UNIVERSITY OF DELAWARE

ENGINEERING

CHEMICAL & BIOMOLECULAR | FALL 2019

ENVISIONING A BETTER WORLD

THROUGH SCIENCE, TECHNOLOGY AND EDUCATION

INSIDE

SUSTAINABLE FUELS

BIOPHARMACEUTICAL BREAKTHROUGHS

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FALL 2019

CHEMICAL AND BIOMOLECULAR ENGINEERING NEWS

Chemical & Biomolecular Engineering News is published for the alumni, friends and peers of the Department.

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ON THE COVER
The Art of Fat
By Eleanor Oates

DEAR FRIENDS OF CHBE

I am pleased to present the 2019-20 issue of Chemical and Biomolecular Engineering News. It's been an exciting year at Delaware, full of change, but with familiar constants: the excellence of the scholarship, teaching, and service produced by the faculty, research teams and students.

In this issue, you can read about the development of sustainable fuels, research efforts to revolutionize chemical and pharmaceutical manufacturing, materials innovations leading to faster charging and safer batteries, and developments that push the engineering of biomolecular systems for new medical therapies and more.

New talent continues to make a home in Delaware. An exceptional class of 35 PhD students from across the US and the world joined us this fall. Undergraduate enrollment remains strong, in part due to the educational environment of Colburn Laboratory, where we gather in lectures and students pursue ambitious research projects under faculty guidance. More students than ever are taking advantage of exchange programs with the National University of Singapore, and over 40 students joined Prof. Millicent Sullivan, the Associate Chair of Chemical and Biomolecular Engineering, to study abroad at the University of Melbourne during Winter Session. We are thankful to our hosts at these world-class institutions, especially alumnus Prof. Ray Dagastine at Melbourne.

Among those we welcomed to the department this year is Prof. Marianthi Ierapetritou, the new Bob and Jane Gore Centennial Chair in Chemical and Biomolecular Engineering. Prof. Ierapetritou has a distinguished record of scholarship focusing on the modeling and optimization of process operations in the presence of uncertainty and process synthesis and design. She is especially well known for her pioneering work in modeling and optimization of pharmaceutical manufacturing. Prof. Ierapetritou has also worked extensively as a departmental leader and role model for younger faculty. Prior to joning us, she served as the Associate Vice President for the Promotion of Women in Science, Engineering and Mathematics at Rutgers University.

We're also recognizing a number of awards and promotions. We celebrated Prof. Bingjun Xu's promotion to Associate Professor with tenure and Prof. Arthi Jayaraman's promotion to Professor. We wished Patti Hall, the department Business Administrator for the past 10 years, a happy retirement after more than 30 years of service to UD. Prof. Sandler also enters a well-deserved retirement as the H. B. DuPont Professor Emeritus after 52 years of teaching, research, and academic leadership.

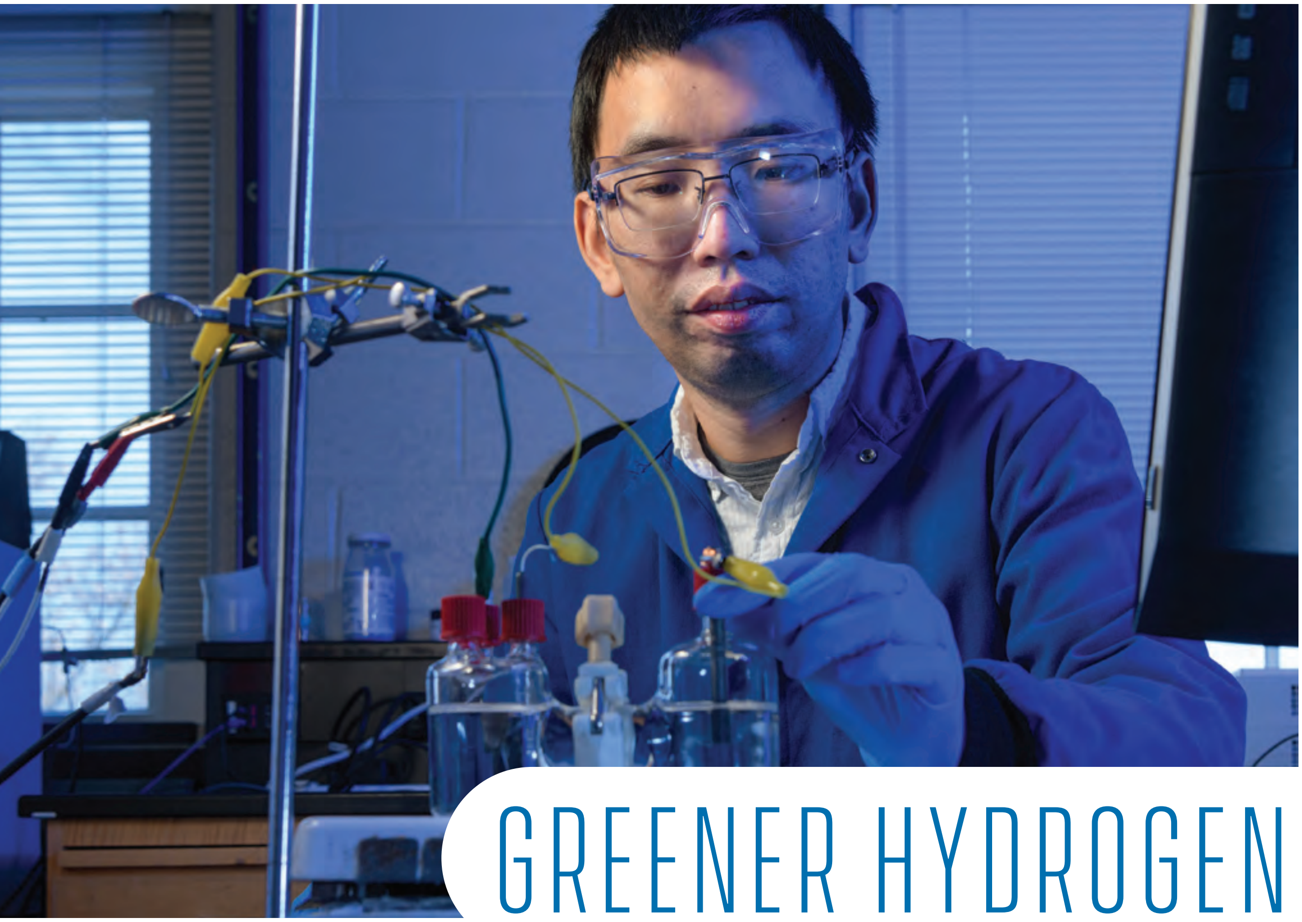
Delaware Chemical and Biomolecular Engineering remains over 600-strong in students, faculty, and staff, working together to learn, teach, and develop groundbreaking scholarship. We are supported by an exceptional staff of professionals and a superb team of associated and adjunct faculty that enrich our teaching from their experience and expertise in engineering practice.

Our vision is to build a better world through leadership and innovation in science, technology, and education. Our mission: To advance knowledge, educate the next generation of chemical engineers, and address the scientific and technological challenges of a diverse, global society.

ERIC M. FURST

DEPARTMENT CHAIR
& PROFESSOR

@EMFURST



Feng Jiao, an associate professor of chemical and biomolecular engineering and associate director of the Center for Catalytic Science and Technology at UD, in his lab.

GREENER HYDROGEN FROM WATER

UD INNOVATOR EXPLORES CATALYSTS THAT PULL THEIR WEIGHT AND SERVE THE ENVIRONMENT

The idea of a hydrogen economy, using hydrogen as a clean energy source, has been a topic of conversation for decades. Hydrogen can be used to power fuel cells or to upcycle biomass into high-value chemicals. But the technology driving these innovations requires fossil fuels and comes with an environmental cost — carbon dioxide. Now, Feng Jiao, an associate professor and associate director of the Center for Catalytic Science and Technology, has patented a process that may hold the key to producing greener hydrogen from water using electricity and a copper-titanium catalyst.

A FOCUS ON RENEWABLES

Jiao and his team focused on developing processes to turn carbon dioxide into useful chemicals, such as ethanol that can be used in synthetic fuels, or ethylene that can be used to produce polymers. A project, funded by the National Science Foundation and later by the National Aeronautics and Space Administration (NASA), explored ways to convert carbon dioxide to oxygen, something that would be very useful for deep space exploration. Jiao and his students developed an efficient system, but they needed a better catalyst to drive the reaction.

As they tested metals for the job, the researchers discovered that a copper-titanium alloy is among only a few non-precious, metal-based catalysts that can split water into hydrogen gas and oxygen. Both copper and titanium are inexpensive and abundant when compared with precious metals, such as silver or platinum, typically suited for the job. Hydrogen is currently produced using steam-methane reforming, where natural gas and high heat are employed to free hydrogen molecules from methane. Jiao

THE IDEA OF USING HYDROGEN AS THE BASIS OF A CLEAN SUSTAINABLE ENERGY SOURCE, OFTEN TERMED A HYDROGEN ECONOMY, HAS BEEN A TOPIC OF CONVERSATION FOR DECADES.

We can start with the most oxidized form of carbon – carbon dioxide – and add hydrogen to produce the same chemicals, which has a lot of potential for reducing carbon emissions," said Jiao.

Copper alone is not effective at producing hydrogen. But add some interesting chemistry — and a teeny bit of titanium — and a world of possibilities suddenly opens to create catalysts that pull their weight and serve the environment.

calls it a "dirty process" because when the hydrogen gas is removed, all that is left is carbon, usually in the form of carbon dioxide.

This got Jiao thinking about cleaner ways to produce hydrogen without the environmental cost.

CLEANER, GREENER PROCESSES

Copper is known to be good at conducting both heat and electricity. However, copper alone is not effective at producing hydrogen. But add some interesting chemistry — and a teeny bit of titanium — and a world of possibilities suddenly opens to create catalysts that pull their weight and serve the environment.
"With a little bit of titanium in it, the copper catalyst behaves about 100 times better than copper alone," said Jiao. This is because, when paired, the metals create uniquely active sites that help the hydrogen atoms strongly interact with the catalyst surface in a way that is comparable to the performance of much more expensive platinum-based catalysts.

While traditional chemical processes start with fossil fuels, such as coal or gas, and add oxygen to produce various chemicals, Jiao explained, with hydrogen the reverse chemical reaction is possible.

"We can start with the most oxidized form of carbon — carbon dioxide — and add hydrogen to produce the same chemicals, which has a lot of potential for reducing carbon emissions," said Jiao.

The Jiao team performs a life cycle analysis on each process they invent to evaluate the economics of how the technology stacks up against currently accepted methods. They ask themselves questions such as "Is the invention cost-effective? Is it better or worse than existing technology, and how much can be gained by using the process?"

Early results show that a copper-titanium catalyst can produce hydrogen energy from water at a rate more than two times higher than the current state-of-the-art platinum catalyst. Jiao's electrochemical process can operate at near-room temperatures (70 to 176 degrees Fahrenheit), for the most part, too, which increases the catalyst's energy efficiency and can greatly lower the overall capital cost of the system.

Jiao has filed a patent application on the process, but he said more work is needed in terms of scaling the process for commercial applications. If they can make it work, the savings would be big — an alternative catalyst that is three orders of magnitude cheaper than the current state-of-the-art platinum-based catalyst.

Future efforts will focus on ways to increase the size of the water electrolyzer from lab scale to commercial scale. Additional testing of the catalyst's stability also is planned. The researchers are exploring different combinations of metals, too, to find the sweet spot between performance and cost.

Jiao and colleagues from Columbia and Xi'an Jiaotong universities reported their findings in ACS Catalysis, a journal of the American Chemical Society. Funding for the work is from the National Science Foundation, NASA and the U.S. Department of Energy.

FUELS WITHOUT FOSSILS

Two chemical engineers at UD are developing new, better ways to produce fuels from sunlight.

Associate professor Feng Jiao and assistant professor Bingjun Xu received a $500,000 grant from the NSF in 2018 for research on solar-driven carbon dioxide utilization for environmental sustainability.

"If successful, this technology could provide the community a green, sustainable way to produce chemicals and fuels without using any fossil source," said Jiao. "This technology also aims to address the challenges associated with renewable energy utilization and storage."

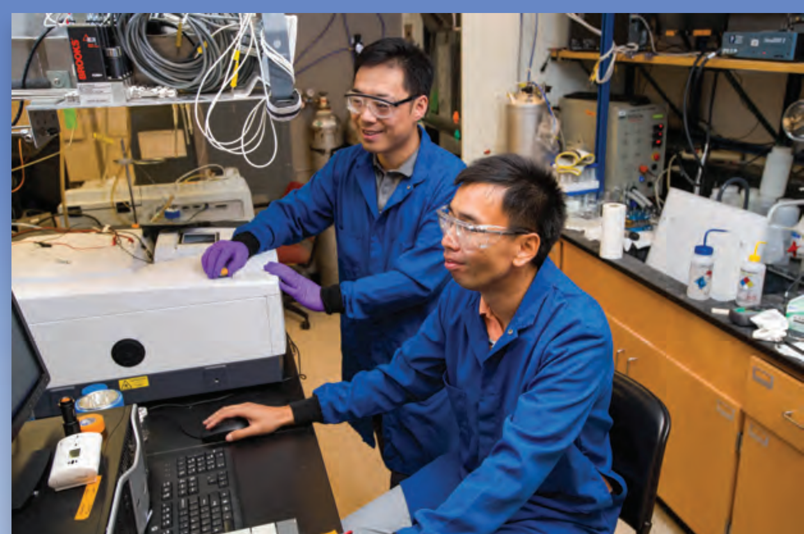
This research is motivated by the fact that the world's population is expected to reach 9 billion people by 2050, and it will be increasingly critical to balance food, energy and water resources and reduce harmful carbon dioxide emissions as the population expands. Many processes involved in food and water production, from water treatment and transport, to farming, to food processing, are major contributors to carbon dioxide emissions.

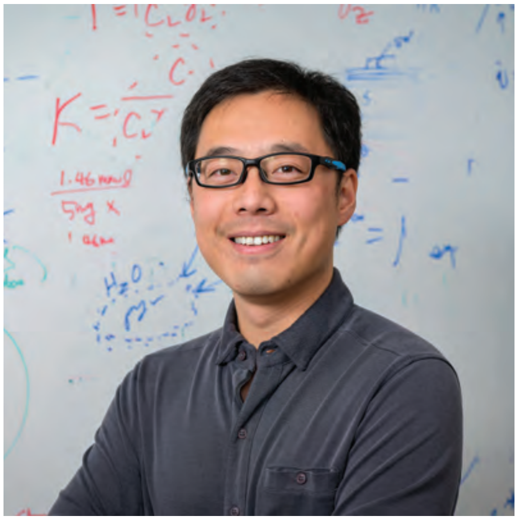
In collaboration with researchers at Tianjin University in China, Jiao and Xu are designing a system that could reduce greenhouse gas emissions by using carbon-neutral solar electricity. Their system will utilize electrolysis to convert carbon dioxide and water to liquid carbon-based fuels such as ethane and propane. They will use copper as a catalyst to speed up their chemical reactions.

Then, the research team will develop a prototype reactor and perform technical and economic analysis to determine the potential to commercialize this technology.
"If the result is positive, we plan to work closely with renewable energy companies and other chemical companies to scale it up," said Jiao. If used on a large scale, this technology has the potential to reduce the environmental impact of fossil fuels and biofuel crops, which require large volumes of water and land to produce.

Finally, the team will determine the environmental impacts of their device.

The technology developed through this collaboration could help the solar industry and research community and could be extended to chemical processes beyond the breakdown of carbon dioxide.





BINGJUN XU RECOGNIZED AS AN INFLUENTIAL RESEARCHER

CATALYZING EXCELLENCE

Assistant professor Bingjun Xu was named to the 2018 Class of Influential Researchers by the journal Industrial & Engineering Chemical Research. He is one of 29 scientists and engineers from eight different countries to make the list.

Xu zooms in to analyze how a variety of catalysts work, especially at the surface. “My group has been doing a lot of work in understanding the surface-mediated reactions,” said Xu. “We are developing tools to better understand how those reactions take place and understand those processes at a molecular level.”

As part of Xu’s recognition, an article co-authored by Xu and three colleagues at the UD-based Catalysis Center for Energy Innovation was featured in a special issue of Industrial & Engineering Chemical Research.

The team developed a tool to determine the oxidation state of catalysts, which is typically difficult to measure, especially in reactions that take place at high temperatures and under high pressures. “We could always analyze the catalyst before we used it or after we used it, but the most important information comes from when the catalyst is actually doing its job,” said Xu.

Xu also recently published two articles in the Journal of the American Chemical Society. In one new paper, UD engineers and collaborators from Brookhaven National Laboratory and Columbia University showed how nanoparticles of the compound vanadium nitride can be used to produce ammonia, a chemical commonly used in fertilizers, from nitrogen.

In another paper, Xu and colleagues at Brookhaven National Laboratory wrapped a porous layer of zeolite, a catalytic mineral, around metal nanoparticles so that only some outside materials could reach the metal inside. This allows for tandem catalysis, where multiple catalysts are used together to make a reaction happen even faster or more efficiently than before.

The potential applications of Xu’s work with catalysts are far-ranging. By understanding catalysts, scientists such as Xu can more effectively use them to transform plant matter into plastics and fuels, reduce atmospheric carbon dioxide into valuable chemicals, or reduce atmospheric nitrogen to ammonia. All of these technologies could allow for more sustainable production of goods with less pollution to the environment.

Xu credits his collaborators as well as his lab group, which includes graduate students and postdoctoral associates, for much of his success.

“Our students have the right combination of being creative and also having good common sense,” he said. “The combination of being creative and realistic is actually a hard balance to strike, and I feel like a lot of our students are good at that, which I really appreciate.”

CLEANER, GREENER U.S. MANUFACTURING

UD TO HELP BOOST ENERGY EFFICIENCY AND MODULAR MANUFACTURING WITH RAPID GRANTS

Above:
Graduate students Eric Steinman (left) and Casper Brady analyze readouts from the RAPID reactor located in Colburn Laboratory.

Below:
Postdoctoral researchers (from left) Himanshu Goyal, Udit Gupta and Talin Avanesian serve as computational experts on UD's RAPID projects.

The University of Delaware will continue to help drive a national push to double U.S. energy productivity by the year 2030 through research on four new projects funded by the Rapid Advancement in Process Intensification Deployment (RAPID) Manufacturing Institute. The awards, totaling $7,135,987, will grow to $15,885,987 with a contribution of $8,750,000 over five years from the State of Delaware.

Established in 2016 by the U.S. Department of Energy and led by the American Institute of Chemical Engineers(AIChE), RAPID is part of a network of 14 Manufacturing USA Institutes, each focusing on a specialized technology. The common goal of these institutes is to advance U.S. manufacturing through innovation, collaboration and education by bridging the gap between the fundamental science conducted at universities and the commercial approach of industry.

"The University of Delaware is an ideal partner in tackling the big energy challenges in manufacturing that RAPID is working to address," said Charlie Riordan, vice president for research, scholarship and innovation. "UD has a legacy of innovation in chemical processing, from Nobel Prize-winning work that revolutionized pharmaceutical production, to recent successes in converting plant waste into useful products."

Managed by the Delaware Energy Institute (DEI), RAPID-funded researchers and partners will work on projects tackling important questions in energy and chemical production and renewability.

"Our goal is to collaborate with industry to accelerate technological developments in existing manufacturing as well as distributed manufacturing for offshore and remote locations," said Dion Vlachos, director of DEI and the Allan and Myra Ferguson Chair of Chemical Engineering. "This will allow us to be more energy-efficient and thus conserve energy and emit less CO2 and tap into underutilized resources, such as trees, biogas, remote natural gas, and food waste."

Basudeb Saha, associate director of research at DEI, and Raul Lobo, Claire D. LeClaire Professor of Chemical and Biomolecular Engineering, are developing a scalable technology to allow for a more efficient and inexpensive conversion of biomass into chemicals and fuels, in partnership with Rutgers University and KU Leuven. Vlachos, Saha and Lobo are also investigating and developing scalable microwave technologies based on renewable electricity that can be applied across industries, in partnership with United Technologies Research Center, Rutgers University and KU Leuven.

Bingjun Xu, assistant professor, Babatunde Ogunnaike, William L. Friend Chair of Chemical Engineering, and Lobo are exploring chemical looping technology to bridge gaps in chemical production, in partnership with Dow Chemical Company.

Vlachos, Xu, Marat Orazov, assistant professor of chemical and biomolecular engineering, Sunita Chandrasekaran, assistant professor in computer and information sciences, and Michela

Graduate students (from left) Monte Baker-Fales and Pierre Desir and postdoctoral researcher Sebastian Prodinger conduct RAPID biomass observations.

Taufer, the Dongarra Professor of electrical engineering and computer science at the University of Tennessee, are building modeling software that can analyze, design, and optimize modular manufacturing processes, in partnership with Process Systems Enterprise, Dow Chemical Company, University of Minnesota and University of Massachusetts.

University of Minnesota associate professor Paul Dauenhauer, assisted by Ogunnaike, in partnership with Sironix Renewables, is establishing more efficient methods for converting renewable feedstocks into called surfactant.

A BIG SPARK FOR ENERGY RESEARCH

The University of Delaware has won a $12.8 million, four-year funding renewal from the U.S. Department of Energy for the continued operation of the Catalysis Center for Energy Innovation (CCEI). The center involves scientists from academic institutions and national laboratories across the U.S. in developing catalytic technologies for converting biomass into chemicals and fuels.

Since its inception as one of the nation's Energy Frontier Research Centers (EFRCs) in 2009, CCEI has discovered or advanced processes that can produce soap, jet fuel, adhesives and many other useful products from substances typically regarded as waste.

In addition to generating new knowledge and spurring economic development — through four startup companies formed, more than 25 patent applications filed and 340 peer-reviewed publications receiving nearly 10,000 citations — the center has contributed to the education and training of 95 doctoral students, 57 postdoctoral fellows, 83 undergraduate students and three high school students. Dion Vlachos, CCEI director and the Allan and Myra Ferguson Professor of Chemical and Biomolecular Engineering at UD, called the renewal an extraordinary opportunity to expand the boundaries of catalysis research.

CCEI is one of the few original EFRCs to still exist, and one of nine to receive renewal. In addition to UD, CCEI comprises Brookhaven National Laboratory; UC Santa Barbara; California Institute of Technology; Columbia University; Johns Hopkins University; University of Maryland; University of Massachusetts – Amherst; University of Minnesota; University of Pennsylvania; and Stony Brook University.

NATURE MEETS SCIENCE IN MUSEUM EXHIBIT

CONTENT DEVELOPED BY APRIL KLOXIN DISPLAYED AT DELAWARE MUSEUM OF NATURAL HISTORY

When children visited the Delaware Museum of Natural History in early 2019, they learned from an educational kiosk developed by associate professor April Kloxin.

The station centered on biomimicry, using nature as inspiration for technology. Visitors held sealed tubes containing burrs attached to felt, similar to Velcro. They built models of the human heart with Legos to see how synthetic tissues are built from the bottom up. They peered into sealed tubes containing diaper particles, hydrogels, soaked with different amounts of water.

"A central focus of my research group is the design of materials to mimic aspects of biological systems, particularly the human body," said Kloxin. "Those materials then are sponge-like materials that absorb a lot of water, and those turn out to be similar types of materials that are the particles in diapers."

Kloxin hopes that kids, especially girls—who are still underrepresented in science and engineering—left the museum inspired to discover the world around them.

"I didn't know a lot about opportunities in science and engineering growing up," she said. "Some of my first exposures to science were at my local library, where they would bring in scientists who would bring in objects from the natural world or occasionally have a raptor show." She wants to provide kids today with a similar opportunity.

Kloxin and the graduate students in her research group, such as doctoral student Amber Hilderbrand, also learned from this exhibit as they refined it. The kiosk first appeared at the Delaware Museum of Natural History in 2015, and the group has added more activities and new insights from today's research.

"The act of making the kiosk is also really educational for the graduate students who work with me," said Kloxin. "They learn how to communicate their science in new ways. We're training them not just on technical concepts but also on how to communicate with people."

This exhibit was developed with funding from the National Science Foundation.

Engineering professor April Kloxin (left) developed this educational kiosk now on display at the Delaware Museum of Natural History.

A NEW WAY TO USE CRISPR

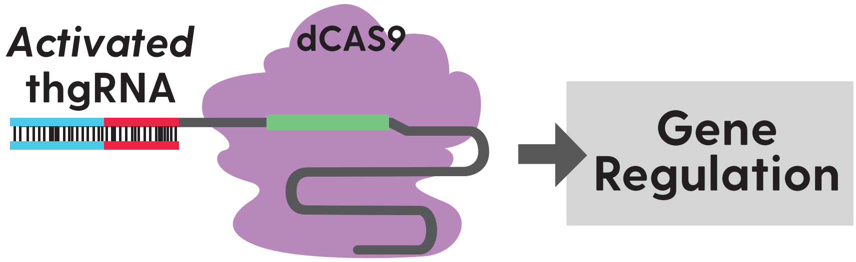
UD ENGINEERS DEVELOP METHODS TO USE CRISPR TECHNOLOGY FOR CONDITIONAL GENE REGULATION

A team of engineers at the University of Delaware has developed a method to use CRISPR/Cas9 technology to set off a cascade of activities in cells, a phenomenon known as conditional gene regulation. Their method, described in the journal Nature Chemical Biology, introduces a new functionality to CRISPR, one of today's most-talked-about technologies.

Gene editing with CRISPR technology has been called "one of the biggest science stories of the decade" for its applications to medicine, agriculture and much more. CRISPR allows scientists to precisely target and edit DNA within living cells, which could help them correct anomalies that cause inherited diseases. The first clinical trials in humans are underway in China.

However, until now, scientists hadn't figured out how to program their CRISPR systems to target DNA while integrating information from within the cells they were studying.
At UD, Wilfred Chen, the Gore Professor of Chemical Engineering, and graduate student Ka-Hei Siu designed structures — dubbed toehold-gated gRNA (thgRNA)— for targeted gene regulation in E. coli bacteria.

Traditionally, in CRISPR/Cas9 genome editing, scientists use a single-stranded piece of ribonucleic acid (RNA) to guide the Cas9 enzyme to the deoxyribonucleic acid (DNA) they want to target. Instead, Chen and Siu installed a hairpin-like structure that blocks part of the RNA from recognizing the DNA. Only a small part, called the toehold, is exposed and capable of binding to other RNA. Then Chen, and Siu used RNA from within the cell as a trigger to open up their blocking mechanism, activating the Cas9 protein so that it could then bind and regulate the DNA."The key thing is that we wanted to use some native cellular information," said Chen. "We wanted to be able to use this native cellular response as a way to modulate the CRISPR/Cas9 protein functions and basically develop a controlled mechanism so that we could modulate cellular functions accordingly."



This technology offers a versatile, "plug and play" design that could be used to induce gene editing and regulation in a variety of systems, says Chen.

"Moving forward, the idea is to be able to use, ideally on paper, any kind of cellular messenger RNA as an activation or deactivation device," he said. "You can imagine that we can activate something based on whether the cells are growing on glucose or starving for phosphate or exposed to high-temperature conditions or low-pH conditions."

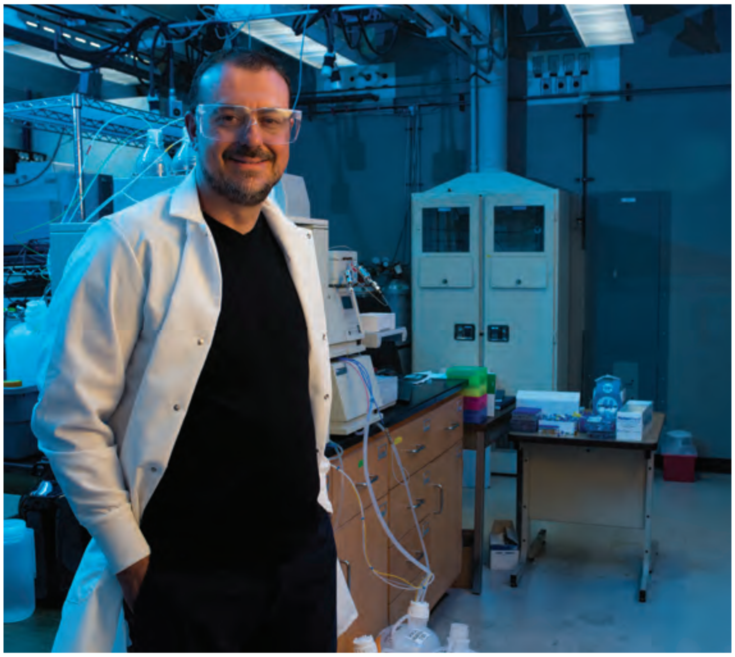
This work was supported by grants from NSF (MCB1615731 and MCB1817675).

MAKING FUEL CELLS MORE POWERFUL, MORE DURABLE, LESS EXPENSIVE

Yushan Yan, Henry B. duPont Chair in Chemical and Biomolecular Engineering, is developing fuel cells that don't require expensive platinum catalysts. These clean energy sources contain hydroxide exchange membranes, which shift the environment within the cells from acidic — the current standard — to alkaline. Using poly(aryl piperidinium) polymers, Yan's team developed hydroxide exchange membranes and ionomers with the most favorable properties yet, including good ion conductivity, chemical stability, mechanical robustness, gas separation and selective solubility. The results are described in the journal Nature Energy.

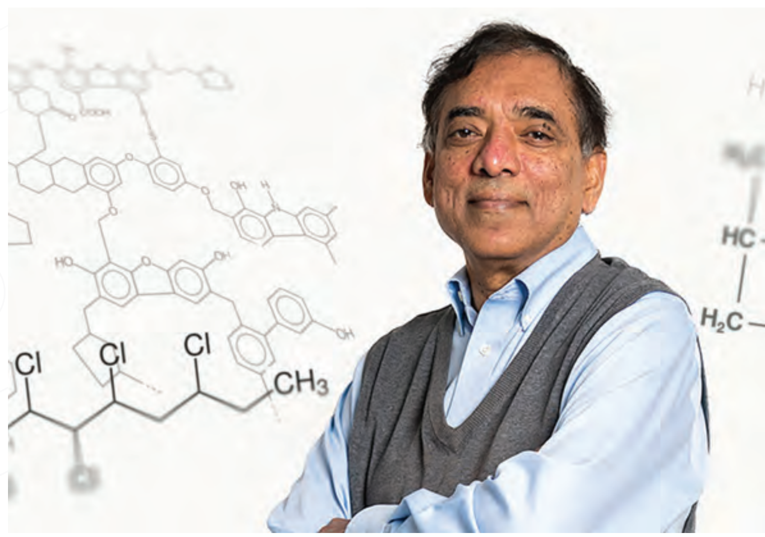
REMOVING CARBON DIOXIDE FROM AN AIR STREAM

A team of engineers at the University of Delaware is among the 40 awardees of the Advanced Research Projects Agency–Energy (ARPA-E) OPEN2018, and has been awarded $1,979,998 in funding to build a fuel cell system fabricated with inexpensive catalysts and structural materials, which is consequently cheaper and more practical than existing fuel cell systems. The team includes Shimshon Gottesfeld, an adjunct professor of Chemical and Biomolecular Engineering with three decades of experience leading fuel cell technology projects, Yushan Yan, Henry B. duPont Chair in Chemical and Biomolecular Engineering, and Brian P. Setzler, a postdoctoral associate in Chemical and Biomolecular Engineering. "This is becoming a leading center for fuel cell technology and electrochemistry," said Gottesfeld.



POWERHOUSE CHEMISTRY

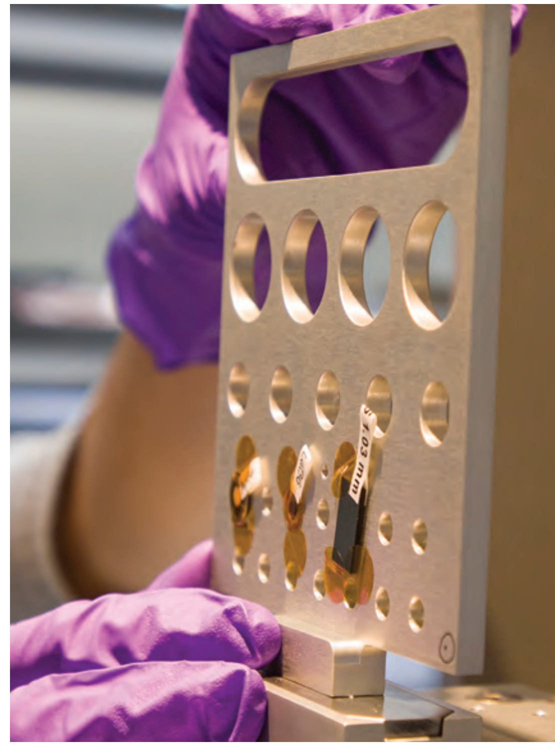
Researchers at the University of Delaware have revolutionized the way in which scientists can design catalyst structures. Their work, featured in Nature Chemistry, has established a new approach for managing highly structure-sensitive chemistries to achieve the highest possible activity while considering catalyst stability. "Optimizing catalysts at the atomic level has been a long-standing problem, as the active centers are typically unknown, and how to best pack them together to perform the chemistry has remained elusive," said Dion Vlachos, Allan and Myra Ferguson Chair of Chemical Engineering at UD and co-author on the paper. "As we engineer materials for improved performance, the stability of materials is critical. Our method is the first to address both crystal engineering with atomic precision and material stability." According to the researchers, what sets their method apart is the streamlining of the material synthesis, using computers to create microscopic variations — or nanodefects — on a catalyst's surface. The researchers demonstrated the effectiveness of their new methodology using a process called the oxygen reduction reaction (ORR), which is often used to generate power in fuel cells for transportation.



COULD TERMITES POWER A 'CLEAN COAL' REVOLUTION?

Termites generally don't elicit a whole lot of love. But surprisingly, this wood-eating insect may hold the key to transforming coal — a big polluting chunk of the global energy supply — into cleaner energy for the world, according to University of Delaware researchers. In the American Chemical Society journal Energy and Fuels, professor Prasad Dhurjati and his research team describe in detail how a community of termite-gut microbes converts coal into methane, the chief ingredient in natural gas. The study, which produced computer models of the step-by-step biochemical process, was a collaboration with ARCTECH, a company based in Centerville, Virginia, that has been working with these microbes for the past 30 years. ARCTECH provided the UD team with the experimental data that was used to validate the models.

UD Professor Thomas H. Epps, III (right) and doctoral student Priyanka Ketkar use the SAXS microscope to examine tiny sensors.



FASTER-CHARGING, SAFER BATTERIES

UD INVENTION AIMS TO IMPROVE BATTERY PERFORMANCE

Imagine a world where cell phones and laptops can be charged in a matter of minutes instead of hours, rolled up and stored in your pocket, or dropped without sustaining any damage. It is possible, according to University of Delaware Professor Thomas H. Epps, III, but the materials are not there yet.

So, what is holding back the technology?

For starters, it would take more conductive, flexible and lighter-weight batteries, said Epps, who is the Thomas and Kipp Gutshall Professor of Chemical and Biomolecular Engineering and a professor in the Department of Materials Science and Engineering at UD. The batteries would need to be more impact-resistant and safer, too.

One way to overcome this challenge in the lithium-ion batteries for the above devices is to improve the battery membranes — and the associated electrolytes — that are designed to shuttle the lithium ions, which offset the electrical charge associated with charging and discharging the battery.

At UD, Epps' team has patented an idea to improve battery performance by introducing tapers into the polymer membrane electrolytes that allow the lithium ions inside the battery to travel back and forth faster.

It is a big idea that begins with tiny parts.

Small science, big impact

It all starts with polymers. By chemically connecting two or more polymer chains with different properties, engineers can create block polymers that capitalize on the salient features from both materials.

Epps was introduced to block polymers as an undergraduate student at the Massachusetts Institute of Technology while working in the lab of Professor Paula Hammond, and again when he worked at the Goodyear Tire & Rubber Company under Adel Halasa as part of a GEM Fellowship. Goodyear was exploring the use of taper-like multi-component polymers to create tires with more elasticity, tires that would grip the road better without sacrificing performance or durability.

Years later, in work at UD, Epps' group took the idea a step further and realized they could tune the nanoscale structure of these polymers to imbue materials with certain mechanical, thermal and conductivity properties.

One of the benefits of block polymers is that they allow scientists to combine two or more components that often are chemically incompatible. This same benefit, however, can present challenges with how the materials can be processed. The Epps group determined that tapering the region where the two distinct polymer chains connect can promote mixing between highly incompatible materials in a way that makes processing and fabrication faster and cheaper by requiring either less energy or less solvent in the manufacturing process.

Manipulating the taper also allowed the researchers to control the nanoscale structures that can be formed by the block polymers. By incorporating the tapers, Epps' team can create nanoscale networks that make the battery materials more conductive—introducing nanoscale highways and eliminating traffic bottlenecks, allowing ions to move at higher speeds and making the polymer more efficient in battery applications.

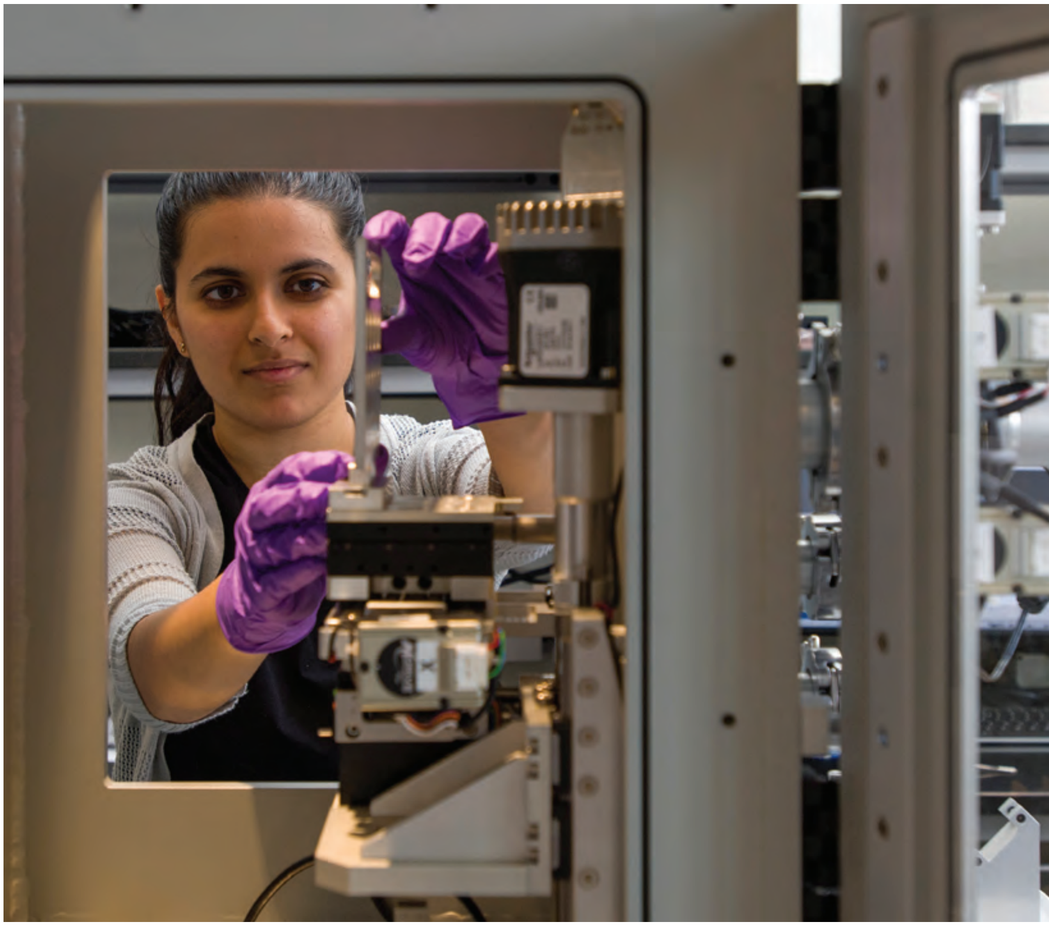
"Technically, we want to conduct ions faster … this approach in polymers would allow us to get more power out of the batteries. It would enable the batteries to charge faster, in a manner that is also safer. We are not there yet, but that is the goal," said Epps, who patented the concept through UD's Office of Economic Innovation and Partnerships. He calls this work a "designer approach" to polymer science.

Priyanka Ketkar, a doctoral student in chemical and biomolecular engineering, wants to make a difference in the world through research. Ketkar described the Epps research group as a good fit, where she is exercising her mental muscle on consequential problems related to energy storage.

In laboratory experiments, Ketkar and others in the Epps group have shown that introducing a tapered region between polymer electrolyte chains actually increased the overall ionic conductivity over a range of temperatures. At room temperature, for example, the tapered materials are twice as conductive as their non-tapered counterparts. But that is not all. The taper improves the material's ability to be processed, too.

"Previous methods for increasing conductivity have either made the polymer harder to process or used greater amounts of chemical solvent, which makes the material more flammable and less environmentally friendly," Ketkar said. "That is why I am really excited about this new approach."

The designer polymers are useful for lithium-ion batteries, but also applicable to other rechargeable systems, such as sodium-ion and potassium-ion batteries, Epps said. Other applications include using tapered polymers to make materials that can be produced at lower temperatures or with less solvent for applications such as tires, rubber bands and adhesives. Funding for this work is from the U.S. Department of Energy's Basic Energy Sciences program, the National Science Foundation's Division of Materials Research, and Samsung. Epps' work includes a collaboration with the National Institute of Standards and Technology, UD's Center for Neutron Science, and Lisa Hall, an associate professor of chemical and biomolecular engineering at Ohio State University.



Priyanka Ketkar is a doctoral student in chemical and biomolecular engineering.

WHY ARE GELS ELASTIC?

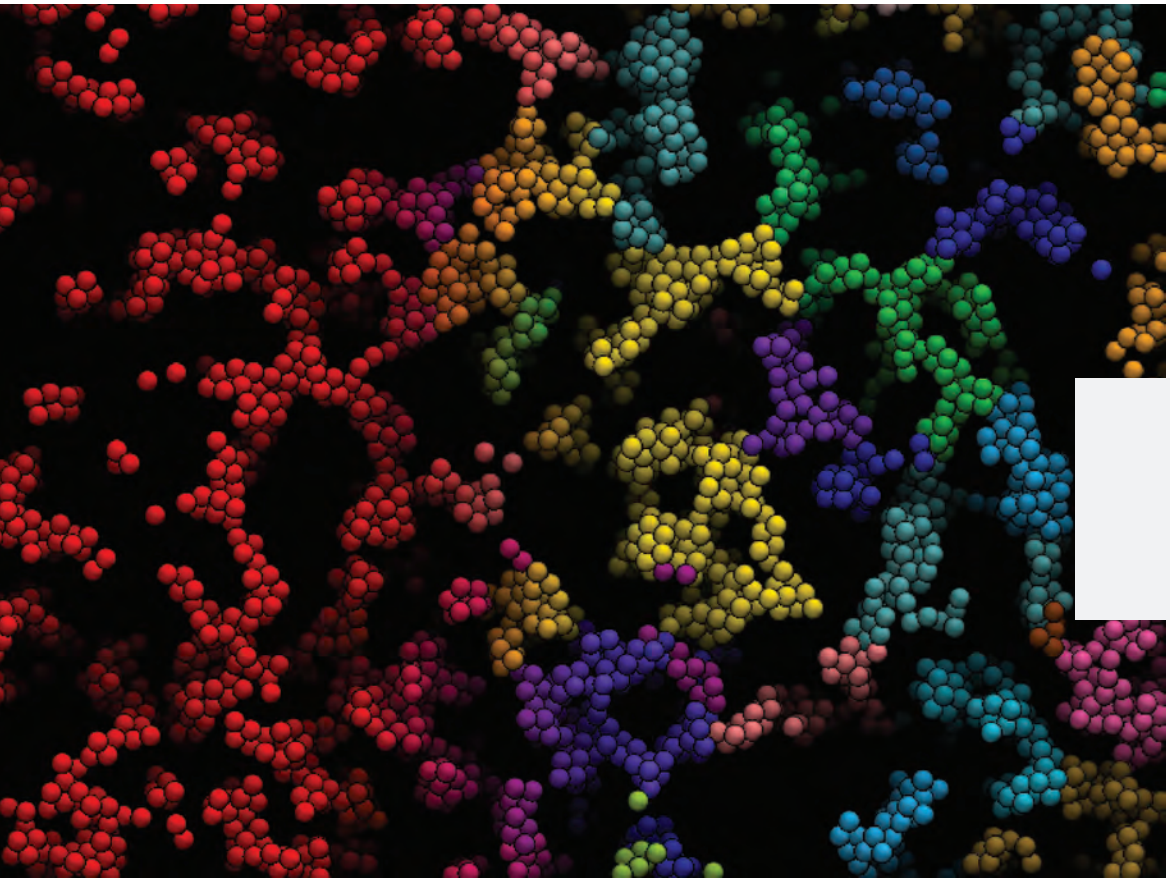
NEW RESEARCH SHOWS HOW CLUSTERED PARTICLES DETERMINE ELASTICITY OF SOME GELS

From the toothpaste you squeeze on your brush first thing in the morning to the yogurt you slurp down to the fabric softener that keeps your pajamas cozy and soft, gels are ubiquitous in consumer products, foods, and in industrial applications, too.

However, until now, scientists have been unable to explain the microscopic structures within gels that impart their elasticity, or springiness, nor how those structures form. A team of scientists from the University of Delaware, Massachusetts Institute of Technology, North Carolina State University and University of Michigan discovered that the elasticity of gels arises from the packing of clusters of particles in the gels, which the group dubbed locally glassy clusters.

This research, described in the journal Nature Communications, could help people engineer better materials and products at the microscale. This insight could help companies in the consumer products, biotechnology, and agriculture sectors and beyond.

Many companies formulate and sell gel products, and sometimes, the stiffness of gels changes as a result of instability. Eric Furst, professor and chair of UD's Department of Chemical and Biomolecular Engineering and one of the paper's corresponding authors, keeps an old bottle of fabric softener on a shelf in his office and uses it to demonstrate what happens when gels separate or "collapse". The product is supposed to be easy to pour, but when it goes bad, it becomes gloppy and unappealing.



A team of scientists, including UD's Eric Furst, discovered that the elasticity of gels arises from the packing of clusters of particles in the gels, which the group dubbed locally glassy clusters.

"Our results provide insight into how to engineer cluster size distribution to control stiffness, flow, and stability of gel materials," said Furst.

The first author of the new paper is Kathryn A. Whitaker, who received a doctoral degree in chemical engineering from UD in 2015 and is now a senior research engineer at Dow in Midland, Michigan.

Investigating gels

Gels are semi-solid materials that flow like liquids but contain solid particles, too. When scientists examine these substances under a microscope, they see that the solid particles within gels form a network, like the structure of a building. To make the substance flow so that you can squeeze it or spread it thin, you need to break that structure. When this requires a lot of force, the substance is stiff and has a high elastic modulus. When less force is required, the substance flows easily and has a lower elastic modulus.
The research group led by Furst studied a gel made of particles of poly(methylmethacrylate) latex (PMMA), commonly known as acrylic, dispersed in a mixture of two colorless liquids, cyclohexane and cyclohexyl bromide. They found that this gel was composed of glassy clusters of particles connected to each other with weak areas in between. To understand how these clusters contributed to the gel's properties, the team wanted to determine the boundaries where each cluster began and ended.

"This is like Facebook," said Furst. "We were trying to figure out — who is connected locally to whom?"

Collaborator James W. Swan, assistant professor of chemical engineering at MIT, conducted simulations to explore the physics behind the clusters. He then applied graph theory, the mathematical study of graphs, to the simulation data to figure out which clusters connected to each other, identify the edges of each group and color-code the clusters. It was like defining the boundaries of intermingling friend groups.

Next, the researchers compared the simulation results to physical studies of the gels and confirmed that the connections and distributions matched their predictions. They determined that the way these locally glassy clusters pack together determines the material's elastic modulus. The interconnected clusters act as rigid, load-bearing units within the gel.

"Until now, no one had seen and described how these clusters packed and how they affected elasticity," said Furst. "We brought the puzzle together."

The paper's authors also include Zsigmond Varga, a process development engineer at ExxonMobil; Lilian C. Hsiao, an assistant professor of chemical and biomolecular engineering at North Carolina State University and Michael J. Solomon, a professor of chemical engineering and Dean and Vice Provost for Academic Affairs, Graduate Studies, Rackham Graduate School at the University of Michigan.

This paper was years in the making as the investigators followed up on lingering questions that bothered them and prompted them to keep working.

"This discovery was the result of the teamwork of the principal investigators, the experimental skills of our students, and the passion and tenacity we all brought as we worked through this problem," said Furst.

Funding for this project came from the International Fine Particles Research Institute, the National Science Foundation, the American Chemical Society (ACS) Petroleum Research Fund.

UD offers a unique master's degree in particle technology through the Department of Chemical and Biomolecular Engineering.

"UNTIL NOW, NO ONE HAD SEEN AND DESCRIBED HOW THESE CLUSTERS PACKED AND HOW THEY AFFECTED ELASTICITY.

WE BROUGHT THE PUZZLE TOGETHER."

GENE THERAPY FOR BLOOD DISORDERS

UD ENGINEERS DEVELOP PARTICLES TO REACH STEM CELLS

Gene therapy holds a lot of promise in medicine. If we could safely alter our own DNA, we might eliminate diseases our ancestors passed down to us.

Now, a team of University of Delaware researchers has demonstrated a major step forward in gene therapy by engineering microparticles that deliver gene-regulating material to hematopoietic stem and progenitor cells, which live deep in our bone marrow and direct the formation of blood cells. In a paper published in Science Advances, doctoral student Chen-Yuan Kao and Eleftherios T. (Terry) Papoutsakis, Unidel Eugene du Pont Chair of Chemical and Biomolecular Engineering, describe how they used megakaryocytic microparticles, which circulate naturally in the blood stream, to deliver plasmid DNAs and small RNAs to hematopoietic stem cells.

With more development, this technology could be useful in treatment for inherited blood disorders that affect thousands of Americans. These include, for example, sickle cell anemia, a disease that causes abnormally shaped red blood cells, and thalassemia, which disrupts the production of the blood protein hemoglobin.

The methods developed by Kao and Papoutsakis could also be used to deliver personalized medicine, because these microparticles can be individually generated and stored frozen for each patient, said Papoutsakis.

This novel approach has advantages over other approaches under investigation.

“A lot of researchers are trying to deliver DNA, nucleic acids, or drugs to target hematopoietic stem cells,” said Papoutsakis. “This is the right cell to target because it gives rise to all blood cells.”

Alter those cells, and you could, in theory, ward off the genetic defect for most or all of the patient’s life.

However, some previously developed methods to target these stem cells deliver genetic material with help from a virus, risking side effects to the patient, said Papoutsakis. Instead, the University of Delaware team developed a method that takes advantage of tiny particles that already float in the blood stream: megakaryocytic microparticles. Kao and Papoutsakis found that they could load these microparticles with gene-regulating material and that they would infiltrate only the desired stem cells, thanks to special properties on the surface of the microparticles.

Eleftherios (Terry) Papoutsakis is the Unidel Eugene du Pont Chair of Chemical and Biomolecular Engineering at the University of Delaware.

COULD BACTERIA FUEL THE FUTURE?

WITH $1.5 MILLION GRANT, UD ENGINEERS STUDY MICROBES FOR BIOFUEL PRODUCTION

A group of bacteria best known for causing stomach trouble could also be a source of sustainable energy.

The U.S. Department of Energy awarded Eleftherios (Terry) Papoutsakis a three-year, $1.5 million grant to study the production of clostridium bacteria as platforms for biofuels. Papoutsakis, the Unidel Eugene du Pont Chair of Chemical and Biomolecular Engineering, will uncover fundamental insights about metabolism and environmental signaling in these microbes for use to produce fuels from renewable resources.

Papoutsakis has been studying clostridium bacteria for decades. He was elected to the National Academy of Engineering in 2018 in part for his work with these microbes.

Clostridia are anaerobic bacteria. As they digest their food, which includes carbohydrates, proteins and many other molecules, they produce compounds such as butanol, acetone and ethanol, which are useful to makers of industrial chemicals and biofuels. Papoutsakis utilizes unique combinations of bacteria to optimize this mix of metabolites.

"The idea is that you have a consortium of organisms that interact syntrophically, which means that one or more of them depends on the others to exist, so you create a stable consortium in nature to be able to do things that no one alone can do," he said.

When multiple microbes are strategically combined, many additional new chemical reactions occur when they combine their metabolic capabilities.

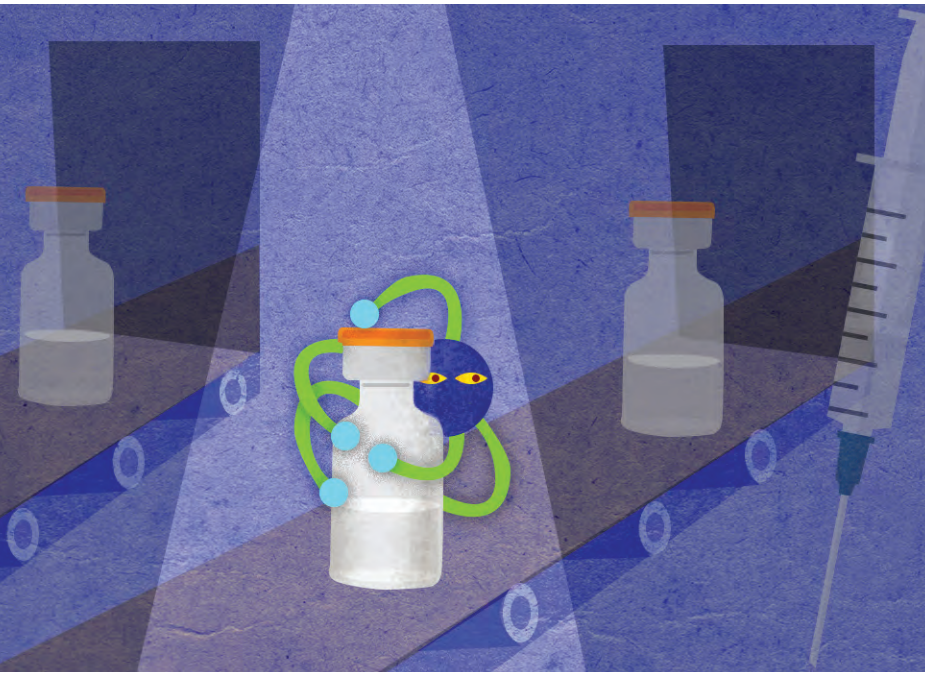
"When they start interacting, you double or triple all the interactions and chemistry that normally goes on through biological events," said Papoutsakis. "That makes the system complex and harder to understand than a single microbe. What do they exchange? How do they communicate? These things are not well understood, and we will address these questions."

Papoutsakis and his team will study and optimize three new systems and study how the bacteria survive, multiply, send out signals and metabolize food. They will use a variety of experimental techniques such as flow-cytometry, time-lapse microscopy and polymerase chain reaction analysis. Maciek Antoniewicz, the Centennial Professor of Chemical and Biomolecular Engineering at UD, and Costas Maranas, the Donald B. Broughton Professor of Chemical Engineering at Penn State University, will collaborate with Papoutsakis on this project. Antoniewicz brings expertise in 13C metabolic flux analysis, a technique that takes snapshots of the metabolism inside bacterial cells. Maranas brings expertise in computational biology, modeling and studying metabolism at the genome scale.

As the researchers study the fundamental biology of consortia, they aim to figure out which mixes of bacteria can best be used to digest waste material and renewable biomass, such as scrap wood, and convert them into useful chemicals and fuel molecules.

Often in the biotechnology industry, scientists use a single type of bacteria for fermentation.

"In this project we aim to demonstrate that using two or more complementary microorganisms can dramatically improve process yields," said Antoniewicz.



HITCHHIKERS HINDER MEDICATION SHELF LIFE

UD INGENUITY SHEDS LIGHT ON KEY BIOPHARMACEUTICAL MANUFACTURING PROBLEM

Why some biopharmaceuticals have a longer shelf life than others is a problem that has baffled scientists and manufacturers alike. Even the same medication, produced by different manufacturers, can vary in its storage life.

Professors Kelvin Lee and Abraham Lenhoff offer insight on one way this can happen in monoclonal antibodies, which comprise a large fraction of biopharmaceuticals.

Traditional small molecule medicines are manufactured using well-defined, discrete chemical reactions between compounds. Biopharmaceuticals, on the other hand, are larger, more complex molecules that are manufactured by growing cells that produce a desired protein (often, an antibody) that is purified to create the medicine.

The human body makes millions of antibodies in small quantities to protect itself from infection, and to some extent, from disease. For example, a chicken pox vaccine helps the body learn to make an antibody against the chickenpox virus. If you get chickenpox after being vaccinated, the body marshals its antibody troops and sends them off to find, and bind, to the virus; then signals the immune system to eliminate it from the body. "Once you get the cell to start making the drug for you, then you grow lots of cells, purify the drug, formulate it and ship it out to doctor's offices and hospitals. This is simplified, of course, but it's generally how these classes of medicines are made," said Lee, the Gore Professor of Chemical Engineering and director of the Manufacturing USA National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL) at UD.

The trouble is that cells don't make just the desired antibody; cells produce thousands of other proteins, too. When a medication is manufactured, these other proteins are removed through purification. However, some proteins may stick to the antibody and piggyback their way through the manufacturing process. Manufacturers have developed methods to separate the piggybacking molecules, but problems can occur if the hitchhiking protein "looks" or behaves like the target medication.

Added to this, antibody-based drugs often are mixed with additives to keep the medication safe and stable for a period of time, say six- or 12-months. One commonly used stabilizer is polysorbate, which is added to keep the protein antibody in solution. One challenge the biopharmaceutical industry has observed is that the level of polysorbate found in some drug products can decrease over time, shortening a medication's shelf life. For many years, there was no discernable reason for why the polysorbate degraded in some cases, but not in other cases.

In previous National Science Foundation-funded work, Lee and Lenhoff were collaborating to understand which contaminating proteins, or impurities, might be especially difficult to remove from a drug product. Lee specializes in proteomics. Lenhoff, the Allan P. Colburn Professor of Chemical Engineering, is an expert in separating mixtures of proteins. Through experiments, one protein that emerged as interesting for its potential to remain throughout the manufacturing process as an impurity was lipoprotein lipase, a common enzyme found in the human body that breaks down triglycerides.

"Lipoprotein lipase is one example of a protein that associates with antibodies and sometimes can't be separated from antibodies using standard approaches. Thus, it may ultimately make its way through the manufacturing process to the other end," said Lee.

The researchers focused additional experiments on lowering the amount of lipoprotein lipase to determine what, if any, effect it had on polysorbate. It turned out that lowering the amount of lipoprotein lipase that was present lowered the rate of degradation of polysorbate.

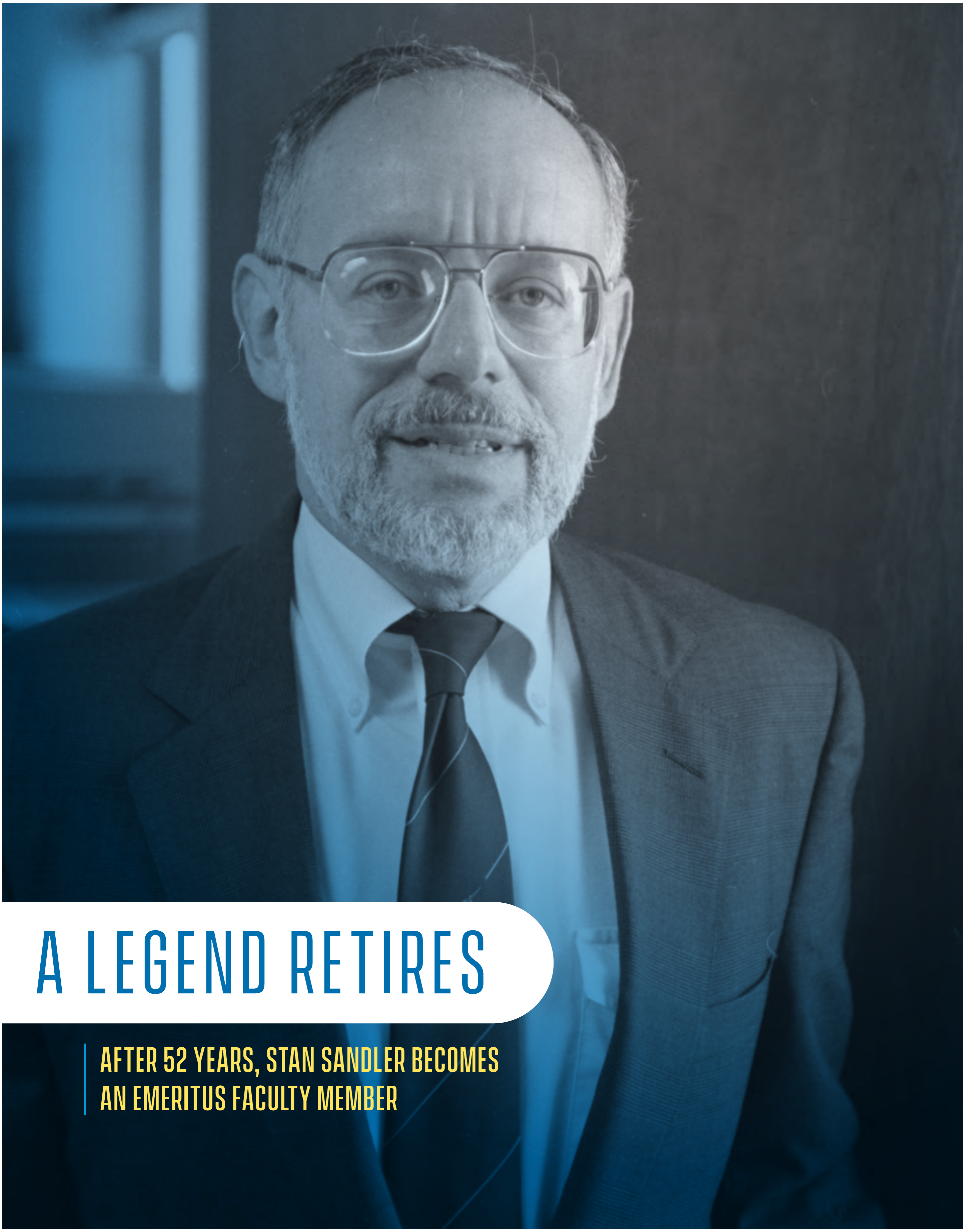
The researchers developed a method to reduce the amount of lipoprotein lipase that's produced by the cells, in order to reduce the amount that might show up downstream as an impurity in relevant antibody-based drug formulations. They patented the idea with the help of UD's Office of Economic Innovation and Partnerships (OEIP). Two former UD doctoral students, Kristen Valente and Nick Levy, both of whom now work in the biopharmaceutical industry, are named on the patent.

DELAWARE GOV. CARNEY TOURS BIOPHARMACEUTICAL BUILDING SITE

Sporting white hard hats, bright safety vests and protective goggles, Delaware Gov. John Carney and a small group of officials visited the construction site of the University of Delaware's Carol Ammon and Marie Pinizzotto M.D. Biopharmaceutical Innovation Center on Tuesday, Feb. 5, 2019. Part of UD's Science, Technology and Advanced Research (STAR) Campus, the six-story 200,000-square-foot project will bring together research by more than 150 universities, private companies and nonprofits from around the United States. It will also serve as the headquarters for the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL).

Charles G. Riordan, vice president for research, scholarship and innovation at UD, emphasized the potential for the building to foster work that will impact the healthcare market in the United States and beyond. "How do you innovate manufacturing of these large molecule drugs to help get them in the market and get them to patients?" Riordan asked rhetorically. "The University is very interested in leveraging all of that manufacturing innovation to continue to grow our basic discovery sciences in that space."

Kelvin Lee, director of NIIMBL and Gore Professor of Chemical Engineering at UD, said the new facility will bring researchers from outside Delaware to campus and help educate future workers in pharmaceutical manufacturing and research. "This space is going to be unique," Lee said.



A LEGEND RETIRES

AFTER 52 YEARS, STAN SANDLER BECOMES AN EMERITUS FACULTY MEMBER

In 2011, a festschrift issue of the publication I&EC Research honored Sandler's lifelong dedication to chemical engineering.

Stanley Sandler has had an illustrious career as one of the most influential chemical engineers of his generation. On September 1, he will retire and become an emeritus faculty member after 52 years of the University of Delaware.

Sandler's influence in the field cannot be understated. He is a member of the National Academy of Engineering and has been named one of the top 30 chemical engineering authors by the American Institute of Chemical Engineers.

He has authored many influential books, including the landmark textbook Chemical, Biochemical, and Engineering Thermodynamics, now in its fifth edition. Of the book, he said: "It not only changed what we do here but also has had an impact on instruction around the world."

He's also proud of the accomplishments of his students, his efforts to promote the use of computers in chemical engineering instruction (for which he won an award from the American Society of Engineering Education) and his initiation of a conference series in thermodynamics that was supposed to be a one-time event but so far has had a 42-year run. The most recent meeting was held in May 2019 in Vancouver, Canada.

Sandler has served as department chair and as interim dean of the College of Engineering, but his heart lies with research and teaching, not with administration. This accomplished academician didn't plan to be a college professor, but the encouragement of one of his professors at City College of New York, Robert Pfeffer, set him on this path.

"In my senior year, he encouraged me go to graduate school — a possibility that had never occurred to me," Sandler says. "I had no idea what one studied in graduate school or that an assistantship would make such a choice financially viable."

"Ever since then," he adds, "I've considered mentorship of students to be very important because I wouldn't be where I am today without him."

After earning his doctorate at the University of Minnesota, Sandler still had no thoughts of academia.

"But I had done my Ph.D. thesis in kind of a weird area, so I was only getting weird job offers from industry, including one from Bell Labs focused on determining the potential effects of a nuclear attack," he says. So, with an offer in hand from UD, Sandler and his late wife, Judith, moved to Delaware. Having grown up in Manhattan, he was unprepared for small-town life, and he promised Judith that they would stay just three years.

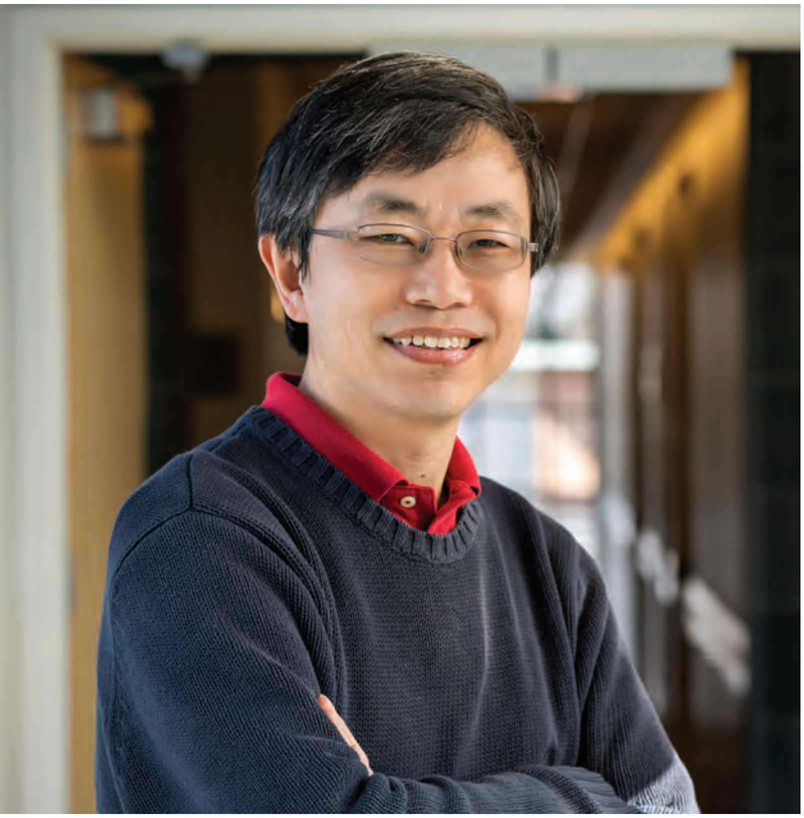
That was in 1967. Three children and several job offers later, they were permanently settled in Newark's Oaklands neighborhood.

Sandler was also apprehensive about how he would fare as a faculty member at a top-ranked chemical engineering program, but his fears were unfounded. He was promoted to associate professor with tenure before his 30th birthday and to full professor by the age of 32. Sandler's early years at UD saw some Vietnam-era unrest, with protests on campus leading to the dismissal of a number of students and faculty. He quickly became an activist and was instrumental in establishment of the AAUP Collective Bargaining Agreement at UD.

In addition to his teaching and research, Sandler has consulted on a number of projects, including the destruction of armed chemical weapons and the encasement of radioactive wastes left over from the production of plutonium for nuclear weapons during World War II and the Cold War. He has also served as an expert witness in patent litigation.

The young man whose parents never owned a car — believing that any place that couldn't be reached by subway wasn't worth going to — has since traveled the world. Between professional trips and personal vacations, Sandler has visited all 50 U.S. states and 110 countries.

Sandler was the Henry Belin du Pont Chair of Chemical Engineering. That title will be now be held by Yushan Yan, who was previously a Distinguished Engineering Professor.



YUSHAN YAN HONORED FOR INVENTIONS

FUEL CELL PIONEER NOW FELLOW OF NATIONAL ACADEMY OF INVENTORS

Yushan Yan, now a Fellow of the National Academy of Inventors, has been an inventor on more than 25 issued or pending patents.

Yushan Yan, Distinguished Engineering Professor in chemical and biomolecular engineering, has been named a Fellow of the National Academy of Inventors (NAI). He was one of 148 renowned academic inventors named to NAI Fellow status on Dec. 11, 2018.

Yan is an expert in electrochemistry and electrochemical energy engineering. He has been an inventor on more than 25 issued or pending patents and is the founder and co-founder of several startups including W7energy, which was founded to design, develop and manufacture platinum-free fuel cell membranes. He introduced the use of zeolite minerals into membranes for desalination, or removing salt from saltwater. A startup company, NanoH2O, was formed to commercialize his nanocomposite desalination membrane technology and was acquired by LG Chemicals in 2014.

"Professor Yan's pioneering work in electrochemical energy conversion is currently enabling the next generation of fuel cells, electrolyzers, flow batteries and solar hydrogen generators" said Brad Yops, director of UD's Technology Transfer Center.

Through these and other inventions, Yan is doing his part to engineer a more sustainable future. Today, much of Yan's research focuses on fuel cells, which convert chemical energy into electricity to power cars without producing pollution. Automotive fuel cell membranes, currently made of a polymeric material called Nafion, require a catalyst to spur power-generating electrochemical reactions. Often this catalyst is platinum, a precious metal, which can stand up to the acidic environment inside fuel cells.

Yan is developing membranes made with a Nafion substitute that shifts the environment within fuel cells from acidic to alkaline. He has termed them as hydroxide exchange membranes.

"These new membranes enable cheaper fuel cell components including little or no precious metal catalysts, making fuel cells more affordable," he said.

Yan joins fellow UD chemical engineers Babatunde Ogunnaike, William L. Friend Chair of chemical and biomolecular engineering (2014), and Norm Wagner, the Robert L. Pigford Chair in chemical and biomolecular engineering (2015) as NAI Fellows. Ogunnaike has worked closely with Yan since 2014.

"Yushan's innovative and creative spirit has led to some stunning scientific research results," said Ogunnaike. "He combines this with the rare talent to take these scientific innovations to the next step beyond publication in high impact journals: commercialization, to the extent possible."

NEW GORE CENTENNIAL CHAIR IN CHEMICAL AND BIOMOLECULAR ENGINEERING

MARIANTHI IERAPETRITOU JOINS THE UNIVERSITY OF DELAWARE

Marianthi Ierapetritou, Distinguished Professor of Chemical and Biochemical Engineering at Rutgers University, joined the University of Delaware as Gore Centennial Chair in Chemical and Biomolecular Engineering on September 1, 2019.

Ierapetritou is a prominent chemical engineer and member of the board of directors of the American Institute of Chemical Engineers. Her research centers on process systems engineering. “For most of my career, I have explored opportunities to contribute to different end applications by providing modeling approaches and exploration optimization frameworks,” she said.

Her research background aligns with two keystones of UD’s research portfolio: energy and biopharmaceuticals.
In the area of sustainable fuels, Ierapetritou has collaborated with Dionisios Vlachos, the Allan and Myra Ferguson Professor of Chemical and Biomolecular Engineering, Director of the Delaware Energy Institute, and Director of the Catalysis Center for Energy Innovation, based at UD.

“We did a lot of work together the last five years in the area of renewable energy and the catalytic conversion of biomass to chemicals and fuels, so I am very interested in exploring further this research direction and actually expanding to include other transformations, including biochemical transformations.”

Meet our newest named professor, Marianthi Ierapetritou.

Ierapetritou also conducts research with applications to biopharmaceutical manufacturing. UD is the home of the National Institute for Innovation in the Manufacturing of Biopharmaceuticals (NIIMBL).

“I have been working in the area of pharmaceutical engineering for the last 10 years, mainly on the small molecules, but in the last five years I’ve been exploring more the area of biologics production and manufacturing,” she said.

Ierapetritou is passionate about helping women in different stages of their scientific careers—undergraduates, graduate students, postdocs and faculty—to identify and understand opportunities to develop and advance. She was associate vice president for Women in Science, Engineering and Mathematics at Rutgers, and earlier, as chair of the Rutgers chemical and biochemical engineering department, she worked to diversify the composition of the faculty and student body.

Ierapetritou received her doctoral degree in 1995 from the Imperial College, London, and completed post-doctoral research at Princeton University. She joined Rutgers in 1998 as an assistant professor and spent 21 years there. “The decision to leave was not an easy one, but what made me attracted to Delaware was mainly the department’s reputation: among the top 10 in the United States and well known worldwide,” she said. “That was an important factor, but when I came and visited, another thing that made me consider it very seriously was the fact that the faculty were very welcoming, warm, open to collaborations and open to research ideas. This energy really made a big difference for me.”

RECOGNITION FOR BIOTECHNOLOGY INFLUENCER

KELVIN LEE RECEIVES MARVIN J. JOHNSON AWARD IN MICROBIAL AND BIOCHEMICAL TECHNOLOGY

As the director of NIIMBL, the National Institute for Innovation in Manufacturing Biopharmaceuticals, Kelvin Lee is a changemaker in the biomanufacturing industry, which has the potential to save lives, improve national security, and increase economic development in the United States.

Kelvin Lee, Gore Professor of Chemical and Biomolecular Engineering at the University of Delaware, has received the 2019 Marvin J. Johnson Award in Microbial and Biochemical Technology from the American Chemical Society's Division of Biochemical Technology.

For his impact in microbial and biochemical technology, Lee, Gore Professor of Chemical and Biomolecular Engineering at the University of Delaware, has received the 2019 Marvin J. Johnson Award in Microbial & Biochemical Technology from the American Chemical Society's Division of Biochemical Technology. He received the award at the spring meeting of the American Chemical Society.

Lee joins 2017 winner Wilfred Chen, Gore Professor of Chemical and Biomolecular Engineering, and two other UD colleagues who have received the Marvin J. Johnson Award —Abraham Lenhoff (2011) and Eleftherios Papoutsakis (1998). UD and the University of California at Berkeley are the only two universities to have four winners of the Marvin J. Johnson Award on their faculties.

AN EMERGING LEADER IN BIOSECURITY

NEW CHEMICAL ENGINEERING PROFESSOR PARTICIPATING IN HIGHLY SELECTIVE FELLOWSHIP PROGRAM

Assistant professor Aditya Kunjapur was named to the Johns Hopkins Center for Health Security's Emerging Leaders in Biosecurity Initiative fellowship program in 2019.

Kunjapur joined 30 people from 13 U.S. states, Canada, and the United Kingdom who were selected from more than 130 applicants. Throughout the year, the fellows attend three multi-day workshops, participate in networking opportunities and engage with top experts in domestic and global health security.

Kunjapur brings expertise in synthetic biology. "My lab seeks to enable living systems to produce and tolerate the kinds of chemical functional groups and reactions that are often only achieved in non-living environments by chemists," said Kunjapur, who joined UD in 2019. Many scientists are utilizing microbes for their ability to produce other chemicals, such as fuels, and Kunjapur wants to use biological substances as chemical factories or protein factories.

"I'm very interested in sustainable chemistry using biomanufacturing platforms," said Kunjapur. "If I achieve my dream of being able to put more and more unusual functional groups either on proteins or small molecules, it starts to blur the lines between what we think of as chemical and biological, and that's where some of the risks come into play that first got me interested in this biosecurity space."

HIGH-LEVEL RESEARCHER REFLECTS ON TEACHING INTRODUCTORY CLASSES

ARTHI JAYARAMAN EXPLAINS HER APPROACH

Arthi Jayaraman, a UD associate professor, recognizes that each group of students presents a new teaching challenge and she tries to adapt her lesson to meet their needs.

Arthi Jayaraman wears many hats.

She is an associate professor. She teaches one class each semester and serves as the graduate program director for the Department of Chemical and Biomolecular Engineering. She does research, regularly travels to present at conferences and personally advises about nine students.

Jayaraman's team designs polymers to advance or discover various materials. She makes simulation models on the computer to test and design the properties of potential new products, such as car tires, bumpers and creating genes to fix damaged DNA. Once a model is ready, she shares her findings with experimental collaborators who develop the physical product.

While Jayaraman does high-level research, she also teaches the basics. She was the co-teacher of Introduction to Chemical Engineering with Joshua Enszer during the spring 2018 semester.

"A lot of time is spent deciding how best to present the material," Jayaraman said. "Because there are different students of different backgrounds and different skill sets, so communicating that same material the correct way is where most of my time goes."

During one of her Tuesday afternoon classes, Jayaraman recapped the previous week's lesson on rate determination. She walked around the room while lecturing and tried to make the environment more intimate, given there were 140 students in the class. She pulled up a problem on the projector and challenged the students to solve it.

"I'd like to hear from some of you," Jayaraman said to the class. "What was your initial process?"

As the students worked on the problem, professors and teaching assistants walked around the room to give class members a few minutes of one-on-one attention. This is a big part of her philosophy for teaching this course.

"That's one way for us to figure out how they think about a problem and what they seem to be enjoying," Jayaraman said.

What results is a lot of tracking. Who's in class? Who's absent? How are students progressing and why is someone falling behind? She said they give a lot of quizzes to keep up with each student. She also offers students a lot of time to get any help they may need. By her calculation between class time, recitation and office hours the students have the opportunity to interact with the professors 16 hours a week.

Some of the same students she taught in the introductory class have taken her senior lab course four years later That full circle is rewarding. She also said it helps there is some separation between her research, Introduction to Chemical Engineering and the more senior level classes she teaches.

"I think having a difference, to some extent, to what I teach and what I do for research helps," Jayaraman said. "It's variety, and to have variety is much better than doing the same thing in class and in research."

FACULTY HIGHLIGHTS

NEWS, HONORS, AWARDS AND APPOINTMENTS

Maciej Antoniewicz
As Fraser Russell has often said, there are times when Delaware faculty must take up important work as emissaries of our great program–disseminating the esprit de corps of this department widely and bringing great scholarship, teaching, and service to other institutions. Professor Antoniewicz will depart this fall. His twelve years of service at Delaware are marked by his dedication to service and a program of scholarship in metabolic engineering that stands as one of the greatest in the world.

Sujata Bhatia
Professor Bhatia is serving as the director of Delaware's McNair Scholars Program. The purpose of the McNair program is to prepare, empower, and expose academically talented low-income, first generation, and underrepresented students toward pursuit of advanced gradate degrees.

Anthony Beris
Professor Beris continues his work on the theory of fluid mechanics and complex fluid rheology and published several articles and a book chapter on hemorheology - the rheology of blood - this past year.

Douglas Buttrey
Professor Buttrey continued to bridge global scholarship and education as a Visiting Professor at the African University of Science and Technology, Abuja, Nigeria.

Wilfred Chen
Professor Chen's scholarship was recognized by the 2019 Food, Pharmaceutical & Bioengineering Division Award, from AICHE and he was invited to deliver the Fan-Tsan Chen Lectureship at the Department of Chemical Engineering, National Taiwan University, November 2018.

Prasad Dhurjati
Professor Dhurjati's elective course, Systems Biology, has been well-received well by students from across the university.

Joshua Enszer
The AIChE student chapter received an Outstanding Student Chapter award at the 2018 Annual AIChE Student Conference with the guidance and support of their faculty advisor, Professor Enszer.

Thomas H. Epps III
Professor Epps' work has been recognized by numerous awards, most recently as an elected Fellow of the Royal Society of Chemistry and by the invitation to join the Science Advances editorial board as an associate editor. In addition to his teaching and scholarship, Professor Epps led the formation of a new research center this year, the Center for Research in Soft Matter and Polymers (CRISP).

Cathy Fromen was one of 28 early-career academics elected to the ACS Biomaterials Science and Engineering's Inaugural Early Career Editorial Board for a three-year term.

Arthi Jayaraman was promoted to professor of chemical and biomolecular engineering, effective September 1, 2019, and was recently appointed as an Associate Editor of Macromolecules. We thank Professor Jayaraman for her service as she steps down as graduate program director.

Feng Jiao
Professor Jiao continues his development of CO2 conversion, with a record of publishing this year that includes four papers in Nature journals. Professor Jiao takes over as the graduate program director and will be the inaugural Robert K. Grasselli Development Professor of Chemical and Biomolecular Engineering.

Michael Klein
Professor Klein's molecular-level kinetic modeling is in high demand, especially among industry collaborators and with colleagues studying the upgrading and conversion of biomass into fuels and sustainable materials. After nearly 40 years as a scholar, teacher, and in academic leadership, Professor Klein has taken a final sabbatical year in 2019 and will retire in 2020.

April Kloxin
Professor Kloxin's scholarship was recognized by the American Chemical Society PMSE Arthur K Doolittle Award and the ACS POLY division Researcher of the Month. We had the opportunity to experience first-hand Professor Kloxin's enthusiasm for her research when she delivered the winter research review keynote talk this year. Professor Kloxin will co-direct the graduate admissions and recruiting role with Professor Xu and will be recognized by the department as a Centennial Development Professor.

Chris Kloxin
Professor Kloxin continues to advance uses of click chemistry, including spatially and temporally controlled polymerization reactions.

LaShanda Korley
Professor Korley's NSF PIRE grant, Bio-inspired Materials and Systems, takes her frequently to the Adolphe Merkle Institute at the Université de Fribourg. She's helping to direct the Center for Research in Soft Matter and Polymers (CRISP) and published a review article on structure-property relationships in polymeric surface coatings in the journal ACS Applied Polymer Materials.

Aditya Kunjapur
Professor Kunjapur is focused on building his lab capabilities and mentoring his first cohort of students, all of whom successfully completed the PhD qualifiers in August. He was named a 2019 Emerging Leaders in Biosecurity Initiative Fellow.

Kelvin Lee
In addition to leading the founding and startup of NIIMBL, Professor Lee maintains an active and visible research program. He was recognized by the ACS BIOT Marvin Johnson Award in Microbial and Biochemical Technology in 2018.

Bramie Lenhoff
Professor Lenhoff continues his work as a leading scholar in areas of biopharmaceuticals and biopharmaceutical manufacturing, including, most prominently, separations and the physico-chemical properties of proteins and protein solutions.

Raul Lobo
Professor Lobo continues to develop a widely-recognized and highly regarded program of scholarship focused on catalysis and chemical transformations in energy and chemicals manufacturing. His professional service includes service as the treasurer of the International Zeolite Association.

Babatunde Ogunnaike
Ogunnaike is enjoying his sabbatical this year after his service as the Dean. He's revising his seminar textbook, "Process Dynamics, Modeling, and Control" and visiting universities and programs across the world.

Marat Orazov
With one year under his belt, Professor Orazov successfully mentored his PhD students through their qualifiers and has been working to build his research laboratories.

Terry Papoutsakis
Professor Papoutsakis' preeminence at Delaware is mirrored by his stature in the national chemical engineering community; he is sought nationally as a speaker in industry which takes him all of the world - from the Blue and Green lectureship at Michigan and Michigan State to the University of Chile, Santiago. This past year the department celebrated his induction into the National Academy of Engineering and his award from the American Society of Microbiology for Applied and Biotechnological Research.

Chris Roberts is serving as the Associate Institute Director, National Institute for Innovation in Manufacturing Biopharmaceuticals, USA (NIIMBL), a role that keeps him on the road frequently, despite also leading the Biomolecular Interaction Technologies Center (BITC).

Stan Sandler
Retirement won't slow down Professor Sandler. He's currently working on the 6th edition of Chemical, Biochemical, and Engineering Thermodynamics as well as updates to his statistical mechanics and Aspen texts. You can find him in Colburn Laboratory most Saturdays. Old habits die hard.

Millie Sullivan currently serves as the Associate Chair of Chemical and Biomolecular Engineering. Professor Sullivan recently received one of the first NSF Emerging Frontiers Rules of Life portfolio grants.

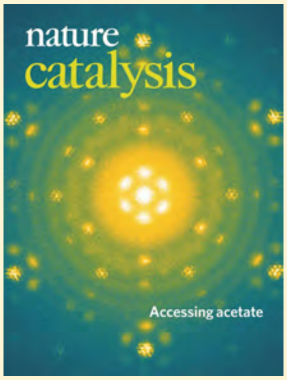
Dion Vlachos
As Director of the Catalysis Center for Energy Innovation (CCEI), an Energy Frontier Research Center (EFRC) funded by the Department of Energy, Professor Vlachos led the center through its second renewal, significantly refreshing the research directions and restructuring the center. He is also a Focus Area Leader on Intensified Process Fundamentals, RAPID, and serves as the director of the Delaware Energy Institute (DEI).

Norm Wagner
Professor Wagner is serving as the President of the Society of Rheology and is working to update his seminal text with Jan Mewis, Colloidal Suspension Rheology. Professor Wagner received the 2018 Sustained Research Prize of the Neutron Scattering Society of America.

Bingjun Xu
Professor Xu was promoted to associate professor of chemical and biomolecular engineering, effective September 1, 2019. Professor Xu will co-direct the graduate admissions and recruiting role in the department and will be recognized as a Centennial Development Professor.

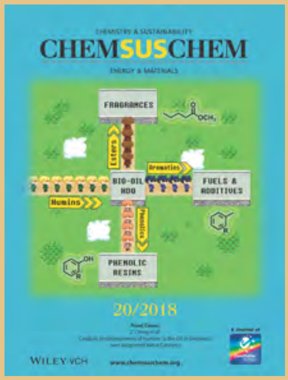
Yushan Yan
Recently elected as a fellow of the National Academy of Inventors, Professor Yan is actively taking his fuel cell technologies to market through the startup W7energy.

RESEARCH AT THE FOREFRONT



"Two-dimensional Copper Nanosheets for Electrochemical Reduction of Carbon Monoxide to Acetate"

By: Wesley Luc, Xianbiao Fu, Jianjian Shi, Jing-Jing Lv, Matthew Jouny, Byung Hee Ko, Yaobin Xu, Qing Tu, Xiaobing Hu, Jinsong Wu, Qin Yue, Yuanyue Liu, Feng Jiao & Yijin Kang



"Catalytic Hydrotreatment of Humins to Bio-Oil in Methanol over Supported Metal Catalysts"

By: Ziwei Cheng, Basudeb Saha, Dionisios G. Vlachos

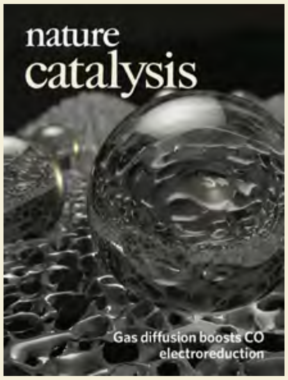
"Charging Toward Improved Lithium-ion Polymer Electrolytes: Exploiting Synergistic Experimental and Computational Approaches to Facilitate Materials Design"

By: Priyanka M. Ketkar, Kuan-Hsuan Shen, Lisa M. Hall and Thomas H. Epps, III

Nature and Catalytic Properties of In-Situ-Generated Brønsted Acid Sites on NaY"

By: Brian M. Murphy, Jingcheng Wu, Hong Je Cho, Juliana Soreo, Chenguang Wang, Longlong Ma, and Bingjun Xu

CONGRATULATIONS TO OUR FACULTY FOR LANDING THE COVERS OF THESE JOURNALS!

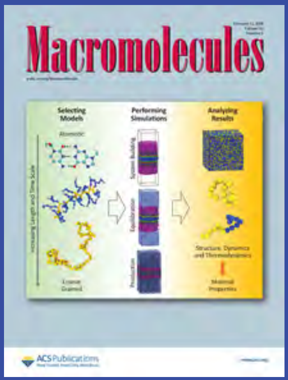


"High-rate electroreduction of carbon monoxide to Multi-carbon products"

By: Matthew Jouny, Wesley Luc and Feng Jiao

"Kinetic Studies of Acid Hydrolysis of Food Waste-Derived Saccharides "

By: Elvis Ebikade, Jonathan Lym, Gerhard Wittreich, Basudeb Saha, and Dionisios G. Vlachos



"Modeling and Simulations of Polymers: A Roadmap"

By: Thomas E. Gartner III, and Arthi Jayaraman

AICHE STUDENT CHAPTER SHINES AT NATIONAL CONFERENCE

THE GROUP WAS NAMED AN OUTSTANDING STUDENT CHAPTER, AND FOUR STUDENTS TOOK HOME PRIZES FOR THEIR RESEARCH POSTERS

The University of Delaware's student chapter of the American Institute of Chemical Engineers (AIChE) received an Outstanding Student Chapter award at the 2018 Annual AIChE Student Conference.

This award is given to student chapters that show an exceptional level of participation, enthusiasm, program quality, professionalism, and involvement in the university and community. In 2018, 27 chapters from across the world received the award, including the student chapter at the Universidad Nacional de Colombia, Sede Bogota, the sister chapter of UD's student chapter of AIChE. UD's student chapter also won this award in 2016.

Sixteen undergraduate chemical engineering students from UD's AIChE student chapter, which was chartered in 1937, took a bus to the 2018 conference. Nine of the students presented posters showcasing their undergraduate research projects, and four came home with awards for their posters.

Elaine Stewart won first place, Materials Engineering and Sciences, for the poster: Optimization of Shear-Thickening Fluids for Space Suit Applications. Erin Hogan won second place, Materials Engineering and Sciences, for the poster: Optimization of Shear-Thickening Fluids for Space Suit Applications. Both do undergraduate research with Norm Wagner, Unidel Robert L. Pigford Chair in Chemical and Biomolecular Engineering. Hogan also received the Freshman Recognition Award for being the most active first-year undergrad in UD AIChE in 2017-2018.

Chris Calo won second place, Materials Engineering and Sciences, for the poster: Controlling Mechanical Properties of 455 nm visible light 'thiol-one' poly(ethylene glycol) hydrogels. He does research with April Kloxin, associate professor of chemical and biomolecular engineering and materials science and engineering.
Justin Terr won second place in Food, Pharmaceutical, Biotechnology for the poster: Lov is BLISS: Creating a Blue Light Induced Spycatcher System. He does research with Wilfred Chen, Gore Professor of Chemical Engineering.

Joshua Enszer, associate professor of chemical and biomolecular engineering, was immediately impressed by the students in UD's student chapter of AIChE when joined the university in 2015. "These are great students who inspire each other in a collaborative, supportive environment," said Enszer, who advises the student group along with Megan Argoe, academic advisor in chemical and biomolecular engineering.

CLASS OF 2019 STUDENT SPOTLIGHT: ELAINE STEWART

Many engineers dream of working for NASA someday, and Elaine Stewart didn't wait for graduation to start that mission. Since 2016, she has worked as a Spacecraft Contamination Control Engineer at NASA's Goddard Spaceflight Center. Stewart supports integration and testing on the James Webb Space Telescope, which will launch in 2021 to investigate every phase of cosmic history, including the first stars and galaxies formed in the early universe, our solar system, and extrasolar planets that may support the building blocks of life. She came to this role equipped with skills she learned in internships, including one at Kennedy Space Center funded by the Delaware Space Grant Consortium, and stints as an undergraduate research assistant for professors April Kloxin, Norman Wagner, and John Gizis. Stewart works with Dr. Wagner on shear thickening fluid, a cushioning and movement-responsive material, for astronauts' spacesuits. "Using this shear thickening fluid will allow the astronauts to have an extra layer of protection on their space suits from micrometeoroids in space or puncture from tools," said Stewart.

REACHING FOR FUTURE ENGINEERS

STUDENT GROUP HOSTS EVENT FOR ASPIRING CHEMICAL ENGINEERS

Recruiting, Engaging, Advancing Chemical Engineers (REACH), a student organization sponsored by the Department of Chemical and Biomolecular Engineering at UD, is helping high school students learn about chemical engineering.

When you were in high school, did you know what chemical engineering was? Recruiting, Engaging, Advancing Chemical Engineers (REACH), a student organization sponsored by the Department of Chemical and Biomolecular Engineering at UD, is spreading the word about this field — which, according to the Bureau of Labor Statistics, is projected to have 8 percent job growth between 2016 and 2026.

REACH, advised by Joshua Enszer, associate professor of chemical and biomolecular engineering, and Megan Argoe, academic advisor for chemical and biomolecular engineering, hosted its first Engineering Day for 21 high school students at the UD's Newark campus on March 9, 2019. This event was a successful result of collaboration between REACH and UD's K-12 Engineering Outreach program, which is directed by academic program manager Melissa Jurist and assisted by Janna Rhodes.

"Unlike most other engineering disciplines, chemical engineering requires thinking about the transformation of the molecular nature of materials to solve big problems," said Enszer. "In high school, students get a chance to learn about transforming materials in chemistry, but that chemistry is not usually connected to engineering. It's important to expose students to the opportunities in this field of engineering."

Even at high schools with strong programs in science, technology, engineering and mathematics (STEM), chemical engineering is not widely explored in engineering-focused classes. The students of REACH want to introduce chemical engineering to high schoolers so that they have every opportunity to excel, said Charlie Jabbour, a junior in the major and recruiting co-leader for REACH.

"There are students in every school who could be the next Albert Einstein or Steve Jobs," he said.

"When UD K-12 Engineering works with undergraduate and graduate students to help reach the K-12 community, we are accomplishing two things," said academic program manager Melissa Jurist, referring to near-to-peer engagement and the need for engineering students to learn to communicate about science.

The event organizers also conveyed that while the chemical engineering curriculum is rigorous, UD's chemical and biomolecular engineering department offers a strong sense of support and community.

"I love the program I'm in," said Emilia Leyes, a junior and recruiting co-leader for REACH. "I enjoy it. Of course, it's very stressful and overwhelming at times, but what I get out of this program is amazing. We have a support system and a true sense of community here."

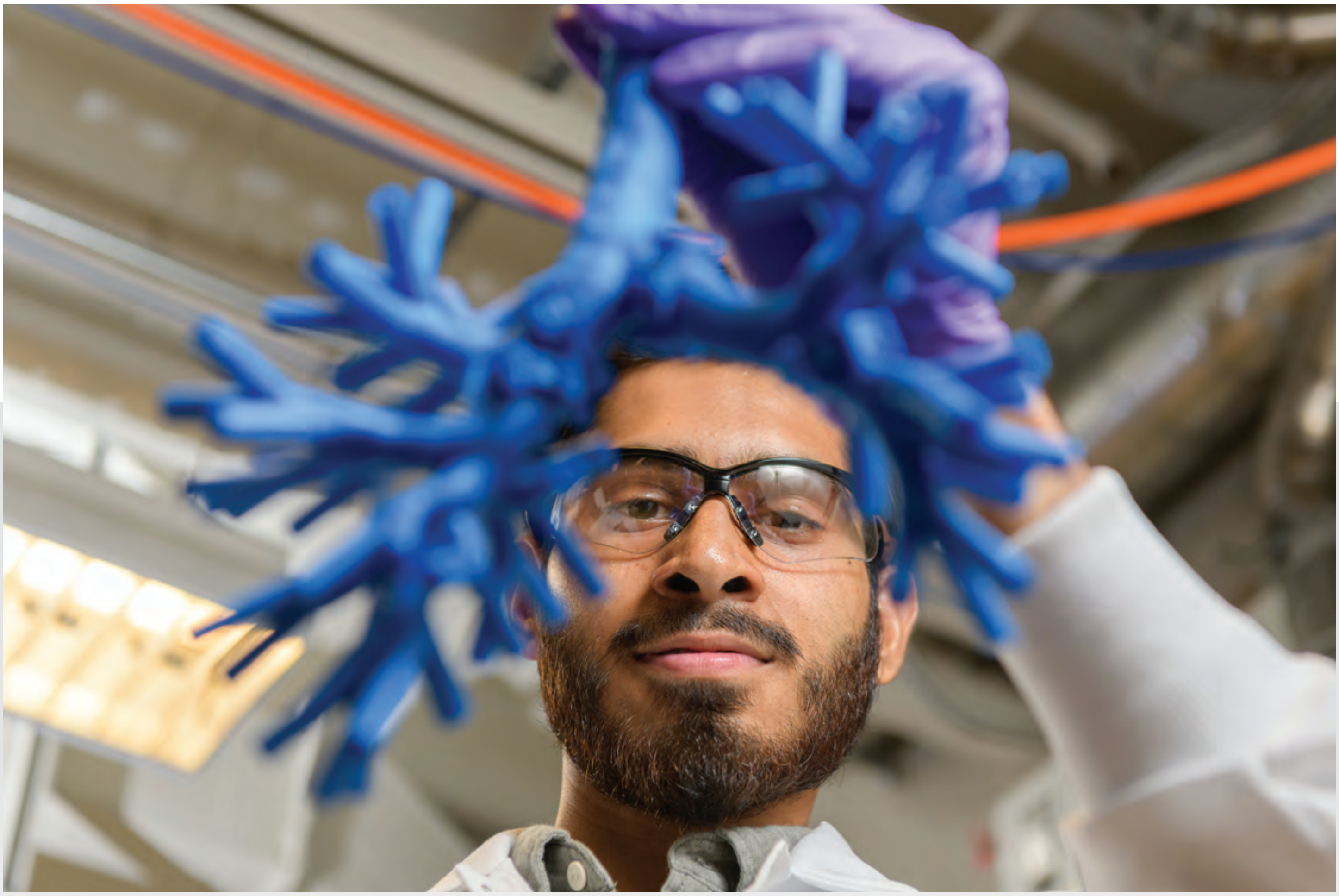
In addition to mini-lectures given by faculty during Engineering Day, the students also participated in a hands-on activity about the science behind gecko feet. Geckos have sticky feet and can walk on glass due to special hairs that give their feet their tackiness. By making polymer silicon nanotubes, students can approximate the effect and hold a similar substance in their hands. Enszer and assistant professor cathy Fromen gave a lesson to draw connections between the theory and the application.

"This is a great way to get kids to think about things in the natural world that they could use as scientists," said Jabbour.

Fromen appreciated the opportunity to show local high school students what is happening in chemical engineering at UD. "It was equally as exciting to see our current UD students directing the program practice their STEM communication skills and spread their love of chemical engineering," she said.
The participants enjoyed the experience. Given the opportunity to provide anonymous feedback, one high school student participant wrote: "I liked the experimentation and learning how people use chemical engineering to solve problems."

Events such as these are beneficial for both participants and organizers. "When UD K-12 Engineering works with undergraduate and graduate students to help reach the K-12 community, we are accomplishing two things," said Jurist. "First, we are providing a near-peer mentor for the K-12ers who are in our programs. It is great for kids to see someone close to their age in a potential career trajectory. Second, it instills the import, for the UD students, of being able to bring your science to everyone (i.e., being able to explain your work to laypeople/younger people), it helps metacognition (the ability to understand your own thought processes), while it brings home the value of encouraging the next generation of engineers. It's a synergy that benefits everyone."

When UD K-12 Engineering works with undergraduate and graduate students to help reach the K-12 community, we are accomplishing two things," said academic program manager Melissa Jurist, referring to near-to-peer engagement and the need for engineering students to learn to communicate about science.



UNDERGRADUATE RESEARCH SPOTLIGHT

AZEEM SHARIEF WORKS ON MODEL TO TRACK PATHWAYS OF INHALED MEDICINE

Azeem Sharief is a chemical engineering major from Newark, Delaware who does research under the mentorship of the mentorship of Catherine Fromen, assistant professor in the Department of Chemical and Biomolecular Engineering. This research focuses on leveraging 3D printing to advance tools for pulmonary drug delivery testing.

He says: "In particular, my research involves 3D printing an entire elastic lung model that includes the throat and upper airways, as well as all the five lobes of the human lung. In addition, I want to be able to expand and contract the lobes of the elastic lung model to simulate inhalation and exhalation of a patient without the use of a vacuum. Upon expansion, the real human lung increases its alveolar surface area by approximately 15 percent, so we hope to create a model with those parameters. After obtaining an entire elastic lung model, I will run particle deposition studies on a technology called the Next Generation Impactor (NGI) and analyze the deposition of particles from an inhaler. To further my understanding of pulmonary drug delivery, I will investigate how the positioning of drugs in an inhaler impacts the region of deposition within the lung. By doing so, we can achieve regional deposition of inhaled aerosol therapeutics to patients' lungs."

FUTURE LEADERS IN POLYMERS

GRAD STUDENTS RECOGNIZED FOR POLYMER PHYSICS RESEARCH

Doctoral students Melody Morris and Thomas Gartner were selected as finalists for the American Physical Society (APS) Division of Polymer Physics (DPOLY) Frank J. Padden Jr. Award in 2019.

This award recognizes an outstanding graduate student in polymer physics research and garners nominations for candidates from all over the world. The winner was Liwen Chen from Rensselaer Polytechnic Institute.

As two of just 11 finalists, Morris and Gartner were invited to give 12-minute oral presentations about their research at the Padden Award Symposium on March 5, 2019, at the APS March Meeting. "This symposium selects the best graduate students working on polymer physics theory, simulation, and experiments from around the world," said Arthi Jayaraman, graduate program director and associate professor of chemical and biomolecular engineering with a joint appointment in materials science and engineering. "To have two of 11 finalists from UD—that says a lot about these talented students and the strength of our polymer and soft materials research."

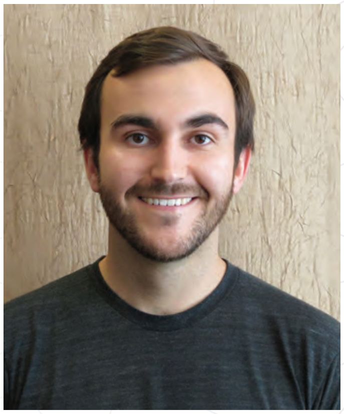
Gartner, advised by Jayaraman, presented a talk on "Solvent quality and polymer concentration effects in linear and cyclic polymer solutions," outlined his work simulating the behavior of polymers. "One of the interesting and important things about polymers is that their properties are controlled by phenomena that happen at very small length scales, as small as a billionth of a meter," said Gartner. These phenomena are difficult to study in laboratories, so computer simulations can be useful especially in comparison with experimental measurements.

Gartner said faculty and students in a variety of academic departments have helped him refine his ideas. "I have really benefited from the really strong polymer community here at the University of Delaware," he said.

Morris, advised by Thomas H. Epps, III, the Thomas & Kipp Gutshall Senior Career Development Professor of Chemical and Biomolecular Engineering and Materials Science and Engineering, gave a presentation titled "Leveraging conductivity-enhancing pathways in homopolymer-blended block polymer electrolytes."

Morris works with block polymer electrolytes, which combine two polymers and offer an alternative over liquid electrolyte materials currently used in energy storage applications, such as batteries. Block polymer electrolytes may enhance performance and stability over other materials, but one drawback is that their conductivity is generally lower than that of single materials.

In her research, Morris found that by using an additive, a high-molecular-weight homopolymer, she could increase the net ionic conductivity of the material. "This technology could be useful in applications that currently require liquid electrolytes, such as grid energy storage," she said.



Melody Morris and Thomas Gartner photographed from top to bottom.

DEVELOPING DIVERSE LEADERS

WORKSHOP PREPARES NEXT GENERATION OF FACULTY IN CHEMISTRY, ENGINEERING AND MORE

The workshop was primarily supported by NSF Grant #1642025 as well as UD's College of Engineering, Department of Materials Science and Engineering, Department of Chemical and Biomolecular Engineering, Tosoh, and the Journal of Applied Physics.

From left to right, UD professors Millie Sullivan, Thomas H. Epps, III, LaShanda Korley, and April Kloxin were mentors at a workshop for future faculty members.

When LaShanda Korley was six years old, she stood at a blackboard, handed out papers, and gave her student — her grandmother — tests.

"I've always known that I wanted to teach," Korley told a roomful of future professors. Korley credits several mentors for helping her get to where she is today — a Distinguished Associate Professor and director of a five-year, $5.5 million NSF-funded project to explore bio-inspired materials and systems.

Korley pays it forward as co-director of a workshop that grooms diverse leaders, including individuals from underrepresented groups, for futures in academia.

At the 2018 Future Faculty Workshop, held at UD, faculty members from 17 universities mentored senior graduate students and postdoctoral fellows who plan to pursue careers as independent academic researchers in chemistry, chemical engineering, materials science, and polymer science with a focus on soft materials and biomaterials.

"I believe that this workshop is so successful because the mentors, both those who are well-established and those who are just getting started, are very transparent," said Korley. "When you're a student, you're not privy to all the many dimensions of what the role of a faculty member is. The transparency of this workshop is vital to its success and allows people to not only be aware of the successes of people they look up to in the field, but also their challenges."

The 2018 Future Faculty Workshop was the third one co-directed by Thomas H. Epps, III, the Thomas and Kipp Gutshall Professor.

"The Future Faculty Workshop provides information and intellectual content to reduce the knowledge gap and improve confidence in the journey toward professorship," said Epps. "Additionally, the Future Faculty Workshop promotes the formation of sustainable networks by pairing small and diverse groups of students/postdocs with active and engaged research mentors to develop career-long relationships. In total, this workshop is vital toward increasing the proportion of underrepresented groups in the science and engineering academic realm, which can positively impact overall diversity in the future science and engineering workforce."

ENGINEERING A GLOBAL PERSPECTIVE

UD STUDENT WINS PRESTIGIOUS AWARDS TO TRAVEL THE WORLD WHILE STUDYING

As a UD engineering student, Richard (Rickey) Egan developed the technical skills to address major global challenges, such as climate change. Now, through two prestigious awards, he is developing the global competency that could help him become a world changer.

In September 2018, Egan began a Fulbright award in Poland, where he is partnering with faculty at the University of Warsaw to better understand some of the many elements that contribute to smog, an environmental phenomenon that kills tens-of-thousands in the country every year.
"While scientists do know the general ingredients in smog, they do not exactly know how it forms — the specific reactions, mechanisms and organic chemistry that result in the compounds that produce smog and air pollution," said Egan. He contributes to the conversation by measuring a number of very specific factors that feed into larger equations to predict how smog forms in Poland.

For Egan, who was awarded his Honors Chemical Engineering degree in May 2018 and is enrolled as a 4+1 student in Particle Technology, thinking globally has been a natural part of his experience as a student at UD.

As an undergraduate, he took courses in French, German and Japanese, and earned scholarship dollars toward study abroad as a member of the Delaware Diplomats Program. He became interested in Japan's language and culture as an exchange student at the National University of Singapore.

"I spent five months abroad and I got to see a lot of Southeast Asia," said Egan, "but the one place I didn't get to see was Japan and I really wanted to go there."

And so he did.

Just one month after accepting his undergraduate degree, Egan departed for Japan, where he continued his language studies with an award from the competitive Critical Language Scholarship Program.

For eight weeks, Egan lived in Hikone, a small town in southern Japan. There, he participated in 20 hours of formal classroom instruction per week and engaged with his host community through weekly cultural excursions and experiences.

Sponsored by the U.S. Department of State, the Critical Language Scholarship (CLS) is a fully-funded intensive language and cultural immersion program for American undergraduate and graduate students. According to the Department of State, CLS prepares students for an increasingly globalized workforce and is one of the many ways that the U.S. government encourages the study of languages critical to national security and economic prosperity. Egan is one of 17 UD students who have won a CLS award.

The Fulbright Program, sponsored by the U.S. Department of State, is the nation's premier international education exchange program, designed to foster mutual understanding between Americans and people of other countries. The prestigious award allows young graduates and graduate students the opportunity to conduct research, study or teach English in one of over 140 countries. Egan is one of nine UD students and alumni to earn a Fulbright award in 2018, marking the largest number of Fulbright award winners in University of Delaware history.

CONGRATULATIONS CLASS OF 2019

UNDERGRADUATES

Mohammed Alfashkhi
Brian Babecki
Rachana Balakumar
Diego Barajas
William Barndt
Derek Bischoff
Stephen Brown
Christopher Calo
Yu Cao
Allan Carlsen
Robert Cipolla
Joseph Di Marco
Samantha Di Ubaldi
Sarah DiBenedetto
Ryan Dreeman
Connor Evans
Richard Evans
Andrew Evans
Reed Forman
John Foster
Alec Francello
Dominic Gallo
Tyler Green
Zachary Grzenda
Lilyan Guastella
Alexander Gugliotta
Garrett Guillemette
Eric Harris
Jiaming Huang
Rebecca Huber
Daniel Intriago
Benjamin Kelly
Noah Kennedy
Grant Knappe
Steven Kuntz
Harrison Landfield
Andrea Ludman
Henry Ludwicki
Michael Malloy
William Manning
James Mannino
Adam Manolakos
Cameron Mertz
Grace Michaels
Ryan Milligan
Kevin Modica
Fernando Morales
Joy Muthami
Isabel Navarro
John Norton
Owen Oesterling
Nicholas Parrish
Edward Pavina
Samuel Poloyac
Nicholas Radziul
Caitlin Reuter
John Reynolds
Matthew Roberts
Luke Schaefer
Albert Schaeffer
Michael Schlosberg
Daniel Schmidt
Mohamed Seck
Jacob Shapiro
Abhilash Sharma
Trent Simonetti
Laura Smith
Sarah Snyder
Jeremy Soja
Rong Song
Ethan St. John
Elaine Stewart
Justin Terr
William Tomhon
Alec Tran
Evan Underhill
Jacob von Herrmann
Thomas Wagner
Jacob Wargo
Brittany Wiebe
George Wieber
Lukas Wieder
Mengjiao Wu
Linting Li
Kevin Peterson
Zhihao Zhang

WHERE DID THEY GO?

Graduate School
University of Colorado Boulder
Temple University Beasley School of Law
University of Texas at Austin
Iceland School of Energy at Reykjavik University
University of Massachusetts, Amherst
Massachusetts Institute of Technology
UC Santa Barbara
Northwestern University
Duke University
University of California Santa Barbara
Pennsylvania State University
University of Pennsylvania
Princeton University
University of Delaware

Industry
Agilent
Air Products and Chemicals
AnandaPure
Applied Control Engineering
Astrazenca
Compact Membrane Systems
Deloitte
Doosan Fuel Cell America, Inc.
Epic Systems
Estée Lauder
ExxonMobil
GE Aviation
Janssen (Johnson & Johnson)
McDermott Lummus Technology
Merck
Naval Surface Warfare Center
Scientific Design
SWM International
The Gill Corporation
W.L. Gore & Associates
WuXi AppTec
Xergy

PhD Graduates
Pratyush Agarwal
Rebecca Pei-Ying Chen
Chen-Yu Chou
Camil C. Diaz
Marco E. Dunwell
Thomas Edward Gartner
Nicholas Stephenson Gould
Amber Marie Hilderbrand
Chen-Yuan Kao
Stijn H. S. Koshari
Wesley Luc
Juan C Lucio-Vega
Rose Xiaoya Ma
Brian Oliver McConnell
Alexander Mironenko
Melody Ann Morris
Brian Maxwell Murphy
Jared H Nash
Huong Thi Thanh Nguyen
Elisa M. Ovadia
Tamas A. Prileszky
Ka-Hei Siu
Mahlet Asfaw Woldeyes

M.Ch.E
Quinten Debruyne
Colleen Fridley
Sai Prasad Ganesh
Roel Smits
Lisa Swartzentruber
Tim Van de Vyver

MEPT
Charles Collins
Richard Egan
Zachary Grzenda
Brandon Newman
Johan McConnell
Nicholas Monroe
Kyle Sala
Rong Song
AJ Walther
Michael Cerri*

**Graduate Certificate in Particle Technology program*

Chemical engineering doctoral students and faculty who participated in the Doctoral Hooding Ceremony as part of Commencement events at UD.

LEADING THE CHARGE FOR CHANGE

KARA ODOM WALKER, EG99, IS ON A MISSION TO IMPROVE THE LIVES OF DELAWAREANS—ESPECIALLY THE MOST VULNERABLE

A young man is gunned down in Wilmington. A woman dies from a drug overdose, alone in her car. Every time there's a tragedy in Delaware, Kara Odom Walker's phone dings. The dings are coming too fast, and she's determined to slow the tempo. As Delaware's secretary of health and social services, Walker, EG99, wants to help Delawareans live healthier, better lives. Her first hurdle: The costs that are crippling the state's health care system.

When Walker took office in 2017, no one could tell her how much Delawareans were spending on health care—and what exactly they were getting for each dollar. Fortunately, the Delaware native is just as comfortable with numbers and spreadsheets as she is in an exam room—thanks in part to her chemical engineering background at UD, which she followed with a medical degree from Jefferson Medical College, a master's in public health from Johns Hopkins, and a master's in health services research from UCLA. "I started looking at the data before we had consultants on board or people who knew data," she says. "I was pulling down spreadsheets from publicly available data, doing my own slides, looking at how to present the information, everything."

What she found shocked her—and later, legislators. Delaware has the third highest per capita health care costs in the nation but is not the third healthiest state. America's Health Rankings put Delaware at No. 31 in 2018. "The big issues remain centered on how we address rising health care costs and improve health generally," she says. "It's true not only in Delaware, but across the country: We haven't figured out how to orient our health care system toward paying for health. Our system is oriented toward taking care of people when they're really sick, but not necessarily toward keeping them healthy."

At a November 2018 meeting of Delaware's Government Efficiency and Accountability Review, Walker explained one of her efforts: Establishing benchmarks to monitor cost and track health outcomes. Reducing expensive and unnecessary emergency department visits, opioid-related overdose deaths, co-prescription of opioids and benzodiazepines, or enhancing prevention efforts around cardiovascular disease and other conditions are important goals to improve health and decrease costs. Although the political scene is often driven by fiery emotions and anecdotes, Walker was armed with facts, data, charts: Spending will double by 2025 unless we do something. Healthcare costs comprise 30 percent of Delaware's budget and are rising faster than the state's economy. When interrupted by a man at the table who had his own point to make, she had a polite and thorough answer.

Unfortunately, she's used to being underestimated. As a woman of mixed race, not many of Walker's peers look like her. Of the 94,530 people who graduated from American medical schools in the past five years, just 3,401 (or 3.6 percent) were women of multiple races and just 3,323 (or 3.5 percent) were black women. Walker has been mistaken for an administrative assistant. She's been told she's too young to be a doctor. "You just take it in stride and work harder than your peers and try to speak up more often than they do, because otherwise, you might get ignored," she says. "And it's worked out, and I'm fortunate to have people who believed in that."

In 2018, Walker was elected to the prestigious National Academy of Medicine, which selected her "for her career-spanning roles" that have "championed health equity and consumer and community engagement."

Before she returned to Delaware, Walker was deputy chief science officer at the Patient-Centered Outcomes Research Institute in Washington, D.C. She feels fortunate for the educational opportunities she's had and wants to give back to those who aren't as lucky. Walker is focusing on opportunities to intervene with at-risk youth and families, engage people in life skills and develop mentorship programs with positive role models. Two generations ago, her own grandparents were working-class poor. Her mother's parents emigrated from the Netherlands to escape political unrest and worked in Delaware as dairy farmers; her father's parents left the southern United States to escape Jim Crow laws and worked in Delaware in blue collar jobs.

"It's not that farfetched to think that if my parents hadn't gotten the chance to go to college, then maybe I would be not so different," Walker says. "The economic mobility of people is very fluid and based on opportunity, and often chance."

UD provided her with opportunities she cherishes. "I grew up in Newark, so from childhood, the University of Delaware was always a part of my life," she says. "I went to reading enrichment classes at UD when I was a kid and swam at the pool near the Field House. I did summer camp for 4-H at the College of Agriculture and Natural Resources. During high school I was involved with the FAME (Forum to Advance Minorities in Engineering) program, the pre-engineering program, and I would go on campus to participate in summer enrichment programs which definitely helped me figure out that I wanted to study engineering in college and exposed me to science careers. The University of Delaware continues to be a big part of who I am, because it wasn't just those four years, it was way beyond that."

ENGINEERING FOUNDATION

UD GRAD SUCCESSFUL IN COSMETICS INDUSTRY CAREER SEARCH

A few weeks shy of graduation in 2018, then University of Delaware senior Monique Michalec had no idea what would happen next. Her dream was to work in the cosmetics industry.

She majored in chemical engineering with minors in entrepreneurial studies and materials science and engineering. She was an engaged student on campus serving as president of the Society of Hispanic Professional Engineers, as an ambassador for the Horn Entrepreneurship and fundraising chair for the Society of Women Engineers and even joined Alpha Sigma Alpha Sorority. But she still had no full-time job prospects in sight.

"There would be days that I would be crying on my bed after another friend had told me they secured a job," Michalec said. "I'd genuinely be happy for them, but then be in my room, saying to myself, 'What's wrong with me? Why can I not get hired?' "

Michalec had completed internships with beauty brands during her years at UD and she hoped to have a full-time job immediately after graduation.

When the full-time job did not materialize, she opted for another internship, with the skin care brand Erno Laszlo in New York. That is when the pieces began falling into place.

Monique Michalec graduated from UD in May 2018 with a degree in chemical engineering and minors in entrepreneurial studies and materials science and engineering. All three areas inform much of what she does in her role as a sales executive for a contract manufacturer.

During that internship, she discovered contract manufacturing: Brand-name companies enter into a contract with another company to produce the product for them. Because of her previous internships in product development and global marketing, Michalec was interested in working on the business side of brands. She found one of these manufacturers in Hamilton, New Jersey — her hometown.

Michalec now works as a sales executive for Advanced Beauty Labs, the sister company to Salvona Technologies. Michalec acts as a liaison between the clients (beauty brands) and her company's laboratory. She serves clients in Delaware, New York, New Jersey, Pennsylvania and Connecticut.

For example, a client might want to add a moisturizer to its product line. The client sends Michalec a description or wishlist of what the product will be and what it will be made of. This includes desired texture, fragrance and the appropriate chemicals. Michalec then works closely with the lab in her company. "I work with the lab to develop samples for them," she said. "I test the samples here, myself, before I send them to my client. Then my clients give me feedback and I go back and forth with the lab until we get to a product that they love and want to move forward with."

The process is not always simple. A trend in the beauty industry is to make products as "clean" as possible. That means non-toxic products mostly made with natural ingredients and more transparency about what is inside products from brands. This is why phrases like "sulfate-free" and "no synthetics" are highlighted on many products. Sulfates are used to create the foaming in shampoo, and consumers have been taught that foaming equals clean, so the lab cannot just do away with it, she said. This presents a challenge for the lab, as it is never a one-to-one replacement to replicate the response they are trying to get. Also, the alternatives are not always healthier, she added.

Michalec loves her job and credits her chemical engineering major and her experience with Horn Entrepreneurship for laying the groundwork for her success. "They could teach me how to talk to clients the best way and how to market the ingredients, but I needed to be able to understand the ingredients, the technology and the science and really be able to explain it to customers to sell it," she said. "It was just an added bonus that I had experience within the industry, so that really helped me a lot, so did my entrepreneurship minor."

Michalec recalled that at age 5 she was fascinated with makeup. Her mother wouldn't let her wear much, but she was excited to paint her nails and wear clear lip gloss. Now she has tons of products and loves to research new ones. She has a 12-step nighttime skincare routine. Her dream is to one day start her own brand.

She hopes other seniors in her position realize securing a job before graduation is not the end all be all. "It's okay to not have everything figured out before graduation, most of us don't," she said. "Then three months after graduation, I was starting my full-time job and my career and I'm super happy with where I am. I didn't even know this job existed before I graduated. So you really never know where life will take you."

IT'S OKAY TO NOT HAVE EVERYTHING FIGURED OUT BEFORE GRADUATION, MOST OF US DON'T

Through her work, Monique Michalec has collected tons of beauty products. She said it helps her stay up to date on the industry and research different products. She also has a 12-step nighttime skincare routine.

The National Academy of Engineering announced that John L. Anderson, who graduated from UD's College of Engineering in 1967, is the organization's newest president.

ALUMNUS TO LEAD NATIONAL ACADEMY OF ENGINEERING

JOHN L. ANDERSON HAS BEEN ELECTED PRESIDENT OF INFLUENTIAL ENGINEERING ORGANIZATION

John L. Anderson, who graduated from the University of Delaware with a bachelor's degree in chemical engineering in 1967, became the president of the National Academy of Engineering (NAE), a nonprofit institution whose membership includes about 2,000 of the most accomplished and influential engineers in America, on July 1, 2019.

Anderson, a native of Wilmington, Delaware, and graduate of Mount Pleasant High School, is a distinguished professor of chemical engineering at Illinois Tech's Armour College of Engineering and was president of Illinois Tech from 2007 to 2015. He was elected a member of the NAE in 1992 for contributions to the understanding of colloidal hydrodynamics and membrane transport phenomena.

Along the way, Anderson and his wife, Patricia, also a UD graduate, have remained dedicated to UD. They recently established the John L. and Patricia Siemen Anderson Engineering Scholarship to support engineering students with financial need. At the same time, they made a commitment to UD Athletics to name a space in the stadium's press box in honor of Pat's father, Bob Siemen, who was a former UD athlete, coach and administrator, and who dedicated his entire adult life to Blue Hen Athletics.

Members of the NAE share expertise and provide independent advice to the federal government on matters involving engineering and technology. Eight current UD faculty members have been elected members of the NAE, and in 2019, another Blue Hen joined the NAE ranks: doctoral alumnus Linda Broadbelt, the Sarah Rebecca Roland Professor of Chemical and Biological Engineering at Northwestern University.

ALUMNI SPOTLIGHT: MARK SHIFLETT

This prolific inventor has a passion for teaching

Mark B. Shiflett, elected to the National Academy of Inventors in 2018, holds 44 U.S. patents. However, he didn't spend his career chasing down patents—he was just committed to solving a big problem. When Shiflett joined DuPont as an engineer in 1989, he and his colleagues worked on formulating new refrigerants to replace chlorofluorocarbons, or CFCs, chemicals that were shown to damage the Earth's ozone layer. "We felt a real commitment to developing alternatives that were safe for the environment," said Shiflett. He enjoyed research so much that he continued his education with a master's degree (1998) and doctoral degree (2001) in chemical engineering from the University of Delaware. During graduate school, and for the 15 years afterward, Shiflett continued to invent new products and processes at DuPont, including three energy-efficient refrigerant mixtures for replacing CFCs used in supermarket display cases, commercial ice machines and refrigerated transportation.

In 2011, Shiflett returned to UD part-time to teach senior undergraduate labs as an adjunct professor in chemical engineering. He enjoyed helping students learn and sharing examples from his career at DuPont with the next generation of inventors. "The longer I spent teaching at UD, the more I realized this was going to be a new chapter for me," he said. In 2016, Shiflett turned the page on the new chapter. He retired from DuPont and joined the University of Kansas as Distinguished Foundation Professor in the School of Engineering. Now, he can tell his students that when they work hard to solve a problem, they might see the benefits years down the road. The ozone layer is healing, in part because of Shiflett's efforts.

ALUMNI SPOTLIGHT: AMOD OGALE

His scholarship in composites engineering started here at UD

Amod Ogale is a foremost scholar in carbon fiber processing and composites. He studies the microstructure of carbon fibers—lightweight, reinforcing materials that hold tremendous potential for applications in defense, sustainable transportation and more. For his more than three decades of contributions to the fields of fibers, films and nanocomposites, Ogale, the Dow Chemical Professor of Chemical Engineering at Clemson University and Director of the Center for Advanced Engineering Fibers and Films (CAEFF), was recently named a Fellow of SAMPE (the Society for the Advancement of Material and Process Engineering. He is also a Fellow of the Society of Plastics Engineers and the recipient of 2013 Graffin Lecturer Award from the American Carbon Society.

Ogale received his doctoral degree in chemical engineering from the University of Delaware in 1986 and got his start in composites research at UD's Center for Composite Materials (CCM). "My experiences at the University of Delaware, including my research at CCM, definitely laid the foundation for my career," he said. "CCM developed a model of working with companies that I utilize to this day. The research that takes place at CCM is not just theoretical work; it translates to real products." Ogale was vice president of UD's the newly formed SAMPE student chapter, which began during the 1984-1985 academic year and thrives at CCM to this day. He recently established a student chapter of SAMPE at Clemson and serves as advisor.

ALUMNI NOTES

'60s

BRUCE JARRELL '69 went on from UD to medical school and remains very active even 50 years later. He practiced transplantation surgery for 30 years and served as chair of surgery at the Universities of Arizona and Maryland. He is now provost at the University of Maryland, Baltimore and professor of surgery in the School of Medicine. Bruce writes, "My engineering degree has been a wonderful foundation for almost every aspect of my career and has been very synergistic with medicine. Being both a surgeon and an engineer has allowed me to be at the intersection of medicine and engineering, even though the discipline of bioengineering did not exist as a major back then at Delaware. It has allowed me to be an NIH-funded researcher for over a decade, to use my engineering and even fluid mechanics knowledge in some of my research projects, and to be awarded numerous patents." These interests led Bruce to help establish two departments of bioengineering and continue to maintain appointments in two schools of engineering. Bruce has been married for almost 50 years to Leslie Robinson, MD and they have three children – a nurse, a patent examiner, and a mechanical engineer, who is also an interventional radiologist – as well as six grandchildren. His interests outside his professional life include woodworking and antique Fords, but for the past 30 years he has concentrated on refining his artistic blacksmith skills to create very delicate and refined art forms. This allows him to exercise his engineering and creative skills to create something visually pleasing and yet functional. Indeed, Bruce advises the next generation of engineers never to stop learning and trying new things.

MICHAEL JONES M'69 has retired from Celanese Corporation, having worked primarily in the Piedmont area of North and South Carolina, mostly in technical support of synthetic fiber manufacturing. Michael has numerous memories of his time at UD, although his recollection of academic details is limited to Art Metzner's problem sets. However, Michael remembers the faculty he encountered as being brilliant but kind. Bob Pigford, "a living legend", gave Michael a copy of his book on Applications of Differential Equations, a volume still highly valued by those familiar with it and one that still sits on Michael's bookshelf. He carpooled briefly with Jon Olson and loved Jon's class notes, as well as using Jon's Runge-Kutta routine for his thesis. Michael had some interesting talks about optimization with Fraser Russell and he was a TA in Jerry Schultz's metallurgy lab. Jerry played flute in the Newark Symphony, which led to Michael's playing bassoon in the orchestra. Michael concludes, "When I learned of the recent death of my thesis advisor, Dr. David Lamb, I was reminded that as we get older, many of our heroes pass away".

ERNEST MAYER D'69 also has memories of graduate school at UD, including Profs. Gerster and Pigford recommending to all 8 of his Vietnam-era class's PhD students that they go to Canada or commit a crime to get out of serving in SE Asia. The students chose to take their chances on the draft lottery instead, and that worked out very well for Ernest, who worked for DuPont for 41 years and retired in 2010. He was a filtration consultant in the Engineering Department, with assignments in water/wastewater treatment, filter media and process filtration, including testing, development, specification, implementation and startup. After retirement he formed a consulting company with 2 partners in all areas of filtration. Ernest has been widely recognized for his impactful career. He received many awards, including three Engineering Excellence Awards and seven Environmental Respect Awards. He is a founding member of the American Filtration and Separations Society (AFSS) and has won every award from AFSS, including the Lifetime Achievement Award in 2005 – the first non-academic to receive it. He has published over 200 papers and part of a textbook, and has organized and chaired multiple technical conferences. At the request of President Jimmy Carter he participated in the Three-Mile Island nuclear cleanup in 1980. Ernest and his wife, Irene, have two children, who both graduated from Ivy League schools and live nearby.

ED MILLER M'69 D'72 was Stan Sandler's first PhD graduate, and he still enjoys occasional contacts with Stan today (see separate article in this issue on Stan's retirement). For his thesis research modeling the transport properties of partially ionized gases, Ed was allowed to run the IBM 1620 computer in the UD Computer Center himself whenever it was free. His Masters thesis, under Jon Olson, was on the self-diffusion of sodium ions in an ion-exchange resin, and Ed recalls that in that era of less regulation, he received his order of radioactive sodium chloride via regular mail. It sat next to his desk for some days until he read the label, following which he made alternative arrangements very quickly! Ed spent his whole employment career at Air Products and Chemicals in Allentown, PA, for much of that time leading the company's modeling and in-house consulting on thermophysical properties. He also had a mid-career assignment to lead the company's program in expert systems and AI, when that technology first captured the interest of industry starting in the mid-'80s.

From left to right: Don Kerr M'68, D'70; Don Sundberg M'68, D'70; Ed Miller M'69, D'72; Jim Wilson M'68.

In retirement, Ed volunteers with a social service organization, as well as helping refugees, and spends much time visiting and traveling with his family, who live in VA and NY. Notwithstanding his career record, Ed feels that building personal relationships tops his UD accomplishments. His wife, Anne Molesky, was a UD undergraduate, and he has had enduring friendships with three other members of his entering UD graduate class. Remarkably, they have held their own annual reunion, with their families, somewhere in the northeastern US or in Canada every year since they left Delaware. Their 49th such reunion was in June in Kennett Square, PA, during which they stopped off in Colburn, photographed above.

KEN PORTEOUS M'69 D'71 came to UD in fall 1966 after earning a chemical engineering degree at McGill University and working for two years as a process engineer with Cyanamid of Canada. He defended his thesis in mid-March 1971 and immediately headed out on the drive from Newark to Edmonton, Alberta, in a convertible, accompanied by his 8+-months-pregnant wife and a cat. Ken muses that "this 2500 mile trip in winter did not seem that daunting after completing a PhD at UD!" Indeed, his graduate experience at UD seems to be imprinted on his memory and he provided numerous recollections of the people and events of the department; these are included as a sidebar. Ken joined Syncrude Canada Ltd, a company owned by several major oil companies, as a research engineer. Syncrude's mandate was to develop, design and construct a 125K bbl/day plant 250 miles north of Edmonton to mine, extract and upgrade bitumen from Alberta's oil sands into light crude. Over 14 years with Syncrude, Ken held several technical positions in process development and design and then moved into technical and corporate management positions. In 1985 he switched to a new career path as a professor of chemical engineering and associate dean at the University of Alberta, which counts Art Metzner and Fraser Russell among its alumni. As associate dean Ken was responsible for the Faculty of Engineering's Student Services, including the co-op program. He retired in 2014 and, while he and his wife still live in Edmonton, they often visit their two daughters and their grandchildren in Calgary and Vancouver.

'70s

RICHARD ROGERS M'69 returned to the R&D organization at the DuPont Chambers Works when he left UD. He worked on process development for a novel fluorocarbon and intermediates for Kevlar, with his most interesting project being implementing a real-time advisory control scheme employing a computer model of reaction kinetics (all in FORTRAN). In 1984 he was transferred to the DuPont TiO2 pigment plant in Mississippi, from which he retired in 2003 as an engineering associate. The highlight of his time there was meeting his future wife, who also was employed there. His recreation includes tennis and sailing (also monitoring hurricane forecasts). Richard's UD memories are varied, and include that in a project with Fraser Russell he studied two-phase flow using the high-speed movie camera that Crawford Greenewalt had developed for his study of the wing motion of hummingbirds in flight. A bit further afield, Richard still has his tenth-anniversary commemorative t-shirt from the Stone Balloon. Expressing a sentiment that we probably hear from more UD students than in most other ChE programs, he says that the most interesting course for him was thermodynamics, especially statistical mechanics, which he uses every day. He remains fascinated that we can actually quantify disorder in a useful way and that it tells us so much about how nature works.

TOM DUJMOVICH '74 retired in 2009 after a 35-year career in design, operations, safety, marketing and business development in the chemical and oil and gas industries. This came after a lot of uncertainty about a ChE career path when he graduated, as his summer job the previous year at SunOlin in Marcus Hook exposed him to an explosion in the ethylene oxide unit that resulted in a classmate receiving burns over 65% of his body. Nonetheless, Tom selected DuPont from among his job offers and started as a project engineer at Chambers Works in Deepwater, NJ. A 1976 assignment to design and build a plant for HMPA, the solvent for DuPont's Kevlar, led to a role as operations supervisor for the new plant, and then several years of overseeing various other operations at Chambers Works. Tom then transferred to corporate in Wilmington, as a survey consultant in the Safety and Fire Department, reviewing management systems at DuPont facilities worldwide. So began the 'travelling' portion of Tom's career. As principal consultant for the Chemical and Pigment and Polymer Products Departments starting in 1988, he spent more than 200 nights a year on the road, a less-than-ideal work/life balance for someone married, with two young children. This led to a 1989 transfer to DuPont's Conoco subsidiary as director of safety and health for worldwide exploration, a position in which Tom learned about the upstream oil industry, including in locations such as Nigeria, Congo, Angola, Somalia, Syria, Russia, Indonesia....he has visited over 90 countries in all. He also chaired the International Association of Geophysical Contractors in Houston and the Exploration and Production Forum (now Oil and Gas Producers) in London, leading to extensive insight into systems and structures, and speeches at numerous venues, throughout the world. Another change came in 2000 when Tom became manager of marketing and business development for Conoco's flow improver business, with offices in Brussels, Moscow and Aberdeen. In 2002, he initiated a partnership with Nalco Chemical and oversaw that until his retirement in 2009. During this assignment, he received the ConocoPhillips President's Award for the development of a flow improver for multiphase applications. A fitting capstone to a career full of challenge and fulfillment.

JOHN K. SMITH JR. '74 has had a particularly varied career path. He remembers his chemical engineering classes as being outstanding, especially those taught by Professors Petty, Gates and Sandler. He worked summers at W.L. Gore and Associates, making a new product dubbed Gore-Tex. However, he earned his chemical engineering degree within the five-year Arts and Engineering program and so he also enjoyed courses in the history of science and technology – a taste of things to come. After a Master's at the University of Virginia, where he was attracted by being a big ACC basketball fan and where he was taught by UD alumni DON KIRWAN M'64 D'67 and JOHN GAINER D'64, he worked at Air Products and Chemicals for three years. However, he didn't feel challenged by the work and became restless, which led him to resign in 1978 and to spend the summer bicycling across the US, and a year later to pursue a PhD in the history of technology at UD. His research on the history of DuPont research became a major project when the CEO, Edward Jefferson, thought that such a history might help to inspire the company's researchers. The final product was Science and Corporate Strategy: DuPont R&D, 1902-1980, co-authored with John's advisor David Hounshell, published by Cambridge University Press in 1988. John has taught history of technology at Lehigh University for the past thirty-one years. Although he has not directly used his chemical engineering knowledge during this time, he feels that the critical skills that he developed during his undergraduate years have helped him to be a better historian.

GARRETT FORSYTHE '79 has retired from DuPont after a variety of operational, business, sales, marketing and supply chain roles. He now has a consulting practice specializing in operational excellence, executive coaching and leadership development. He and Vicki live outside of Atlanta.

BRUCE VICKROY '79 went on from UD to earn a PhD in chemical engineering at UC Berkeley (under prior UD professor Harvey Blanch), specializing in biochemical engineering. He has spent most of his career at GlaxoSmithKline, working on biopharmaceutical processes in both development and manufacturing roles. Bruce writes that his UD chemical engineering education gave him a solid grasp of fundamentals and taught him how to research a topic and think critically, and that his engineering background generally enabled him to work with others from various educational fields to solve very challenging manufacturing problems in a timely manner. Bruce has been back to UD many times over the years, including in a teaching role. He was one of four industry participants who piloted a new course, Bioprocess Engineering in Practice, last spring, and he felt that "the students were talented, resourceful and asked great questions". Bruce and his wife, Karen Krippahne, first met at UD through the swim team. They were married in 1980 and have two daughters, one of whom graduated from UD in 2008. Over the years they have enjoyed family, dogs, travelling, bicycling, walks, swimming and sailing.

'80s

RON OZER '84 went on from UD to complete a PhD in catalysis and surface science at Cornell in 1990, followed by a long and productive industrial career. His research efforts at DuPont, at Victoria and Orange, TX, and the Experimental Station, working on Nylon, led to more than 30 issued patents, primarily in reaction engineering and refining (including defining work in next-gen adiponitrile technology). In 2003 he moved to Invista (DuPont Nylon's new owner), then to Ciba (now BASF) Newport (pigments), and back to DuPont Central Research developing new green processes for polymer intermediates and plastic bottles (including seven weeks on 3 trips to China assisting in operations of a major pilot facility). In 2016 Ron left DuPont and formed his own consulting business in process development and pilot-plant design, and also undertook an adjunct role at UD in final-semester capstone senior design projects. In 2018 he became a full-time visiting professor at Villanova, teaching primarily Heat Transfer, Technical Communications, Senior Projects and Junior Lab. Ron says he now has a newfound respect for his UD professors... Ron has a double D marriage (Dorinda Dove (BSN '84), a nurse-midwife and co-owner of The Birth Center in Newark) with two daughters, who live in Brooklyn. He also does volunteer work running the concert series at Arden Gild Hall.

STEWART HEN '89 has fond memories of his time at UD – "smart classmates who I learned from, amazing faculty who were both expert and motivational, and many great laughs with friends". Stewart has been in the investing world now for nearly twenty years and it blends his love of science with the excitement of finance and strategy. He currently manages a health-care investment firm called Serrado Capital, based in NYC. He encourages fellow alumni with similar interests to get in touch. On the personal side, he is happily married with two great kids and lives in NYC.

HENRY LAMB D'89 went straight from graduate school to an assistant professor position at NC State University. He received a Presidential Young Investigator Award from the NSF in 1989 and was promoted to his current position as a full professor in 2007. His research has focused on heterogeneous catalysis and surface science, with a biofuels emphasis in recent years. Henry has taught a variety of undergraduate courses, including mass transfer and unit operations, chemical kinetics and reactor design, and bioreactor engineering; the latter is a senior course that he developed while working with the Biomanufacturing Training and Education Center at NC State. Henry and his wife, Linda, live in Apex, NC, where they raised their four children, all of whom graduated from NC State and live in the Research Triangle Park area. They have one granddaughter and another grandchild on the way.

BAICHEN LIU D'89 has just retired from Zachry Engineering in Omaha after a varied career that included a fair bit of zigzagging across the continent. He plans to relocate one more time – to somewhere warmer, without snow. All his jobs focused on modeling, simulation and optimization, which created both value for his employers and fun for him. A model-based control scheme that he developed for Dow Chemical's waste incinerators created $10 MM NPV for the pilot implementation alone. He especially enjoyed his role at ConAgra in using ExtendSim models to project the 5-year capital investment plan for their Hunt's ketchup plant in California. He is delighted that his training and passion fitted closely with his career.

JIM PARKS '89 reports that his family has just completed a momentous year – the 30th anniversary of his graduation and also the year that both his sons graduated from UD, one in marketing and one in history. Along with Jim's wife, a UD double major in psychology and sociology whom he met in the midst of junior lab and thermodynamics, that makes 4 graduates from UD in the household. What's more, Jim grew up and went to school in Newark and he still lives a few blocks from Morris Library, from where he enjoys seeing the town change character twice a year as the students come and go. Jim has spent much of his career in pharma. He worked for Lonza in Conshohocken, PA, for about 15 years, making small-molecule active pharmaceutical ingredients. His roles included process engineering, process automation group leader, maintenance manager and finally project manager. When Lonza sold the plant in 2010 he moved on to DuPont, working in their process dynamics and control group, which did consulting throughout the company in process control, simulation and modelling, and systems integration, with Jim's primary specialization being batch automation. During the initial period of the DuPont-Dow merger in 2017, Jim moved to Incyte, a pharmaceutical company in Wilmington that is home to many DuPont alums from the old DuPont-Merck joint venture; in fact Jim's process chemistry group is located at the Experimental Station in the old DuPont-Merck laboratory. His main focus is technology transfer of organic synthesis processes to contract manufacturing organizations, as all Incyte's commercial manufacturing is performed externally. Even at work UD has a presence as Jim had a UD ChE student as an intern with him over the summer.

KARENANNE (O'BRIEN) STEGMANN '89 has spent the full 30 years since graduation with Occidental Chemical Corporation. The first 24 years were in chemical facilities in Houston and New Jersey, but after 13 years in the plant manager position for several facilities she transferred to the corporate headquarters in Dallas, where she is currently director - supply chain. In this role she manages teams responsible for all logistic commercial contracts and shipments for all modes of transportation (pipelines, marine, rail, trucking, packaging and warehousing) and production planning. Karenanne has been married for 19 years to Tom, who works in software sales, and they have twins, who will be juniors in high school next year. They stay busy with family activities, as Nathan is an Eagle Scout this year and Colleen is a top distance runner. A recent UD alumni event has Karenanne and Tom reflecting back on their college days as they start the college visit process.

JACK ZIEGLER '89 has been happily employed as a professional chemical engineer for the last 30 years, initially in oil refineries and chemical plants in the Delaware Valley. In 2010 he moved to SunCoke Energy in Lisle, IL, a company that supplies metallurgical coke to blast furnaces in the midwest. Most of Jack's career has been focused on process control, but he recently added responsibilities for helping capital projects get funded. Jack's daughter Jenny will be following in his footsteps as she enters the UD chemical engineering program as part of the class of 2023.

'90s

ASHISH LELE D'93 retired from the National Chemical Laboratory in Pune, India, in August 2017, after 24 years of dedicated service and great success. This included his receiving the Infosys Award in 2013, one of the most prestigious technical awards in India. Ashish's retirement was followed by a productive one-year in-house sabbatical-cum-"cooling-off" period, after which he joined Reliance Industries Ltd (RIL) in Mumbai, to head a new group called Advanced Materials and Alternative Energy in RIL's R&D. At RIL he reports to AJIT SAPRE D'80, so he is in good hands.

LEAH LANGSDORF D'94 began her career at ARCO Chemical in Newtown Square, PA, after graduation, but after a few years, she pursued a new opportunity at Promerus, LLC (a 30-person R&D subsidiary of Sumitomo Bakelite Co., Ltd.) in the Cleveland area. Leah has been there for 22 years and wears many hats, including product development manager, safety manager, quality manager and analytical manager. She says that the job is different every day, just like the weather in northeast Ohio! Leah has been happily married to Stephen Tomasko (MFA ’91) for 27 years and they are especially proud of their daughter, Alexandra, who has just finished her first year of medical school. Both have fond memories of their days in Newark, especially the Zydney group’s potluck dinners, which always featured delicious foods from around the world!

JOHN RICHARDS D'94 retired from DuPont in 2014 after 37 years of service. He was already established at DuPont when he joined UD as a graduate student, and completed his PhD part-time. He worked on various processes and plant sites employing polymerization and biological modeling and process control, and the impact of his work is reflected in his having received 3 DuPont Engineering Excellence Awards and in his appointment as a research fellow in DuPont Engineering Research & Technology. He was also very active outside DuPont, in publishing articles and books, organizing sessions at AIChE and ACC meetings and was Conference Industrial Co-chair at the 2009 Polymer Reaction Engineering (PRE) VII conference. These activities were also recognized by election as an AIChE Fellow in 2011 and the CAST Computing Practice Award in 2012. John continues to offer the Professional Engineering Review Course in Chemical Engineering at UD to help candidates pass the Principles and Practice of Engineering (PE) exam, as he has been doing since 1983. He has also worked with Professional Publications, Inc., for many years contributing to their manuals for the PE exam, and is a co-contributor to the 9th edition of Perry’s Chemical Engineers’ Handbook. John is an educational associate at the Mount Cuba Astronomical Observatory and also co-taught the Introduction to Chemical Engineering course in our department in the spring of 2015.

COSTAS DIMITROPOULOS D'99 has been living in the Bay area since 2002, the intervening years after graduation having been spent on flow modeling for Fluent in Evanston, IL, and completing his military service in Greece. His initial California position was in turbulent flow research at Stanford but in 2004 he joined Lumileds, one of the world’s leading LED manufacturers. He currently leads Lumileds's R&D reactor development department. Their work has contributed greatly to the proliferation of solid-state lighting, arguably one the most successful clean technologies and widely encountered in LED flash on mobile phones, LED headlamps in cars, and LED lightbulbs. Costas says that he continues to use many chemical engineering concepts he learned as a graduate student at UD. However, an even more noteworthy factor from his time as a graduate student is that he met his wife, VASSIA TEGOULIA D'00, at UD. They have two daughters, Nicole (8) and Natalie (6), who keep them very busy.

CHRISTINE FRAZIER-HOLLINS '99 has been in the Houston area for nearly 16 years, after stops in West Virginia, South Carolina and Salt Lake City. She spent nearly 12 years with Praxair, Inc., in a variety of roles, from plant engineer to pipeline optimization manager and lean sigma black belt, and then spent 5 years working for Chevron in advanced analytics for Chevron Pipeline. She is still with Chevron, as a global upstream base business operations advisor for reliability and asset integrity. She has been actively involved in outreach and volunteer activities, with a focus on women working in operations and STEM careers, and is currently the site lead for the Houston chapter of Chevron’s Women’s Employee Network. She is eager to support programming targeted at continuing to increase the number of women (especially minority women) studying engineering – "there are still far too few of us", she notes, and adds that the industry benefits from the diversity of thought and ideas to continue advancing. Christine is a 10-year cancer survivor and she, her husband and children are active and passionate advocates for special-needs children and their families. In her spare time she enjoys listening to podcasts. She also looks back fondly on her time at UD – "definitely a hidden gem" – and misses having a college team to root for deep in SEC territory.

MANOJ MENON D'99 worked with Andrew Zydney on ultrafiltration processes for protein purification for his PhD, and writes that the UD experience has allowed him to pursue a fulfilling, international career in biotechnology to help deliver life-changing medicines to patients. He started with Genzyme (now Sanofi) in Boston, working on manufacturing and process development of recombinant therapeutic enzymes, then spent 6 years at Lonza in Singapore, working on the start-up through licensure of two large-scale biotechnology manufacturing facilities. He is now director of biologics external supply and global technical operations at AstraZeneca in Maryland, where he is responsible for technical oversight of all external commercial manufacturing. He was the global product technical lead for Fasenra (now approved in over 20 countries), leading a global cross-functional team responsible for technical strategy and execution in support of commercial manufacturing and analytical testing. Manoj lives in Rockville, MD, with his wife and two daughters, aged 12 and 7. He speaks of the transformative impact that UD had on his personal and professional life and believes that the UD experience has been a key factor in shaping the person he is today.

KEITH WELP D'99 began his industrial career post-UD at Air Products and Chemicals, starting with 4 years in a technical position but subsequently in a commercial role. This included 10 years of gradually-growing responsibilities in specialty chemicals product lines that concluded in several years as Americas region business director for polyurethane additives. In 2014 he moved to Minerals Technologies Inc., where his current position, as director of technology and marketing, merges the two parts of his career – he leads a global technology team and is involved in technical engagement and customer support, but retains the commercial and strategy activities. On the home front, Keith and Janet celebrated their 20th anniversary with a family trip to Hawaii in 2018. They continue to enjoy the balanced urban and rural lifestyle of the western edge of the Lehigh Valley. Their older child will be a high school senior this fall and is considering law school or an academic career teaching history, but their younger, a rising high school freshman, seems more inclined toward the family business of science and engineering. Either way, Keith finds himself pondering university life (and costs!) in much greater detail these days…

'00s

ERIC BENNUNG '09 joined the company founded by his grandfather (also a chemical engineer) in 1951, Acrymax Technologies, Inc., after graduation. The company manufactures and engineers high-performance paints and coatings for the construction, OEM, and aerospace industries. Since it is a small business, Eric wears many hats at the company in his roles as vice-president and product development engineer, but he says that the most enjoyable activity is watching a product come to fruition from concept to lab batches and then optimization of the full-scale production. Acrymax products have even been used around the UD campus to protect and preserve several buildings. Eric has also been back to UD to talk to department chair Eric Furst about non-Newtonian fluids, building on their prior history of doing research together. Eric (Bennung) would be happy to hear from good engineers looking for either summer internships or full-time positions (eric@acrymax.com). Eric and his wife were married in 2014 and live a very full life in Philadelphia with their one-year-old son and a rambunctious black lab.

PETER ATTIA '14 recently completed his PhD in materials science and engineering at Stanford, where his work focused on improving the lifetime of lithium-ion batteries, using both traditional materials science approaches and machine learning. Peter says, "I loved my time at Stanford and credit my UD ChemE education for teaching me the fundamentals". He is excited that he'll be able to continue to work on his favorite renewable-energy technology in a position with Tesla's battery engineering team, where he will start in the fall. He also got married a year and a half ago and was happy to have many UD friends in attendance; his wife, Victoria, works with special-needs children. They enjoy the weather, cuisine and outdoor attractions in the San Francisco Bay area but hope to move closer to family (and farther from exorbitant rents) eventually. Among the family is Peter's younger brother Lucas, a UD chemical engineering junior.

LAUREN CARBERRY '14 worked in semiconductor manufacturing at Cree in Raleigh, NC, for 4 years following graduation. This past year she took the plunge to pursue an MBA full-time at the UNC Kenan-Flagler Business School, from which she will graduate in the spring of 2020. Lauren and JASON COFFMAN '13 are coming up on their 8-year anniversary (thank you Colburn Lab!) and enjoy their hobbies of DIY home renovations and fostering dogs in their community.

JEROLD (JERRY) SCHULTZ

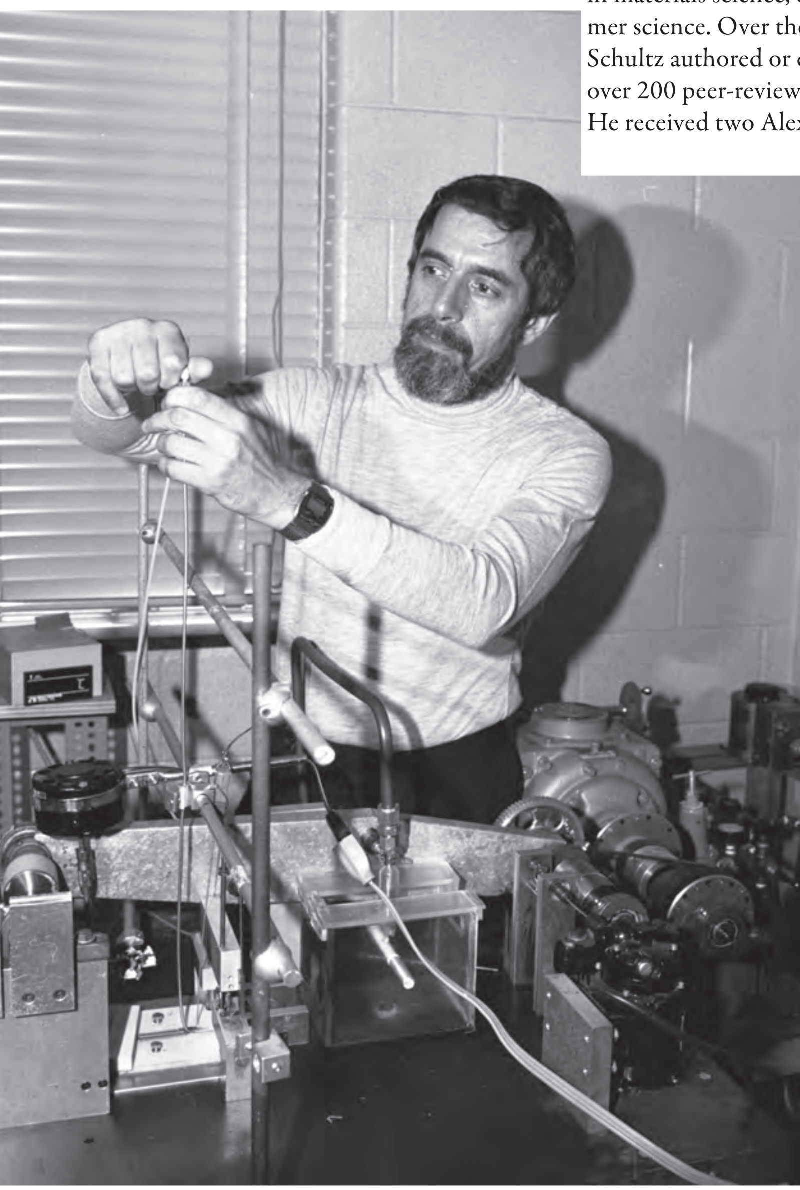
Jerold (Jerry) M. Schultz, emeritus C. Ernest Birchenall Professor of Chemical Engineering with a joint appointment in materials science and engineering at the University of Delaware, died on October 20, 2018.

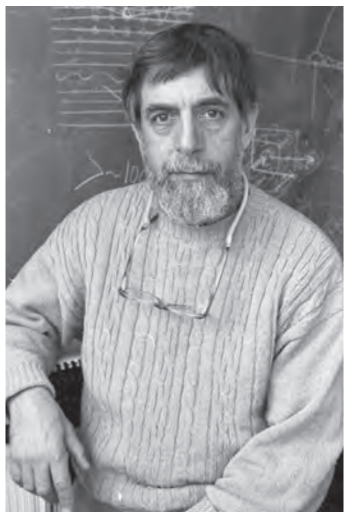
He was born in 1935 in San Francisco and attended the University of California-Berkeley for a bachelor's degree and master's degree in metallurgical engineering. He worked at Westinghouse Research Laboratories for two years and then received a doctoral degree in metallurgical engineering at Carnegie Mellon University.

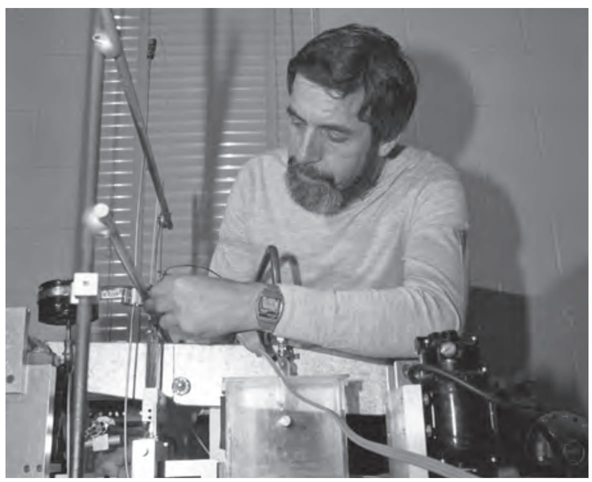
Schultz joined UD in 1964, teaching courses in materials science, diffraction and polymer science. Over the course of his career, Schultz authored or co-edited six books and over 200 peer-reviewed scientific papers. He received two Alexander von Humboldt Stiftung Awards, a Kliment Ohridski Medal from Bulgaria for his work in academic exchanges, and a Fulbright Fellowship. He was also a fellow in the American Physical Society and served for many years as an associate editor of Macromolecules.

He advised 29 master's students and 27 doctoral degree students.

"Over more than a half-century, Jerry Schultz was a loyal and influential member of the University of Delaware community," said Levi T. Thompson, Dean of the College of Engineering. "He made an impact on countless students, including me, as I discovered my own passion for research as an undergraduate researcher in his lab. Jerry's research on polymers helped shape an entire field, and his texts on the subject have been consulted by scientists and engineers worldwide for decades. And while he was a very accomplished engineer and educator, Jerry also made time to give back to the UD community. Two decades ago, he helped the College of Engineering start a materials science and engineering department, which







day. Jerry will be greatly missed at the University of Delaware and beyond."

Babatunde Ogunnaike, William L. Friend Chair of Chemical Engineering, spoke at Schultz's memorial service.

"Jerry was the sort of old-school academic who, even though very accomplished, never took himself too seriously," said Ogunnaike. "But beneath all that self-deprecating wit and dry humor was a world-renowned pioneer in the field of Polymer Crystallization. Jerry was also an accomplished musician who played the flute with the Newark Symphony Orchestra for many years. But above all, Jerry was a generous soul, a mentor who spent time with, and influenced the lives of, a wide variety of students, many of whom have gone on to be successful professors in their own rights. They don't make them like Jerry anymore, and for that and for many more reasons, we will all miss him terribly in the department."

Schultz loved bluegrass music and established a bluegrass jam that met regularly at St. Thomas's Episcopal Church in Newark. He was also a classical flutist and one of the original members of the Newark Symphony Orchestra. He was a bird lover and enjoyed kayaking, hiking and travel.

He is survived by his wife, Peggy, children Carrie (Rob), Tim (Nanette), Peter (Cara), and Anna (Mark), grandchildren Megan and Jamie Deaton, and Carter Schultz, and step-grandchildren Emily Haraldsson (Per) and Nicholas Dracon (Lauren).

IN MEMORY OF

PHIL REISS

BChE'58 | 1937-2018

Phil caught the computational chemistry bug early and worked closely with Prof. Lamb in the late 50's developing calculations for an analog computer. His sister, Linda Reiss Freeman, Ph.D. writes: "Phil was devoted to the University of Delaware, proud of his time with you, and grateful for the fine education in chemical engineering you provided him (BChE). He returned many times for reunions of his class of 1958

IN MEMORY OF

DAVID LAMB

Proffesor of Chemical Engineering
1933-2019

IN MEMORY OF

ARTHUR THOMAS

MChE'56 | 1933-2019

IN MEMORY OF

DONALD WOODMANSEE

BChE'63 | 1941-2019

UD GIVING

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KEN PORTEOUS M'69, D'71

RECOLLECTIONS OF GRADUATE SCHOOL

The graduate programs at UD were demanding and set high standards. This experience prepared me to deal with the many challenges which I faced over my career.

Art Metzner was my supervisor for my Master's degree. Students wishing to pursue a PhD had to write three qualifying exams. I wrote these in Fall 1967 and the Department faculty met on a Friday morning to determine who had passed which of these exams. That afternoon I asked Art if I had passed the exams. He smiled and said he would tell me on Monday morning. My weekend was anxious to say the least but the news was good.

Another PhD requirement was an original proposition or problem. This had to be an original piece of research outside your thesis area and defensible before a committee of Department faculty. The effort required to identify a topic, complete the literature survey and then undertake and writeup the research was considerable and often took a couple of months. While faculty members would answer your questions, they could not offer direct help. Defending the work was a rather intimidating but character-building experience.

UD had a policy of never hiring its own PhD graduates. In my time, there had been only one exception made in this regard, Fraser Russell. The story, albeit second-hand, was that Bob Pigford was so impressed with Fraser's original proposition that a decision was made to bring him on faculty.

The PhD also had a foreign language requirement – two of French, German or Russian. There was one other Canadian graduate student. He told me that the French exam was easy with four years of high school French supplemented with technical vocabulary gleaned from journal abstracts. So I wrote and passed French in my first summer. Sometime in late 1967 or early 1968, the Department reduced the language requirement to one of German or Russian. However, there was a further twist in this policy decision. Anyone who had completed French would be considered to have fulfilled the language requirement. This good fortune was not much appreciated by my fellow graduate students. My effort to pass the French exam was minimal whereas, without a background in German or Russian, these were major hills to climb. Fraser Russell especially had experience with this.

The German exam was considered serious business. Art Metzner was proficient in German. There is a story that shortly after Art came to Delaware he had the idea that he would deliver a paper in German at some conference. Kurt Wohl, who was raised and educated in Germany, was on faculty at the time and suggested to Art that this might not be a good idea. He offered to listen to a dry run of the presentation and give Art feedback. Subsequently, the paper was delivered in English. The French language exam written by chemical engineering graduate students was set and marked by whatever department in Arts offered French. However, the German language exam was often set and marked by Art. His choice of a passage(s) from a published paper(s) did not represent easy material. I remember my fellow graduate students complaining about one exam which was based on a very technical fluid mechanics paper written in high German. Art's grading scheme was reportedly quite straightforward. He counted the total number of lines in the passage(s) to be translated. He also counted the number of errors in the translation. If the latter exceeded the total number of lines, this was considered a fail. So Art's high standards applied to both research and the German language exam!

The weekly seminars were educational and entertaining. Graduate student attendance was compulsory and the seats closest to the back door were preferred. Those fortunate enough to claim these could slip out early and undetected. Jon Olson's questions were always tough but when prefaced by Jon's "let me ask a dumb question" we knew the speaker had a problem.

Art Metzner was going to Cambridge on sabbatical in fall 1968 and asked me to go with him, complete my Master's thesis and start my PhD research. While this was tempting, I thought it would probably add an extra year to my program and decided I was not prepared pay this price. So I chose to do my PhD with Mort Denn.

Mort's office was always a mass of paper; this was before desktop computers. To accommodate all the paper, he had two desks. He worked on one desk until there was no longer room in front of his chair for an 8 1/2 x 11 sheet of paper. Mort would then turn his chair around to the second desk which was already covered with multiple layers of paper and clear this desk by throwing everything in the garbage. The cycle time on this exercise was about six months. Mort's rationale was that if there had been anything important on the second desk someone would have asked about it sometime in the preceding six months.

GIVING BACK

We extend our sincere appreciation to the following alumni and friends of the Department of Chemical and Biomolecular engineering who made gifts between July 1, 2018, and June 30, 2019.

Contributions from these generous individuals help us to provide the vital resources that allow our students, our faculty and our campus to thrive.

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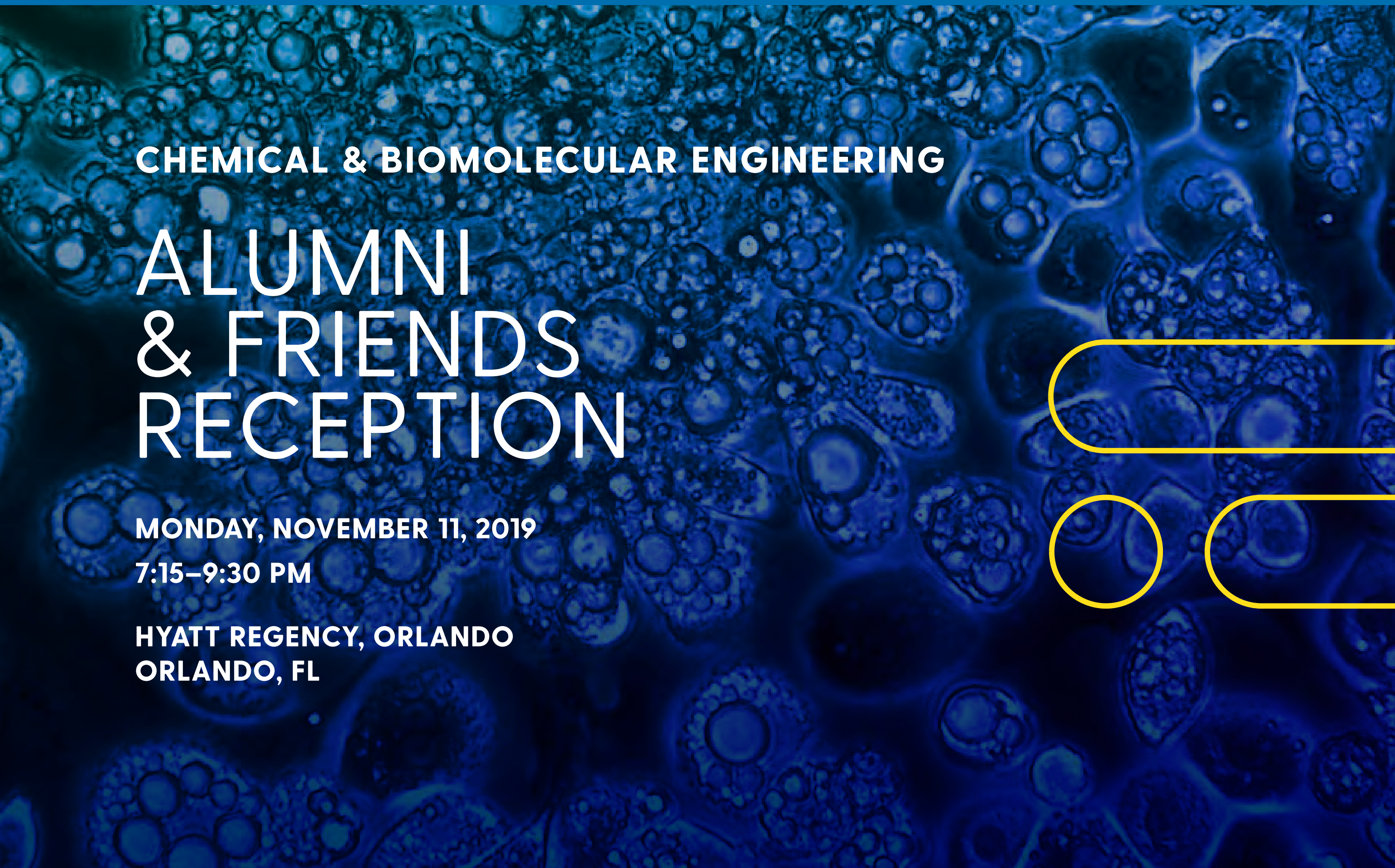

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