP has to offer, visit go.chbe.illinois.edu/CargillGlobalScholars.

2022 Cargill Global Scholars

Graduate Research Symposium

The Department of Chemical and Biomolecular Engineering and the Graduate Student Advisory Council (GSAC) hosted the 21st annual Graduate Research Symposium on Oct. 14, 2022. The event included poster and oral presentations covering a wide range of topics that were evaluated by a panel of judges.

Graduate Research Symposium Judges

Christopher Burcham (BS '91), *executive director of engineering, Eli Lilly and Company, works in the small molecule design and development department within product research and development. He earned his doctorate in chemical engineering from Princeton University in 1998. He served as the department's December convocation speaker in 2017.*

Ashlee Ford Versypt (MS '09, PhD '12) *is an associate professor at the University at Buffalo, The State University of New York, where she leads the Systems Biomedicine and Pharmaceutics Laboratory. She earned her bachelor's degree in chemical engineering from the University of Oklahoma, where she also started her academic career. She is among the department's 2022 Alumni Award recipients.*

Dale Kyser (PhD '87), *recently retired as the vice president of research and nutrition sciences, Mondelēz International, a global snack foods leader with iconic brands such as Oreo, Cadbury, and Ritz. He holds a bachelor's degree in chemical engineering from the Missouri University of Science and Technology. He served as the department's December convocation speaker in 2018.*

R. Mohan Sankaran, *the Donald Biggar Willett Professor in Nuclear, Plasma & Radiological Engineering at the University of Illinois, is known for his work on atmospheric-pressure microplasmas and their application in nanomaterials synthesis. He received his bachelor's degree from the University of California at Los Angeles and his doctorate at the California Institute of Technology, both in chemical engineering.*

Graduate Research Symposium Poster Presentation Winners

First place (tie)

Richa Ghosh

Jarom Sederholm

Richa Ghosh *(Flaherty Group), "Mechanistic insight into flow electrochemical alkene epoxidation kinetics over gold"*

Jarom Sederholm *(Braun Group), "Single step electrochemical recovery and regeneration of cathode materials"*

Runner-up (tie)

Melanie A. Brunet Torres *(Kraft Group), "Depth correction of 3D NanoSIMS images show intracellular lipid and cholesterol distributions while capturing the effects of differential sputter rate"*

Yash Laxman Kamble *(Guironnet Group), "Precision of architecture controlled bottlebrush polymer synthesis: A Monte Carlo analysis"*

Other Presenters

Aashutosh Boob, *"Design of diverse, functional mitochondrial targeting sequences across eukaryotic organisms using variational autoencoders"*

Ziqiu Chen, *"Polyethylene in dead-end silica nanopores: Forces and mobility from non-equilibrium statistical mechanics and EXSY NMR"*

Jiachun Shi, *"Understanding DIW 'printability' in terms of recovery rheology"*

Siying Yu, *"Control over particle size and uniformity of Pt-based nanoparticles in thermal treatment"*

Tianhao Yu, *"PENCiL: A contrastive learning framework for high-quality enzyme function prediction of understudied proteins"*

Graduate Research Symposium Oral Presentation Winners

First place

Susannah Miller *(Guironnet Group), "Novel encapsulated Pt catalyst"*

Second place

Meng Zhang *(Zhao Group), "Z-mRNA as an effective vaccine against SARS-CoV-2"*

Third place

Ryan Miller *(Kong Group), "Extending the bioavailability of hydrophilic antioxidants for metal ion detoxification via crystallization with polysaccharide dopamine"*

Other presenters

Roger Chang, *"Protein stabilization by alginate binding and suppression of thermal aggregation"*

Soumajit Dutta, *"Computationally guided design of selective partial agonists for cannabinoid receptors"*

Jialing Li, *"Efficient intermolecular charge transport in π-Stacked pyridinium dimers using supramolecular complexes"*

Tsai-Wei Lin, *"Size and temperature effect on penetrant diffusion in dense crosslinked networks"*

Armin Shayesteh Zadeh, *"Crystal growth impedance from boundary layer transport, conformational interconversion, and dimerization kinetics"*

Chris Torres, *"Effects of confined solvent-surface interactions on alkene epoxidation catalysis in Ti-MFI"*

Graduate Fellowships

External Fellowships

NSF Graduate Research Fellowship
Paola Baldaguez Medina
Aliki Kolliopoulos
David Potts
Darien Raymond
Anaira Roman Santiago
Chris Torres

Studying Abroad Scholarship by the Ministry of Education, Republic of China
Ching-Yu Chen
Joanne Hwang

Campus Fellowships

Beckman NSF/NRT Fellowship
Keertna Bhuvan

Chemistry-Biology Interface Training Program
Keertna Bhuvan

GEM Associate Fellowship
Liliana Bello Fernández

Graduate College Fellowship
Vanessa DaSilva
Austin Lomas
Howard Weatherspoon

Graduate College Distinguished Fellowship
Michael Taleff
Archana Verma

Grainger Mavis Future Faculty Fellowship
Krutarth Kamani
Yash Kamble
Vinh Tran
Michael Volk

Grainger SURGE Fellowship
Liliana Bello Fernández
Melanie Brunet Torres
Destiny Collazo
Vanessa DaSilva
Ryan Miller
Genesis Rios-Adorno
Anaira Roman Santiago
Alyssa Spencer
Howard Weatherspoon

Sloan Scholar
Austin Lomas
Alyssa Spencer

TechnipFMC Fellowship
Nayeong Kim

Departmental Fellowships

3M Corporate Fellowship
Liliana Bello Fernández
Apurva Godbole
Victoria Kriuchkovskaia

Harry G. Drickamer Fellowship
Tsai-Wei Lin

DuPont Science and Engineering Fellowship
Melanie Brunet Torres

Samuel W. Parr Fellowship
William Baker
Keertna Bhuvan
Melanie Brunet Torres
Ching-Yu Chen
Vanessa DaSilva
Melanie Fournier
Trevor Gayer
Richa Ghosh
Matthew Jacobson
Nayeong Kim
Huston Locht
Austin Lomas
Darien Raymond
Anaira Roman Santiago
Jarom Sederholm
Alyssa Spencer
Michael Taleff
Gunnar Thompson
Archana Verma
Howard Weatherspoon
Hao Xu
Rui Hua Jeff Xu
Song Yin
Zhixin Zhu

Tom and Yolanda Stein Fellowship
Jemin Jeon

Glenn E. and Barbara R. Ullyot Fellowship
Riccardo Candeago

A.T. Widiger Fellowship
Melanie Brunet Torres
Krutarth Kamani
Yash Kamble
Azzaya Khasbaatar
Rui Hua Jeff Xu

CURIE Summer camp
inspires dozens of up-and-coming engineers

This summer, the Worldwide Youth in Science and Engineering Program (WYSE) at The Grainger College of Engineering hosted nearly 600 seventh- to twelfth-grade students from 29 states and eight countries.

Grainger's WYSE programs included Catalyzing Ur Interest In Chemical Engineering (CURIE), coordinated by associate professor **Diwakar Shukla**.

The CURIE cohort comprises 24 students each year from all corners of the country to learn about engineering education and research at Illinois. This year's program ran from July 24 to 30.

CURIE introduces rising sophomore, junior, and senior high school students to basic chemical engineering principles and broader STEM fields.

"The classroom activities introduce chemical and biomolecular engineering concepts, including reaction engineering, separations, and biomolecular structure and function," Shukla said. "Students learn about these fundamental principles in the morning slots via hands-on experimental activities. They learn about current research on these topics during sessions led by faculty in the afternoon. This structure allows students to appreciate the current research pursued in the department and its impact."

Faculty presenters included professors Li-Qing Chen, Ying Diao, Mary Kraft, Simon Rogers, Alex Mironenko, and Charles Schroeder.

The CURIE program is also a part of Grainger's IDEA camps—mission-driven camp sessions led by departments aiming to "Increase Diversity, Equity, & Access" in STEM majors and careers.

Bridging the gap between accessibility and historically underrepresented communities is a cornerstone of IDEA camps. They provide a safe environment to build a community of peers and mentors who empower one another to be confident in their exploration of STEM.

"The most important trait our campers all share is the curiosity to learn about the fundamentals and the current applications of chemical and biomolecular engineering," Shukla said. "The students are curious to learn about the current work while discovering how engineering shapes the future world."

Students experience the wonders of chemical engineering firsthand through engaging activities. These include using silly putty to understand the physics of fluids, playing computer games to understand human protein function, and learning how engineers make large amounts of chemicals used in everyday products.

Campers also go on field trips—online and in-person—to further understand concepts within chemical engineering and witness how these topics apply to the real world.

This year's cohort visited local chemical plants including the Lyondell Basell plant in Tuscola, Illinois, and Abbott Power Plant in Champaign. Learning about the day-to-day life of engineers working on-site in chemical plants was one of the many highlights of the CURIE camp.

The camp is made possible by many faculty,

Graduate students lead tenth- through twelfth-graders through hands-on experiments—tray dryer, reaction engineering, polymer extruder and continuous distillation—at the summer camp called Catalyzing Ur Interest In Chemical Engineering (CURIE). The camp is part of the Worldwide Youth in Science and Engineering Program.

> "By the end of the camp, the students are already talking about what type of courses they can take and credit transfers."
>
> **Diwakar Shukla**

graduate, and undergraduate students who are investing in the next generation of chemical and biomolecular engineers.

"By the end of the camp, the students are already talking about what type of courses they can take and credit transfers," Shukla said. "They are asking very detailed questions about the program. Some of them have made up their mind that they will apply to an engineering school."

The CURIE camp concluded with a ceremony inviting friends and family to share a recap of the program and a shared vision for the future of chemical and biomolecular engineering as a discipline that will play a significant role in future industries and in solving complex global challenges such as climate change.

Empowering students with knowledge and access to learning is critical for goals like these to become a reality.

Learn more at go.chbe.illinois.edu/CURIEcamp.

Paul Winterbotham

Your support can make all the difference.

Your investment supports the best and brightest students with fellowships and scholarships; it supports world-renowned faculty and their innovative research and teaching; it funds essential upgrades to laboratories, classrooms, and technologies; and it funds outreach efforts to inspire the next generation of engineers.

You can make a gift online at **go.chbe.illinois.edu/give**, or by scanning the QR code provided. In addition to outright gifts, you can support the Department of Chemical and Biomolecular Engineering as part of your overall financial, tax, and estate planning with deferred gifts such as bequests, charitable trusts and annuities, pooled income funds, retained life estates, retirement accounts, and life insurance.

If you are interested in learning more about these or other gift options, contact **Paul Winterbotham**, assistant director of development, at paulww@illinois.edu or 217-300-6222.

Hong Yang:
Understanding structure and property phenomena, bettering the world

Richard C. Alkire Chair Hong Yang describes chemical engineering as combining concepts from chemistry with engineering principles to develop processes for chemical and energy products.

"Both the conceptual and quantitative sides of the brain have to work together to achieve the engineering goal; I guess that's another way to put it," he said with an easy laugh. "You can achieve amazing things in this profession."

Yang said that the career paths and fields available to chemical engineers are many and varied: energy, pharmaceuticals, mico-electronic companies, modeling for Wall Street and financial firms, consulting companies—or teaching and research.

He has chosen the latter. Yang's work centers on the design and synthesis of metal and metal oxide nanostructures for a range of catalytic applications, including in hydrogen-powered fuel cells and low-temperature electrolyzers for water splitting.

In middle school, Yang was charmed by the transformation he witnessed during an experiment where sugar was carbonized by sulfuric acid, producing a rising column of black carbon. At that moment, he wanted to understand and manipulate these phenomena.

This pursuit, along with his aptitude for chemistry and physics—and ambition—plucked Yang from Northern China's coal region and brought him to one of the world's most populous cities, Beijing, where he studied at the prestigious Tsinghua University.

Tsinghua's recruiters assigned Yang to the physical chemistry degree program based on his high scores in physics and chemistry on the national entrance tests. Luckily, at that time, he could choose his department: chemical engineering.

Yang went on to earn his master's degree at the University of Victoria and doctorate at the University of Toronto before completing postdoctoral research at Harvard University.

"There were a few hurdles for me during the time I grew up in China, and back then, the education and research environment was completely different from today's China—you probably cannot imagine," he said.

Indeed, Yang has overcome obstacles and had a few "lucky" breaks along the way.

He was among the first students from his hometown area to be selected to attend a highly selective middle school, which he commuted to daily by riding in the back of a truck. He tested into one of the top universities in the country and was among the first to graduate from the chemistry department that was established halfway through his degree. To pursue his studies abroad, he passed the GRE TOEFL exam using any reading material he could get his hands on, including an aviation trade magazine.

However, the study of phenomena in the chemical sciences is at the heart of Yang's story. For his bachelor's degree thesis, he worked on drug delivery and reducing the toxicity of a cancer drug by encapsulating it in vesicles made of fat molecules called lipids. He studied the separation of lipids from eggs as a proxy for this process.

"This was my introduction to research for the function of materials," Yang said. "I am very curious about 'why it happened.' My curiosity and simple quest for function in materials are continuously led in the

direction of applied fundamental research."

Yang went to the University of Toronto to further his graduate studies and to earn a doctorate. There, he worked under the direction of **Geoffrey A. Ozin**, known for his seminal work in nanochemistry. Yang was attracted to a new subject that he had not explored before that point in his studies. His research focused on a self-assembly approach to make two- to five-nanometer crystalline porous materials—something still difficult to achieve today—called ordered mesopores that could maximize catalysis and the chemical separations of important chemicals, such as lipids and proteins. The results of his first three years of research appeared in three Nature papers, including a featured cover of the magazine.

"The idea is that you can maximize the utilization of those materials at a nanometer scale," Yang said. "I'm extremely interested in making nanostructure materials, whether it's a particle or something that supports particles. We are now making functional materials as catalysts—because we cannot wait for millennia for reactions to happen."

When he began his doctoral studies, Yang wanted to work as an industrial researcher in materials development, but Ozin inspired him to choose a different path in academia.

During his postgraduate studies, Yang transitioned from understanding nanomaterials' anatomy to application. Working with professor **George Whitesides** at Harvard, Yang worked on the development of uniform nanomaterials that could be assembled into functional materials.

When Yang began his faculty career at the University of Rochester, he started a collaboration with General Motors' Hydrogen Fuel Cell Center, also in the Rochester area. He realized the octahedral-shaped nanomaterials made of platinum, iron, and cobalt alloys he was developing were ideal for hydrogen fuel cell cathode development.

"That's how I repositioned our nanomaterials project for several applications, but all in sustainability development," Yang said. "What makes these nanomaterials unique is that we try to control not only for the size of the particle but also for the shape. Now, as we try to push performance higher and higher, it turns out which surface is exposed makes a huge difference."

His team published a series of papers that showed that they could control the platinum-nickel and other so-called low platinum group metal electrocatalysts with the right geometry.

In 2012, Yang joined the faculty at the University of Illinois, drawn by the university's research infrastructure and collegial colleagues.

Today he is known for his research efforts related to sustainability; he is creating

> "My curiosity often drives me to know how and why things happen and how we can improve the process. If I need new knowledge, I get to work on a subject and learn what I need to know. Working in chemical engineering allows me to think critically and practically in tackling new problems. When no obvious solutions are present, I do not shy away from exploring an engineering solution, and we do it based on what we know."
>
> **Hong Yang**

Professor Hong Yang, graduate student Siying Yu (left), and postdoctoral fellow Jung Hyun Park (middle) analyze the performance of a hydrogen fuel cell.

From left to right: Professors Jonathan Sweedler, Richard Alkire, Hong Yang, and Paul Kenis at Yang's investiture in 2015.

nanomaterials for electrolyzers and hydrogen fuel cells. His group is also developing a new type of electrocatalyst by using single atoms as the active site to reduce the amount of active material needed for a reaction.

“I am still dealing with nanostructured materials and how we can optimize them to get the best performance,” Yang said. “That is fascinating to me, and there’s a lot of unsolved issues there. How can you arrange all these atoms in a way that we like them to behave? We cannot work against thermodynamics, but we can play so many different tricks at the nanometer scale to improve the properties.”

In 2015, Yang was invested as the Richard C. Alkire Chair, established in honor of emeritus professor **Richard Alkire** who joined the department in 1969.

At Yang’s investiture ceremony, Alkire said, “The research of professor Yang represents a superb example of this next-generation of engineering—the manipulation of atomic-scale distributions of elements on catalytic surfaces to optimize their catalytic activity and stability for reducing oxygen—one of the most important chemical reactions of them all.”

In a relatively new line of research for Yang’s lab, they are working on the missing pieces needed to complete fuel cell technology: the production of hydrogen. While it is easy to produce hydrogen in a water electrolyzer, it is tricky to produce oxygen at the other electrode to match the high production rate of hydrogen, which is needed to complete the reaction in splitting water molecules. His team is working on creating stable, low-cost, complex metal oxide catalysts with specific surface and bulk features and structures to produce hydrogen from water.

"My curiosity often drives me to know how and why things happen and how we can improve the process," Yang said. “If I need new knowledge, I get to work on a subject and learn what I need to know. Working in chemical engineering allows me to think critically and practically in tackling new problems. When no obvious solutions are present, I do not shy away from exploring an engineering solution, and we do it based on what we know.”

From developing workhorse catalysts to realizing educational opportunities in a difficult era, Yang has a unique ability to manipulate and understand phenomena to achieve the desired outcome—all for the world's benefit.

Professor Hong Yang and graduate student Bidipta Ghosh set up an apparatus to study the property of an electrocatalyst for splitting water molecules.

Class Notes

Fikile Brushett wins the 2022 Charles W. Tobias Young Investigator Award

Chemical and biomolecular engineering alumnus **Fikile Brushett** (MS ’09, PhD ’10) was recently honored with the 2022 Charles W. Tobias Young Investigator Award from the Electrochemical Society.

Established in 2003, the prize recognizes outstanding scientific and engineering work in fundamental or applied electrochemistry, or solid-state science and technology, by a scientist under the age of 40. The award honors the memory of Charles W. Tobias who played a seminal role in electrochemical engineering.

Brushett is an associate professor of chemical engineering at the Massachusetts Institute of Technology. His research group seeks to advance the science and engineering of electrochemical technologies that enable a sustainable energy economy. He earned his bachelor’s degree in chemical and biomolecular engineering from the University of Pennsylvania in 2006 and his master’s degree and doctorate under department head Paul Kenis, the Elio E. Tarika Endowed Chair. He went on to be a director’s postdoctoral fellow in the Electrochemical Energy Storage Group at Argonne National Laboratory under senior chemist John T. Vaughey.

Brushett is especially interested in the fundamental processes that define the performance, cost, and lifetime of present and future electrochemical systems. His research combines the synthesis and characterization of redox-active materials, the design and engineering of electrochemical reactors, and the techno-economic modeling of electrochemical systems.

He strongly emphasizes connecting system-level performance and cost goals to materials-level property requirements and leveraging this knowledge to guide the exploration of new chemistries and reactor formats.

As part of the award, he presented a talk, “Advancing Porous Electrodes for Electrochemical Systems,” at the ECS Meeting held Oct. 9-13, 2022.

“Electrochemical processes are poised to play a pivotal role in the evolving global power system as the efficient interconversion of electrical and chemical energy can enable the deployment of sustainable technologies that support the decarbonization of the electric grid, power the automotive fleet, and offer new opportunities in chemical manufacturing,” Brushett wrote in the abstract. “However, advances in electrochemical science and engineering are needed to address the stringent performance, cost, and scale requirements of these emerging application spaces.”

Ultimately, Brushett aims to develop robust and transferable guiding principles for the design of materials, processes, and devices that harness electrochemical phenomena.

From left: Professors Fikile Brushett (MS ’09, PhD ’10) and Paul Kenis at the 2022 ECS Meeting where Brushett received the Charles W. Tobias Young Investigator Award.

In Memoriam

William "Will" Kays

William "Will" Kays (BS ’77) of Cincinnati died on Dec. 7, 2021, at the age of 66. Born Sep. 9, 1955, in San Diego Naval Hospital, California, and raised in Mt. Zion, Illinois. Will graduated from the University of Illinois with a degree in chemical engineering and from Ohio State University with an MBA. He started his career in Kansas City before transferring to Cincinnati via Columbus, Ohio. He worked in various finance and management roles before ending his career at Cincinnati Bell as vice president of finance. He also generously donated his expertise as a volunteer to Cincinnati Habitat for Humanity. After retiring, he consulted as a CFO with various companies throughout the Cincinnati area. An avid outdoorsman, Will had many hobbies and passions including photography, hiking, biking, and fishing. Loving father of Alex (Erica) Kays and Victoria Kays. Beloved son of James and Nina Kays. Dear brother of Randy (Paula) Kays and Karen (Shawn) Statzer. Cherished uncle to three nephews, one niece, and two great nieces. Survived by numerous aunts, uncles, cousins, and friends.

John Windsor Harding (MS ’59, PhD ’61), 88, of Bartlesville, Oklahoma, died peacefully on June 6, 2022. John was born in Akron, Ohio, and grew up in Akron and Baltimore Maryland. He received bachelor’s, master’s, and doctoral degrees in chemical engineering from the University of Illinois where he was a member of Tau Beta Pi and Sigma Xi. He served in the U.S. Army at the Ordnance Guided Missile School at Redstone Arsenal in Huntsville, Alabama. He worked as a chemical engineer in various Exxon organizations, working with polyolefin processes. After early retirement, he consulted in that area for several years. For several years, he was a member of Bay Area Unitarian Universalist Church in Clear Lake where he at one time served on the board and a few committees. John always felt he had a good life and especially enjoyed his family. He took immense pride and joy watching his children and grandchildren grow into "fine adult citizens.” In person and via Marco Polo videos and Zoom video conferences, he also took great pleasure in watching his great-grandchildren develop and grow. He is survived by friend and partner Christa Drugan Marteny and her son, Jack Drew of Bartlesville, Oklahoma, and his children: Vicki Ruth Harding and husband Ken Herring of Florence, Arizona; Gwen Lee Harding-Peets and husband Mike Peets of Staatsburg, New York; Eric Harding and wife Frances Aileen Harding of Baytown, Texas. Grandchildren are Chris Harding (wife, Alicia), Danielle Harding (husband, Nich), and David Harding (wife, Suzy). He had five great-grandchildren.

John Windsor Harding

Henry J. Nalepa (BS ’49) died on Nov. 25, 2021, at the age of 98. A veteran of World War II, he served with the U.S. Army Air Corp in the China-Burma-India Theater. After obtaining his bachelor’s degree in chemical engineering, he worked for Merck & Company for three years and the Union Carbide Corporation for 41 years. He was a member of the Research Society of America. He served the church through the offices on the parish committee at the Church of Our Savior in Lawrenceville, New Jersey, and through his activities in the Central Diocese of the Polish National Catholic Church. He served his community through the offices he held in the Trenton Chapter of the Polish American Congress, the North Trenton Lions Club zone and district, the Trenton Polish Business and Professional Mens' Club, The Polish American Democratic Club, and the Polish Arts Club of Trenton. He was a member of the Catholic War Veterans Holy Cross Post 417. Son of the late Peter and Nellie Zuczek-Nalepa, brother of the late Harriet Koval, uncle to the late Kathleen, Daniel, and Robert Koval, and husband of the late James Lithgow, he is survived and loved by his sister Helen Buchanan, eight nieces and nephews, 12 grandnieces and nephews, and 14 great-grandnieces and nephews, soon to be 15.

REMEMBER WHEN...

Enjoy this collection of photos from the tenure of **Paul Kenis** as department head.

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