UNIVERSITY OF DELAWARE

ENGINEERING

CHEMICAL & BIOMOLECULAR

FALL 2020

NEW MRSEC, EFRC AT UD

FUNDED CENTERS TO ADVANCE MATERIALS RESEARCH

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BIOPHARMACEUTICAL INNOVATION

GROUNDBREAKING NEUTRON SCIENCE

REMEMBERING BOB GORE

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FALL 2020

CHEMICAL AND BIOMOLECULAR ENGINEERING NEWS

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

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Department of Chemical
& Biomolecular Engineering
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ON THE COVER
Pd Nanocubes
By Xuan Yang, Post Doc
Courtesy of Art In Science 2018

DEAR FRIENDS OF CHBE

I am pleased to present the 2020-21 issue of Chemical and Biomolecular Engineering News.

What a year! I will never forget the sudden storm that arrived in March 2020. While the seriousness of the SARS-CoV-2 spread started to become apparent, the department made a quick decision to "virtualize" our second graduate recruiting visit. Then in a matter of days, we barreled into lockdown as Delaware coped with the wave of initial COVID-19 cases spreading on the east coast. In the weeks and months that followed, we navigated quarantines and contract-tracing, a complete shutdown of on-campus research which would last for several months, a turn to entirely online instruction (continuing into the fall semester) and, over the summer, a slow restart of on-campus research. Throughout the year, our students, faculty, and staff have remained committed to the mission and vision of the department and pulled together with tremendous resolve. Another chair in the College of Engineering observed that the resilience and commitment in our department comes from a deep and lasting culture of excellence and esprit de corps.

Yet, despite the pandemic, the department landed on exceptionally strong footing to weather this storm. The simultaneous award of the NSF Materials Research Science and Engineering Center (MRSEC) CHARM and an Energy Frontiers Research Center funded by the Department of Energy, the Center for Plastics Innovation position the department and the college as preeminent destinations for materials-based research. The center activities will be highly multi-disciplinary and span across the department, college, and University. These centers, along with the current national centers and institutes led by Chemical and Biomolecular Engineering faculty, highlight the tremendous leadership of our faculty.

Our other position of strength comes from recent success in faculty hiring. Despite challenging situations, the department recruited Kevin Solomon, currently an Assistant Professor at Purdue University in Agricultural and Biological Engineering, and Mark Blenner, who leaves his position as the McQueen-Quattlebaum Associate Professor of Chemical and Biomolecular Engineering at Clemson University. Solomon and Blenner will join the faculty in January 2021, and both will add to our strengths in synthetic biology, biomanufacturing, and bio-based materials. And last fall, the faculty were delighted to recruit Alexandra Bayles (UD BChE 2018, PhD UCSB 2013). Dr. Bayles will join the faculty in September 2021 after completing her postdoctoral training at ETH Zurich as an ETH Postdoctoral Fellow. Her research focus in materials and transport phenomena will align superbly with the MRSEC. Our new colleagues balance retirements and unexpected losses in the faculty ranks, notably with the sudden and sad death of Prasad Dhurjati and the retirement of Michael Klein.

New talent continues to find Delaware and call it their home. The department recruited another exceptional class of PhD students as 28 students from across the US and the world joined the program this fall. Undergraduate enrollment remains strong, in part due to the intimate educational environment that our faculty strive to foster. We long to return to the halls of Colburn Laboratory, the Harker ISE building, and now, the Ammon-Pinizzotto Biopharmaceutical Innovation Center on the STAR campus.

With over 400 undergraduates and more than 50 postdoctoral trainees and scientific staff, together with graduate students and faculty, the department remains well over 600 strong. Few programs in the US can boast a breadth and productivity of scholarship, education, and service that Delaware continues to lead in the 21st century. So, continue on to read about efforts that will revolutionize biomass-derived products, carbon capture and use, multidisciplinary solutions to plastic waste, and of course, important work addressing COVID-19 and our ability to address future emerging global crises and grand challenges, as well as updates on student achievements and notes from our alumni.

ERIC M. FURST

DEPARTMENT CHAIR
& PROFESSOR

@EMFURST

Left: Photo of Thomas Epps, III

UD CHARM is advancing foundational understanding of new materials driven by theoretical and computational predictions paired with cutting-edge experiments led by interdisciplinary teams.

Right: Distinguished Associate Professor LaShanda Korley mimicked the architecture of the bristle worm's jaw system by adding a zinc-coordinated supramolecular polymer into a covalently crosslinked polyethylene glycol network.

UD MAKES MATERIAL IMPACT

FEDERALLY-FUNDED CENTER TO ADVANCE MATERIALS RESEARCH

A new center at the University of Delaware will advance research to transform the way materials are made.

The UD Center for Hybrid, Active, and Responsive Materials (UD CHARM) will drive fundamental materials science research with the potential to enable critical innovations in biomedicine, security, sensing and more.

The effort is led by UD's Thomas H. Epps, III, the Thomas and Kipp Gutshall Professor of Chemical and Biomolecular Engineering, with $18 million in funding from the National Science Foundation. Epps also holds a joint appointment in materials science and engineering. LaShanda Korley, Distinguished Professor of Materials Science and Engineering and Chemical and Biomolecular Engineering, will co-direct and coordinate operational aspects of the center.
The center is part of a network of academic partners and national labs focusing on the development of new materials. Regional research partners in the UD-led center include the University of Pennsylvania and the National Institute of Standards and Technology (NIST).
It is one of 11 Materials Research Science and Engineering Centers (MRSECs) across the country funded by the NSF in 2020.

MRSECs are an important part of the materials science enterprise in the United States with a focus on fundamental research. They serve as hubs for national and international collaboration in research and in-

dustry partnerships, and also are critical developers of educational and outreach content for the materials community.

A major educational and outreach thrust of UD CHARM will be to improve the diversity landscape at all levels of the academic and research enterprise. Key initiatives include providing exciting research and education opportunities in materials science for students from underrepresented groups, in partnership with Delaware State University in Dover, Delaware, and Claflin University in Orangeburg, South Carolina, two historically black colleges and universities (HBCUs).

According to Epps, one particularly exciting component of the partnership with DSU and Claflin University is the MRSEC fellows program, which will create a pathway to graduate school for undergraduate students by exposing them to materials science early on in their college careers. DSU, for example, does not offer a materials science degree program. Through the MRSEC fellows program, DSU and Claflin students will have the opportunity to participate in UD undergraduate research opportunities and materials science courses at no cost to them, with the goal of furthering their educational objectives and curiosity.

Annually, the center will support approximately 40 undergraduate and graduate students and postdoctoral researchers, along with five high school students over the six-year grant.

"Coupled with networking and mentoring opportunities, students will be able to envision themselves in these spaces, and find trusted resources and role models for guidance," said Epps.

BIO-INSPIRED MATERIALS

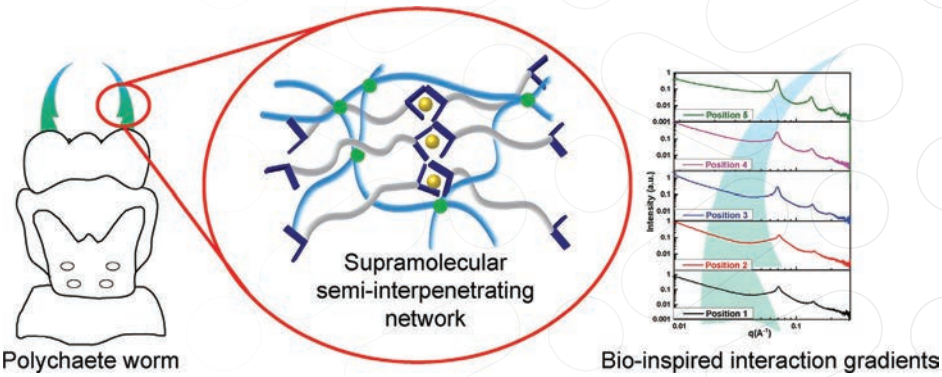
KORLEY GROUP DRAWS INSPIRATION FROM NATURAL MARVELS TO MAKE NEW MATERIALS

A tiny bristle worm, wriggling around the ocean, can extend its jaw outside its mouth to ensnare its prey. The worm's shape-shifting jaw is made of one singular material containing the mineral zinc and the amino acid histidine, which together govern the joint's mechanical behavior through what is known as a metal coordination chemistry.

Scientists like LaShanda Korley want to recreate these chemistries and build similar structures in synthetic materials. By doing so, they can develop new, improved materials for use in sensors, healthcare applications, and more.

In the European Polymer Journal, Korley's research group described how they built a network of materials, made of zinc and polymers, that mimicked the mechanical gradient of a bristle worm's jaw system. They added a zinc-coordinated supramolecular polymer into a covalently crosslinked polyethylene glycol network. With the right concentrations, they found that they could govern the material's mechanical properties.

Korley is the principal investigator of PIRE: Bio-Inspired Materials and Systems, a five-year, $5.5 million grant from the National Science Foundation.



TAKING AIM AT PLASTIC WASTE

UD WINS FEDERAL GRANT TO ESTABLISH CENTER FOR PLASTICS INNOVATION

The Center for Plastics Innovation (CPI), led by Professors LaShanda Korley and Thomas H. Epps, III, will focus on chemically transforming plastic waste into fuels, lubricants and other valuable products in an energy-efficient manner. It is one of six new Energy Frontier Research Centers established across the U.S. and the second to be directed by the University of Delaware.

Photo by Nick Fewings on Unsplash

Think about how the entire planet would benefit if more plastic could be recycled or reimagined.

The Center for Plastics Innovation (CPI) at UD is taking aim at that challenge. Funded by an $11.65 million grant from the U.S. Department of Energy, CPI is one of six new Energy Frontier Research Centers (EFRCs).

CPI brings together researchers from UD, the University of Chicago, University of Massachusetts Amherst, University of Pennsylvania and Oak Ridge National Laboratory to "upcycle" plastic waste — chemically transforming it into fuels, lubricants and other valuable products in an energy-efficient manner.

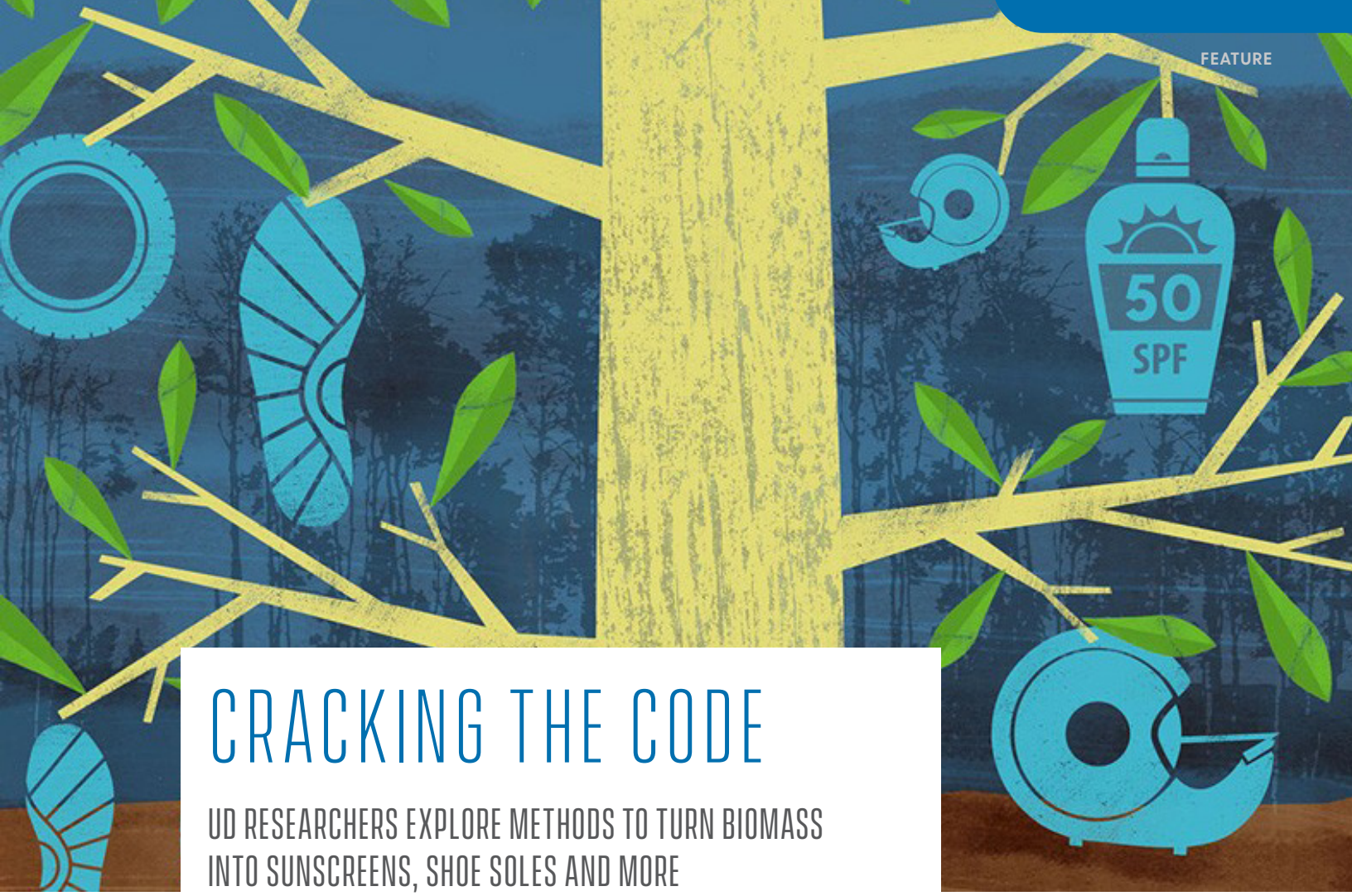
UD's LaShanda Korley, Distinguished Professor of Materials Science and Engineering and Chemical and Biomolecular Engineering, leads the effort. Thomas H. Epps, III, UD's Thomas and Kipp Gutshall Professor of Chemical and Biomolecular Engineering, serves as co-director.

As an Energy Frontier Research Center, UD's Center for Plastics Innovation will play an important role in advancing the nation's energy future.

Worldwide, more than 350 million tons of plastics were produced in 2018 alone. Only 12% of this plastic waste is reused or recycled, according to an industry report. Current recycling strategies fall far short in recovering material that is as high in quality as the material you started with — a major hurdle the CPI will be working to overcome.

The CPI team is focusing on the most difficult plastics to recycle because of their complex chemical structure. Examples include high-density polyethylene (HDPE), used in containers for milk, motor oil, shampoo and bleach; low-density polyethylene (LDPE) found in sandwich bags and plastic grocery bags; polystyrene used in Styrofoam coffee cups and other food packaging; and poly (methyl methacrylate) (PMMA), from which acrylic sheets such as Plexiglas are made.

"We have a unique skill set at Delaware, with strengths in catalysis, polymer science, computational design, synthetic biology and machine learning," Korley said. "Our collaborators and partners bring great expertise in computational materials science and enzymatic catalysis, and also contribute characterization and computational facilities critical to advancing this work."



CRACKING THE CODE

UD RESEARCHERS EXPLORE METHODS TO TURN BIOMASS INTO SUNSCREENS, SHOE SOLES AND MORE

Lignin is a major waste product of the pulp and paper industry that can be converted into chemical building blocks to create other materials. It comes from trees, grasses and other biomass.

With a $3.69 million grant from the National Science Foundation, University of Delaware's Thomas H. Epps, III and an interdisciplinary team of experts will unlock new routes to sustainably develop materials from lignin.

Epps, the Thomas and Kipp Gutshall Professor of Chemical and Biomolecular Engineering at UD, is the project's principal investigator. The research team aims to develop and evaluate comprehensive strategies to convert lignin into more valuable products, such as lubricants, sunscreens and adhesives, or impact-resistant materials, from rubber bands, gaskets and shoe soles to car tires, dashboards or bumpers.

The project leverages UD's institutional strengths in catalysis, energy and polymeric materials, and it involves faculty from three of UD's eight colleges: the College of Engineering, the College of Earth, Ocean and Environment and the College of Agriculture and Natural Resources.

Major faculty participants and co-principal investigators (PI) on the project include Dion Vlachos, director of the Delaware Energy Institute and the Catalysis Center for Energy Innovation, and the Allan and Myra Ferguson Professor of Chemical and Biomolecular Engineering; Delphis Levia, professor of ecohydrology and chair of geography; Aditya Kunjapur, assistant professor of chemical and biomolecular engineering; Changqing Wu, associate professor of food toxicology; and LaShanda Korley, Distinguished Associate Professor of Materials Science and Engineering.

With a $3.69 million grant from the National Science Foundation, University of Delaware researchers are working to unlock new routes to sustainably develop materials from lignin.

IN MEMORIAM: ROBERT W. GORE

UD MOURNS THE LOSS OF BELOVED ENGINEERING ALUMNUS, PHILANTHROPIST UNIVERSITY OF DELAWARE ALUMNUS AND BENEFACTOR ROBERT W. "BOB" GORE, CHAIRMAN EMERITUS OF THE BOARD OF DIRECTORS OF W. L. GORE & ASSOCIATES, DIED ON SEPT. 17 AT THE AGE OF 83.

Dr. Gore was an internationally renowned inventor and member of the National Academy of Engineering and National Inventors Hall of Fame. In 1969, while working at W.L. Gore and Associates, a company founded by his parents, Dr. Gore developed expanded polytetrafluoroethylene (PTFE), which led to product applications including Gore-Tex fabric, the world's first breathable waterproof fabric. He held nine patents, and his inventions led to materials found in spacesuits, medical devices and more.

EDUCATION AND CAREER

Dr. Gore was born on April 15, 1937, in Salt Lake City, Utah. His family moved to Newark, Delaware, and he graduated from Newark High School before enrolling in the University of Delaware to study chemical engineering.

At UD, he played the trombone in the Marching Band and was a member of UD's chapter of the American Institute of Chemical Engineers (AIChE); Alpha Tau Omega fraternity; Alpha Chi Sigma, a professional chemistry fraternity; and Tau Beta Pi, an honor society for undergraduate engineering students.

During his sophomore year at UD, Dr. Gore suggested to his father, engineer Bill Gore, an idea for an innovative multiconductor wiring strip. This provided a key solution to a manufacturing problem and earned Dr. Gore his first patent.

Dr. Gore graduated from UD in 1959 with a bachelor's degree in chemical engineering and then went on to the University of Minnesota for a doctoral degree.

He was named to the W.L. Gore & Associates board of directors in 1961, and two years later joined the family firm as an employee. His research shaped the company's future, and he later served as president of the company (from 1976 to 2000) and chairman of its board of directors. He became chairman emeritus in 2018 after 57 years of service on the board of W.L. Gore & Associates, with 30 of those years spent as chairman.

During Dr. Gore's time as president, W.L. Gore & Associates became a billion-dollar company. It is now a $3.2 billion company with more than 11,000 employees and offices in more than 25 countries.

The company has more than 3,400 unique inventions worldwide in a wide range of fields, including electronics, medical devices and polymer processing.

"Bob was a true pioneer that influenced the lives of so many. He was a thought leader in the industry and instrumental to the creation of a multitude of innovative products that have had a significant impact on society," said Terri Kelly, ENG83, retired president and CEO of W.L. Gore & Associates. "On a personal note, I am truly grateful for his years of mentorship and support that he provided to me throughout my career. Bob was known for his sharp mind, deep technical expertise and creative approach. He would always ask some of the most insightful questions that helped me grow as a leader. His guidance, encouragement and the opportunities he gave me, helped me achieve more than I thought possible. I am honored to have known him, and he will clearly be missed."

Dr. Gore's impact on industry was well recognized. In 2005, he received the Perkin Medal from the Society of Chemical Industry. This is considered the highest honor given in American industrial chemistry.

IMPACT ON UD

Dr. Gore's legacy will live forever at UD. "Bob was a gifted engineer whose clever inventions touched countless lives, from astronauts protected by space suits with Gore fibers to everyday people who exercise wearing breathable Gore-Tex gear," said Levi Thompson, Dean of the College of Engineering. "More importantly, Bob was a wonderful and generous person. It is truly an honor to count Bob among our alumni, and we are grateful for his unwavering support of UD engineering. We will continue to be inspired by his legacy of innovation and service, and we will train our students to be the kind of engineers that he was."

TIMELINE OF BOB GORE'S UD EXPERIENCES AND INVOLVEMENT

1956: Freshman year at UD; joins UD Marching Band and AIChE

1957: Joins Alpha Tau Omega and Alpha Chi Sigma; introduces the idea for an innovative multiconductor wiring strip called the MULTI-TET™ cable, leading to his first patent

1959: Senior year at UD and graduation

1965: Makes his first gift to the University ($3)

1986: Joins the University of Delaware Research Foundation

1987: Established the W.L. Gore Entrepreneurial Scholarship

1990: Starts serving on the Chemical and Biomolecular Engineering Advisory Council - Departmental and Special Program Boards

1991: Becomes a member of the 150th Campaign Committee

A LEGACY OF GENEROSITY

In 1965, Dr. Gore made his first gift to the UD--$3 to the unrestricted University fund. That humble gift to his alma mater sparked a lifetime of generosity and philanthropy from Gore and his family, who committed more than $32 million during his lifetime to advance UD's people and programs.

His loss is mourned by the entire University community, but his legacy and lasting philanthropy will continue to have a transformational impact on current and future Blue Hens for years to come.

SUPPORTING STUDENTS

Students are at the core of a university's mission. Gore and his family have ensured countless Blue Hens—of today and tomorrow—have resources and opportunities that wouldn't otherwise be possible.
In 1987, Gore's mother, Genevieve Gore, established the W.L. Gore Entrepreneurial Scholarship in memory of Bob's father and her husband, Bill Gore. She wanted to continue the Gore legacy at UD while honoring the qualities her husband exemplified, especially as an outstanding proponent of the entrepreneurial spirit in business. To date, 189 students have benefitted from the scholarship.
In addition to supporting undergraduate students, Gore also greatly valued graduate education. In 2011, he donated $1 million to establish the Robert W. Gore Fellowship in the College of Engineering. The fellowship is awarded to two academically deserving Ph.D. students in the College of Engineering. Since 2012, 19 graduate students have received this support.

FUNDING FACULTY

Gore recognized that direct support for students wasn't the only way to help them succeed. Recruiting and retaining talented faculty has long been a way to attract bright students while also enabling and continuing innovation that marked Gore's career—advancing research and elevating the University as a whole.

In 2001, Gore established the Robert W. Gore Professorships in Chemical Engineering and the Arthur B. Metzner Professorship in Chemical Engineering. Wilfred Chen and Kelvin Lee currently hold the titles of Gore Professors of Chemical Engineering while Antony Beris holds the title Arthur B. Metzner Professor of Chemical Engineering. All three named professors teach and engage students in their innovative research that will have lasting impact far beyond campus, something Gore himself experienced as he carried the lessons learned from beloved professors with him after his time at UD. In addition, Lee is the director of the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL).

"The support Bob provided for me and my colleagues impacts us as faculty members, our students and the broader University community," Lee said. "We have been able to use his generosity to not only cultivate interesting and innovative research, but to leverage against federal dollars to create new initiatives, growing the prominence of the University into being a global leader in biopharmaceutical manufacturing. I hope my work continues to be a tribute to Bob's ingenious thinking and inventive spirit."

Gore and his wife Jane's support to recruit talented faculty continued when they committed $3 million to establish the Bob and Jane Gore Centennial Chair of Chemical and Biomolecular Engineering in 2014, in celebration of the department's 100 year anniversary. The named position attracted Marianthi Ierapetritou, who was the Distinguished Professor of Chemical and Biochemical Engineering at Rutgers University. She began her tenure at UD last September and gave her inaugural lecture, called "Process Systems Engineering in the Era of Big-data and Industry 4.0 Revolution," in February 2020.

"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 in the area of biologics production and manufacturing," Ierapetritou said. "I was thrilled I had the opportunity to meet Bob at the inaugural

1992: Joins the UD Board of Trustees and is recognized as a member of the UDAA Wall of Fame

1994: Serves on the Colburn Campaign National Committee

1995: Commits $18.5 million to Gore Hall on The Green; elected to the National Academy of Engineering for his technical achievements

1997: Serves as co-chair for the Campaign Steering Committee until 2003

1998: Gore Hall is dedicated.

2001: Establishes the Gore Professorship of Chemical Engineering to support two professors; creates the Arthur B. Metzner Professor of Chemical Engineering

2005: Commits $1 million to supporting the Roselle Center for the Arts; receives the Perkins Medal

2006: Inducted into the U.S. National Inventors Hall of Fame; begins serving on the College of Engineering Advisory Council– College and Program Advisory Board

2010: Receives the honorary Doctor of Science degree

lecture and speak with him in person about my research, which his and Jane's support enabled me to bring to UD. Now, I can help Blue Hens pursue hands-on learning and also have the opportunity to help women in my classes through the different stages of their science careers. I am thankful the Gores ensured I could be part of this wonderful Blue Hen family."

With much of his support for students and faculty falling under the College of Engineering, deans and department chairs have surely felt the impact of Gore's giving throughout the years.

Babatunde A. Ogunnaike, dean of the College of Engineering from 2013 to 2018 and William L. Friend Chaired Professor, witnessed the profound impact of Gore's philanthropy firsthand.

"The Gores have so generously invested in the faculty and students in the College of Engineering—positively changing the trajectory of the college, its people and programs," Ogunnaike said. "We have lost a truly irreplaceable friend and a pillar of the community at UD, in the College of Engineering and in the chemical and biomedical engineering department, but his legacy lives on in the countless lives he has touched with his generosity, and in the outsized footprints he left on the sands of time."

CREATING SPACES

The way students learn is undeniably tied to where they learn. The innovative facilities made by possible by Gore's generosity ensure Blue Hens will always have collaborative spaces conducive to learning and succeeding.

In the mid-1990s, Gore and his family began their impactful support of UD facilities. After a conversation with then-President David Roselle about the need for more general purpose classroom space on the campus, Gore agreed to contribute $15 million for such a building to fill the last empty space on the north Green. When the project cost climbed to $18.5 million, Gore was unwavering in his support; he was adamant that it should mirror the classic Georgian style of its neighboring buildings on The Green.

The result was Gore Hall, the first new building on The Green in more than 35 years, completing a design plan originally approved by the Board of Trustees in 1915. The new building, designed by noted architect Allan Greenberg, created a home to 25 high-tech classrooms and the Center for Teaching & Assessment of Learning. It also solidified the family's legacy as part of the beauty of The Green.

When the University announced it was building its first major laboratory in 20 years – now the Harker Interdisciplinary Science and Engineering Laboratory (ISE Lab) – Gore and his wife, Jane, were among the first to step up, committing $10 million to create the research wing of the state-of-the-art facility, now named the Bob and Jane Gore Research Laboratories.

The labs house core research facilities and equipment, including an imaging and microscopy suite, a nanofabrication facility and a materials characterization lab. This section of the building also is home to three of the University's key research centers—the UD Energy Institute, the Delaware Environmental Institute and the Catalysis Center for Energy Innovation.

In addition to investing in students, faculty and key spaces on campus, Gore also supported the 1994 renovation of Colburn Lab and the University of Delaware Research Foundation.

HONORING BY SUCCEEDING

In honor of their tremendous philanthropy that changed the landscape of UD—both physically and through impact on Blue Hens—Gore and his wife Jane were named inaugural members of UD's Founders Society in October 2018. The Society recognizes the University's most generous donors who have committed $1 million or more during their lifetime.

But the true tribute to their generosity is in the success of those impacted throughout the years.

2011: Commits $1 million to establish the Robert W. Gore Fellowship in the College of Engineering

2013: Commits $10 million to build the University of Delaware's ISE Lab

2014: Commits $3 million to establish the Bob and Jane Gore Centennial Chair of Chemical and Biomolecular Engineering

2017: Becomes an emeritus member of the Engineering College Advisory Council – College and Program Advisory Board until 2019

2018: Recognized, along with wife Jane, as members of the Founders Society

2019: Recognized as part of the UDAA Alumni Circle unveiling

2020: Inaugural Gore lecture held Feb. 26

IN MEMORIAM: T.W. FRASER RUSSELL

Thomas William Fraser Russell, the Allan P. Colburn Professor Emeritus of Chemical and Biomolecular Engineering at the University of Delaware, died on Nov. 29, 2019.

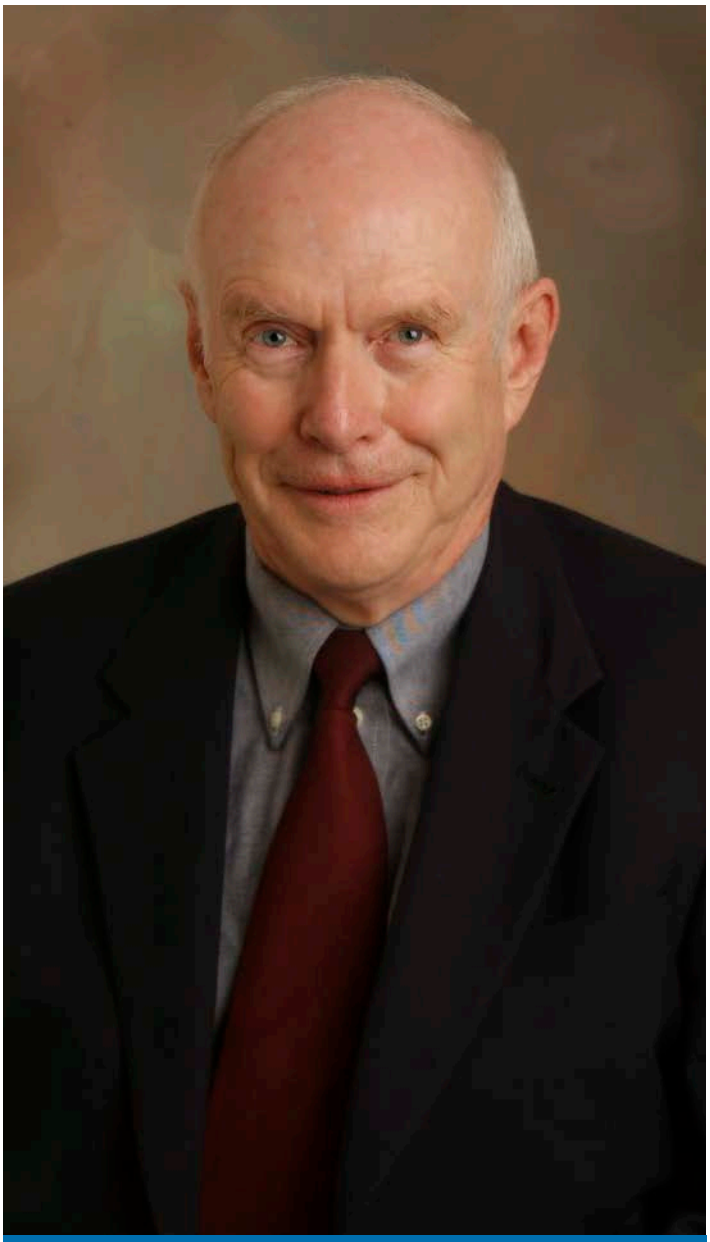
Dr. Russell received his bachelor's degree and master's degree in chemical engineering in 1956 and 1958, respectively, from the University of Alberta and then worked for the Research Council of Alberta and then Union Carbide Canada before arriving at the University of Delaware in 1961. He received his doctoral degree in chemical engineering from UD in 1964 and joined the faculty that year—the only UD chemical engineering faculty member ever to join the faculty immediately after graduating from the doctoral program. In 2009, Dr. Russell retired from teaching.

Over his 45 years as a chemical engineering faculty member, he held several administrative appointments, including UD's vice provost for research from 2000 to 2005, director of the Institute of Energy Conversion (IEC), the IEC chief engineer, chair of the chemical engineering department, acting dean of the College of Engineering and associate dean of the college.

"Fraser Russell was a giant in the field of chemical engineering who garnered significant acclaim for his work in reaction engineering, solar cell manufacturing and more," said Levi Thompson, dean of the College of Engineering. "A true scholar and educator, he was dedicated to sharing his knowledge with students and early-career faculty, and his influence lives on in the many engineers he has inspired. On a personal note, I am grateful to have had him as one of my professors while an undergraduate student. He was among my favorites then and now."

Dr. Russell, author of three textbooks, eight book chapters, seven patents, 90 technical papers and 11 engineering education research papers, was named a member of the National Academy of Engineering, among the highest honors for an engineer, in 1990. The American Institute of Chemical Engineers honored Dr. Russell with the Warren K. Lewis Award for Chemical Engineering Education in 2010, named him a Fellow in 1995, and awarded him the AIChE Award in Chemical Engineering Practice in 1987.

The American Society for Engineering Education (ASEE) honored Dr. Russell with the ASEE Chemical Engineering Division Lifetime Achievement Award in Chemical Engineering Pedagogical Scholarship in 2010 and the Chemical Engineering Division 3M Lectureship Award in 1984.



FOR MORE TRIBUTES FROM FRIENDS AND COLLEAGUES OF DR. RUSSELL, VISIT **HTTP://WWW.UDEL.EDU/007878**

IN MEMORIAM: PRASAD DHURJATI

Prasad Dhurjati, a professor of chemical and biomolecular engineering and mathematical sciences at the University of Delaware, died on June 30, 2020.

Dr. Dhurjati joined the University of Delaware faculty in 1982 after receiving his doctoral degree in chemical engineering from Purdue University. He received a bachelor's degree in chemical engineering from the Indian Institute of Technology, Kanpur, in 1977.

Dr. Dhurjati was known for his scholarship in the biotechnology field and was honored with the NSF Presidential Young Investigator Award and College of Engineering Special Faculty Award in 1986 and was named to the American Institute of Medical and Biological Engineering (AIMBE) in 2004.

Levi Thompson, dean of the College of Engineering, said, "Prasad had a very positive influence on countless students, colleagues and others during his many years at UD. Those who had the pleasure of working with him will always remember his generosity and encouragement. We will miss him greatly."
Dr. Dhurjati took pleasure in collaborating with those in other disciplines and was often exploring how his expertise in computer modeling could advance another person's research.

In a recent, wide-ranging interview with UDaily about a spring semester class he was teaching on computer modeling techniques, Dr. Dhurjati talked about the pleasure he found working with motivated students — even in the strange new "Zoom" context demanded after the emergence of the COVID-19 pandemic.

"If you ask me 'why are you at a university?' I will tell you there's nothing that makes me happier than a student with a desire to learn," he said. "I tell them they can ask questions forever — from 5 in the morning until midnight. Send me your questions and I will help you.

"That's my reward — to see highly motivated students wanting to make a contribution, wanting to learn. You can't beat it. Nothing material can beat that reward. And that's why I'm at a university."

Always generous with his time and encouraging of others, Dr. Dhurjati served as the 47th president of the UD Faculty Senate and held many leadership roles within the organization.

DR. DHURJATI LEFT A LASTING LEGACY ON MANY FRIENDS, STUDENTS AND COLLEAGUES.

FOR MORE TRIBUTES FROM FRIENDS AND COLLEAGUES OF DR. DHURJAIT, VISIT **HTTP://WWW.UDEL.EDU/007877**

An interdisciplinary team of researchers from University of Delaware and Brookhaven National Laboratory report new advances in converting biomass to potential biofuels. Pictured left to right are: Top row: Jiayi Fu, Jonathan Lym Middle row: Weiqing Zheng, Konstantinos Alexopoulos, Alexander V. Mironenko Bottom row: Dionisios G. Vlachos, J. Anibal Boscoboinik.

GOING SMALL YIELDS BIG RESULTS

ATOMIC-SCALE CATALYSTS MAY PAVE THE WAY FOR CONVERTING BIOMASS TO FUELS, CHEMICALS

University of Delaware researchers from the Catalysis Center for Energy Innovation (CCEI) and collaborators at the U.S. Department of Energy's Brookhaven National Laboratory have developed a new class of catalysts for converting agricultural biomass, such as plant waste, into valuable fuels and chemicals.

CCEI is a multi-institutional Energy Frontier Research Center, housed at UD and funded by the Department of Energy. Catalysts are materials that accelerate chemical reactions.

The scientists have designed a catalyst composed of single platinum atoms and clusters smaller than billionths of a meter on the surface of a metal oxide called titanium dioxide. Titanium dioxide is the white pigment used in sunscreen, paints and cosmetics. The metal oxide is a stable and inexpensive material.

The researchers have reported promising results in Nature Catalysis demonstrating that, by working at the single-atom scale, scientists can selectively control the chemical reactions required to convert a plant derivative called furfuryl alcohol into a potential biofuel, known as 2-methylfuran.

This same approach has been a challenge using metal catalysts at larger scales.

The strategy could be applied to design stable, active and selective catalysts based on a wide range of metals supported on metal oxides. This would allow researchers to produce industrially useful chemicals and fuels from biomass-derived molecules.

New characterization techniques developed at the Catalysis Center for Energy Innovation may help improve electrochemical storage technologies, such as fuels cells used in UD's hydrogen fuel cell buses.

RENEWABLE ENERGY ADVANCE

UD RESEARCHERS REPORT NEW METHOD FOR CHARACTERIZING MATERIALS THAT MIGHT EVENTUALLY HELP STORE ENERGY

Renewable technologies are a promising solution for addressing global energy needs in a sustainable way.

However, widespread adoption of renewable energy resources from solar, wind, biomass and more have lagged, in part because they are difficult to store and transport.

As the search for materials to efficiently address these storage and transport needs continues, UD researchers from the Catalysis Center for Energy Innovation (CCEI) report new techniques for characterizing complex materials with the potential to overcome these challenges.

The researchers reported their technique in Nature Communications.

Currently technologies exist for characterizing highly ordered surfaces with specific repeating patterns, such as crystals. Describing surfaces with no repeating pattern is a harder problem.

UD doctoral candidate and 2019-2020 Blue Waters Graduate Fellow Josh Lansford and Dion Vlachos, who directs both CCEI and the Delaware Energy Institute and is the Allan and Myra Ferguson Professor of Chemical and Biomolecular Engineering, have developed a method to observe the local surface structure of atomic-scale particles in detail while simultaneously keeping the entire system in view.

The approach, which leverages machine learning, data science techniques and models grounded in physics, enables the researchers to visualize the actual three-dimensional structure of a material they are interested in up close, but also in context. This means they can study specific particles on the material's surface, but also watch how the particle's structure evolves — over time — in the presence of other molecules and under different conditions, such as temperature and pressure.

Put to use, the research team's technique will help engineers and scientists identify materials that can improve storage technologies, such as fuel cells and batteries, which power our lives.

NIIMBL GETS $8.9 MILLION FOR COVID-19 RESPONSE

UD-BASED NATIONAL INSTITUTE WILL ADDRESS TESTING, DIAGNOSTICS, SUPPLY CHAIN AND VACCINE MANUFACTURING

The nation's battle against the coronavirus (COVID-19) pandemic gained new muscle in May 2020 with an $8.9 million grant from the U.S. Department of Commerce to the National Institute for Innovation in Biopharmaceutical Manufacturing (NIIMBL).

NIIMBL, a public-private partnership headquartered at the University of Delaware and part of the Manufacturing USA network, will use the money to expand testing and diagnostic capability, address problems in the supply chain and help develop approaches to accelerate manufacturing once a vaccine has been developed and approved for use.

"Never in our lifetime have we experienced a global crisis of this magnitude," said Kelvin Lee, director of NIIMBL and Gore Professor of Chemical and Biomolecular Engineering at UD. "It presents a massive challenge but also an opportunity — one that I deeply believe we are positioned to help meet."

U.S. Sen. Chris Coons of Delaware, who has called for expanding the nation's vaccine manufacturing capacity, applauded the new grant in a statement released by his office: "The scary truth is that the United States is currently not ready to mass produce a vaccine for COVID-19, even once we've developed one — and that's a problem we need to fix right away," he said. "I'm thrilled that Delaware scientists and engineers at NIIMBL will be leading that effort."

The work will draw on NIIMBL's partnerships with more than 150 members, including those in industry, small business, federal and university-based labs.

"We have the ingenuity, grit and expertise to find new ways to produce what we need to regain America's health, build the critical manufacturing supply chain and strengthen our ability to respond swiftly and effectively to future challenges," Lee said.

The National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL) headquarters is in the new Ammon Pinizzotto Biopharmaceutical Innovation Building on the University of Delaware's Science, Technology and Advanced Research (STAR) Campus.

SPECIFICALLY, THE NEW GRANT WILL SUPPORT EFFORTS TO:

- Provide virus proteins to improve blood testing capabilities
- Assist regional hospital systems with validation of rapid in-house testing
- Identify domestic supply chains to reduce dependence on foreign suppliers of respirators and protective masks
- Validate decontamination approaches for clinical spaces
- Develop automated contact tracing technology within pharmaceutical manufacturing facilities to limit the spread of COVID-19
- Position the nation to scale up medical response to pandemics more quickly by developing flexible manufacturing capabilities for biologic therapies and rapid-release testing

The grant was made by the Department of Commerce's National Institute of Standards and Technology, part of its first round of funding through the Coronavirus Aid, Relief and Economic Security (CARES) Act.

MAJOR STEP FOR BIOPHARMA RESEARCH

NIIMBL AND FDA SIGN AGREEMENT TO SUPPORT INNOVATION IN BIOPHARMA MANUFACTURING

The University of Delaware entered into a Collaborative Research and Development Agreement with the U.S. Food and Drug Administration on behalf of the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL) in 2019.

According to the agreement, known as a CRADA, the FDA and NIIMBL have the ability to collaborate in a pre-competitive environment to strengthen research, innovation, training and collaboration in the biopharmaceutical manufacturing industry.

The CRADA will enable the FDA and NIIMBL to support investments in regulatory science research and training needed to foster advanced manufacturing innovations in areas such as continuous manufacturing, on-demand manufacturing and advanced process control technologies, among others. Ultimately, advancements in these areas will help increase NIIMBL's national impact by enhancing patient access to new and improved medicines.

"Biopharmaceuticals are more challenging to manufacture than traditional pharmaceuticals and NIIMBL seeks to enhance patient access by innovating the biopharmaceutical manufacturing technologies and processes," said Kelvin Lee, NIIMBL director and Gore Professor of Chemical and Biomolecular Engineering at UD.

"This CRADA establishes a framework for FDA engagement in NIIMBL projects and initiatives that strengthens the existing NIIMBL-FDA relationship and supports the development of advanced biopharmaceutical manufacturing innovations," Lee said.

LUNG EXPERTS TACKLING COVID CRISIS

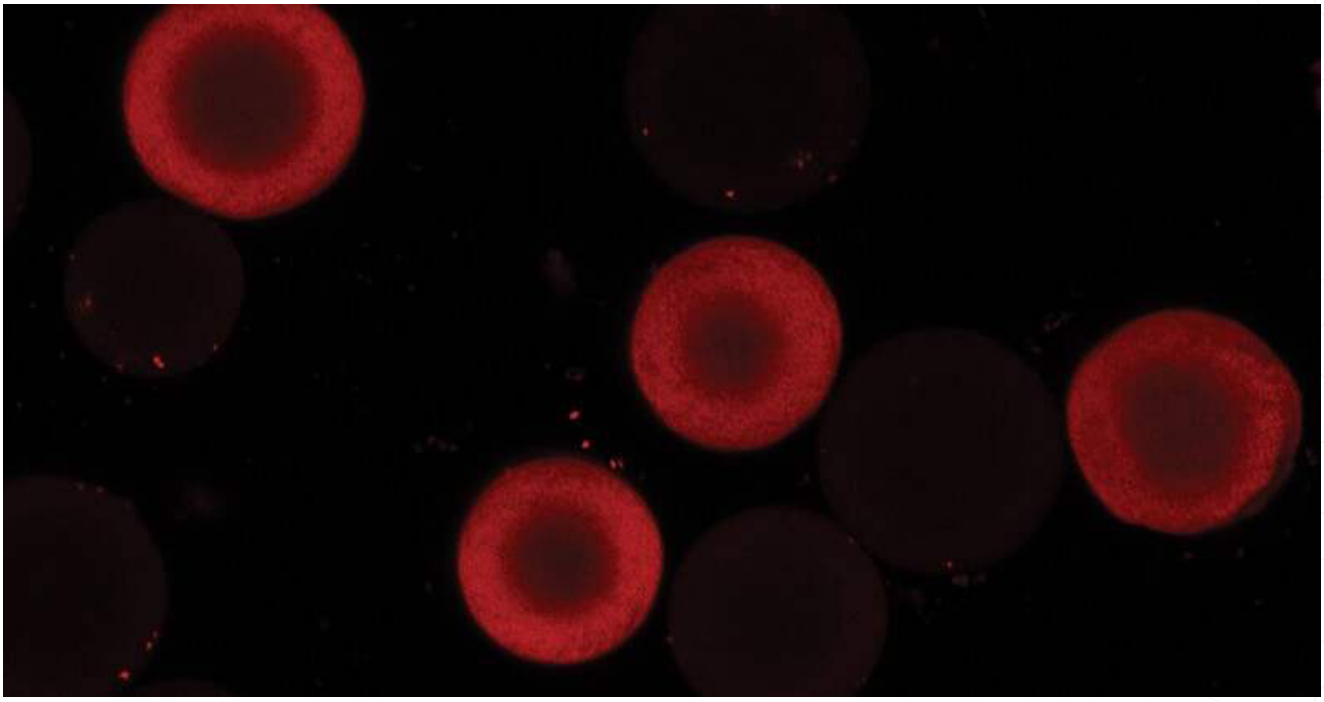
Left to right:
Cathy Fromen and Jason Gleghorn

Cathy Fromen, an assistant professor of chemical and biomolecular engineering, studies immune response in lungs, and Jason Gleghorn, an associate professor of biomedical engineering, studies how lung tissue develops.

In the age of COVID-19, a disease that ravages lung tissue, their work—and burgeoning collaboration—is more important than ever.

This team received a six-month, $40,000 grant to develop an inhalable microparticle system for the sequestration of SARS-CoV-2 virus within the lung airspaces through the Delaware Clinical and Translational Research Program (DE-CTR) ACCEL's COVID-19 Rapid Science Grant Program.

Fromen, Gleghorn, associate professor of biomedical engineering Ryan Zurakowski, biomedical engineering doctoral students Jasmine Shirazi and Michael Donzanti, and chemical engineering doctoral student Katherine Nelson co-authored a review and perspective paper in the journal Cellular and Molecular Bioengineering that highlighted questions surrounding SARS-CoV-2, the virus responsible for COVID-19, including temporal immune dynamics, infection of non-pulmonary tissue, early life exposure, and the role of circadian rhythms. The team also explored risk factors and discussed how bioengineering approaches can be employed to help understand COVID-19.



A NEW UNDERSTANDING OF PROTEIN MOVEMENT

UD ENGINEERS UNCOVER ROLE OF SURFACE DIFFUSION IN PROTEIN TRANSPORT, WHICH COULD AID BIOPHARMACEUTICAL PROCESSING

A team of engineers has shown that surface diffusion in protein transport into ion-exchange beads depends on adsorption affinity — a measure of attraction between the two materials.

Many of the most promising medicines under development are proteins, often antibodies, to help patients fight disease. These proteins must be purified as part of the manufacturing process — a task that can be tricky and result in costly waste.

Scientists have struggled to directly measure the movement of proteins, known as protein diffusion, in materials that include both solid and liquid components. They have also disagreed on how movement at the surface of the material contributes to protein movement when using ion-exchange chromatography, a laboratory and manufacturing method for separating materials based on their charge. Proteins can creep into the pores of resin beads used to perform ion-exchange chromatography and bind on the walls, based on charge.

Now, a team of engineers from the University of Delaware, with a collaborator from pharmaceutical company Amgen, has shown that surface diffusion in protein transport into ion-exchange beads depends on adsorption affinity — a measure of attraction between the two materials. By exploiting this relationship, the team developed a procedure to purify a monoclonal antibody — a type of molecule that mediates immunity — with productivity 43% higher than usual.

The team's results were published in the Proceedings of the National Academy of Sciences in March. The paper's authors include Ohnmar Khanal, a doctoral student in chemical engineering; Vijesh Kumar, postdoctoral fellow in chemical engineering; Fabrice Schlegel, a principal engineer at Amgen; and Abraham Lenhoff, Allan P. Colburn Professor of Chemical Engineering.

A NEW SCIENTIFIC INSTRUMENT FOR THE NATION

UD TAPPED TO LEAD DEVELOPMENT OF WORLD-CLASS NEUTRON RESEARCH INSTRUMENT

The University of Delaware has been tapped to lead the development of a world-class neutron spin echo spectrometer for the United States. This scientific instrument will advance U.S. research on countless materials important to humanity, from new medicines to more powerful batteries.

Norman Wagner, the Unidel Robert L. Pigford Chair in Chemical and Biomolecular Engineering and director of the Center for Neutron Science, will lead the project, which is funded by an $11.8 million grant from the National Science Foundation.

It was among the first awards in NSF's Mid-Scale Research Infrastructure program, announced Sept. 17, 2019.

Wagner will work together with colleagues at the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland, and at the University of Maryland to elevate the nation's best neutron spin echo spectrometer, housed at NIST, to world-class status, boosting research in engineering, soft matter such as gels and polymers, and the biological sciences.

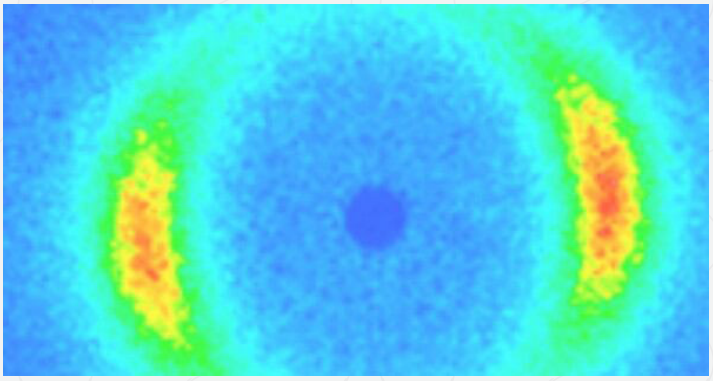
The upgraded instrument, which will become part of the Center for High Resolution Neutron Scattering, a national research facility at NIST, will allow scientists to see how molecules are moving through things, whether it's the proteins in a biopharmaceutical drug or the molecules that trap salt rather than let the water flow through a water purification membrane. These motions, viewed over a few hundred nanoseconds, may sound minuscule, but they can affect the properties of a material in critical ways, Wagner said.

Formerly, scientists believed the structure of a material gave it its function — that was more of a three-dimen-

The University of Delaware will lead the development of a world-class neutron spin echo spectrometer, which will be installed at the National Institute of Standards and Technology's Center for Neutron Research, shown here.

sional way of looking at the world. But 21st-century thinking is in 4D – where time provides the fourth dimension, as structure is dynamic. Wagner's French colleagues refer to it as "4D structuration," and Wagner, who collaborates with neutron researchers around the world, is eager to move the concept forward

"During the next five years, UD, NIST and Maryland will be working together to engineer this new tool for scientific discovery," Wagner said. "And our UD students will be part of it, preparing the scientific community for this awesome new instrument that will be equal to, or better than, the best in the world."



This image was obtained during a neutron scattering experiment.

CELEBRATING THE PROMISE OF NEUTRONS

October 30, 2019 was Neutron Day at the University of Delaware. Over 100 scientists and students from across UD, the National Institute of Standards and Technology (NIST), and nearby local universities and industries gathered at UD for a symposium that included technical presentations, posters, and networking.

Key themes of the meeting included the use of neutron spin echo scattering instrumentation to solve grand challenge problems in soft matter science and biology, as well as the use of neutron scattering more broadly to aid scientists and engineers in their research that is developing advanced medicines, advanced nanocomposite materials, and sustainable energy production.

Feng Jiao is the Robert Grasselli Development Professor of Chemical and Biomolecular Engineering at the University of Delaware.

ADVANCES IN CARBON UTILIZATION

In an effort to develop sustainable solutions to humanity's energy needs, many scientists are studying carbon capture and utilization — the practice of using excess carbon dioxide in the atmosphere or from point sources, instead of fossil fuels, to synthesize chemicals used to make everyday products, from plastics to fuels to pharmaceuticals.

Feng Jiao, Robert Grasselli Development Professor of Chemical & Biomolecular Engineering, is a leader in the field of carbon capture and utilization. Now, he and his colleagues have made a new discovery that could further advance carbon capture and utilization and extend its promise to new industries.

In the journal Nature Chemistry, Jiao and collaborators from the California Institute of Technology, Nanjing University (China), and Soochow University (China) describe how they formed carbon-nitrogen bonds in an electrochemical carbon monoxide reduction reaction, which led to the production of high-value chemicals called amides. These substances are useful in a variety of industries, including pharmaceuticals.

The team is the first to do this. "Now, starting with carbon dioxide as a carbon source, we can expand to a variety of products," said Jiao, who in July 2020 became the director for UD's Center for Catalytic Science and Technology (CCST).

Also, in a perspective paper published in Nature Catalysis, Jiao and colleagues described the state of carbon monoxide electroreduction technology and described device designs that could push the field forward. The team, which includes Matthew Jouny, a graduate student in chemical engineering, and Gregory S. Hutchings, a Postdoctoral Innovation Fellow at UD's Horn Entrepreneurship, also performed an original economic and life cycle analysis, which shows how a two-step conversion from captured carbon dioxide to chemicals can be both profitable and sustainable.

"Electrochemical carbon monoxide reduction should be considered as a key technology for carbon utilization because of the technological and economical advantages over direct CO2 electrolysis," said Jiao.

If brought to full production scale for just two potential end products, ethylene and acetic acid, the complete system, powered by renewable energy, could save up to 200 million metric tons of carbon dioxide per year from ending up in the environment, as well as dramatically reducing dependence on oil and natural gas in the chemical industry.

Jiao and Hutchings founded a startup company, Lectrolyst, that is turning this chemical synthesis platform into commercially-ready devices.

NEW TWIST ON CRISPR TECHNOLOGY

WILFRED CHEN, EMILY BERCKMAN TWEAK GENE RESEARCH PROCESS

In a two-year collaboration, two UD researchers aimed to improve an assembly-line process that could be helpful in producing such things as pharmaceuticals and biofuels.

Wilfred Chen, the Gore Professor of Chemical Engineering, and Emily Berckman, a doctoral student in the Department of Chemistry and Biochemistry, published their method in *Chemical Communications*.

The collaboration was expedited by the Chemistry Biology Interface Program, which is sponsored by the National Institutes of Health. Funding also came from the National Science Foundation.

The goal of their work was to engineer a more efficient method of producing certain biochemical reactions in cells — specifically, the way enzymes work together to promote those changes in the cells.

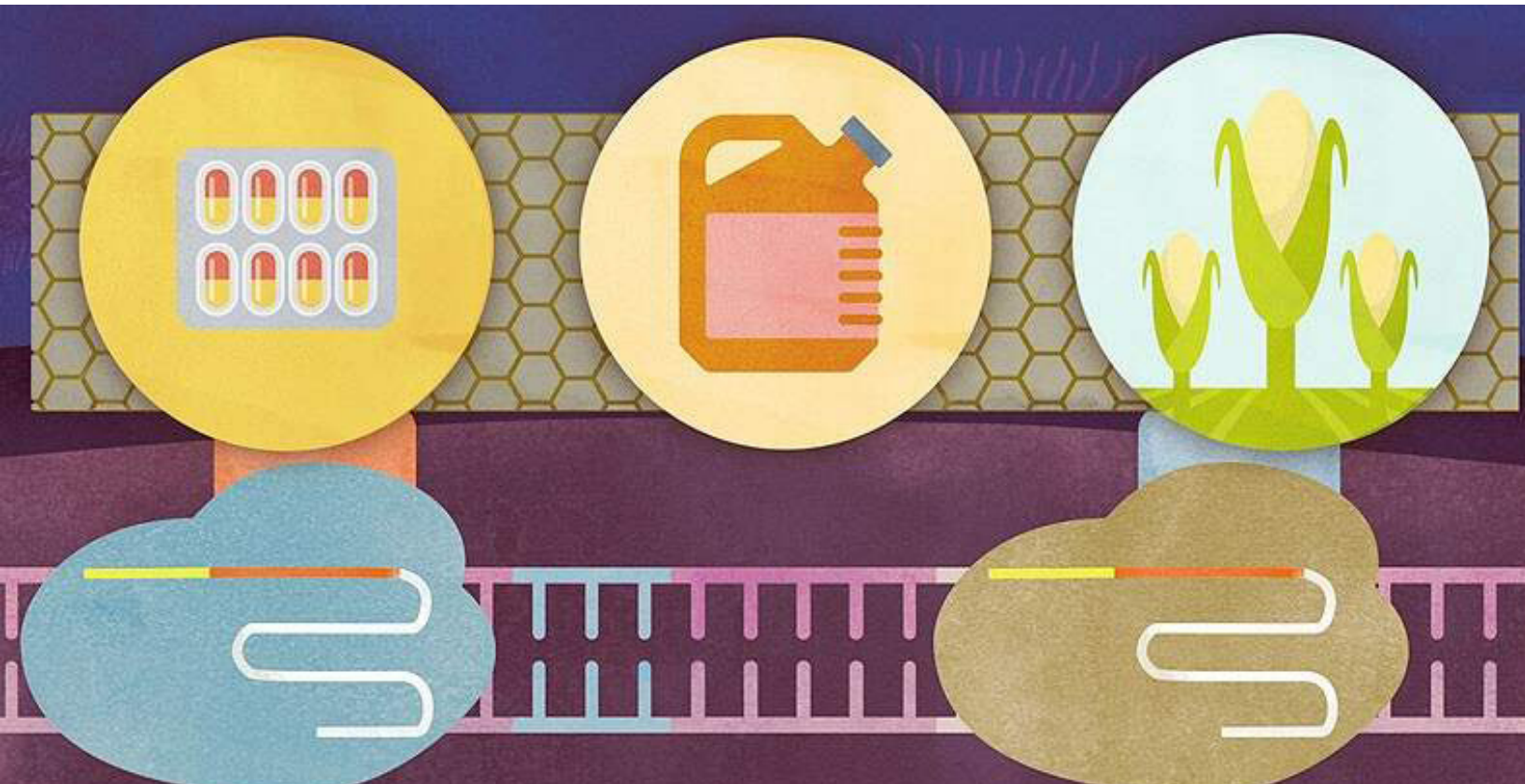
Imagine a relay team at a track meet, with one member of the team after another advancing the baton and passing it along to the next as they move toward the finish line. Enzymes do some of their work that way within cells, working as catalysts to speed up reactions and pass that new product along to the next enzyme. In this case, the "batons" are the products of these reactions, changing between each handoff. So enzyme No. 1 modifies the baton and hands it off to enzyme No. 2, which modifies the baton and hands it off to enzyme No. 3 and so on until the desired product is achieved.

"Imagine that you want to pass a product along to the next person," Chen said. "But you are so far apart that it's hard to pass it on. If you reduce the distance between the different partners, you get better efficiency and accuracy and you reduce competition."

In nature, enzymes often gather in groups to do this collaborative work in closer proximity, using protein-based scaffolds as their gathering place and producing a "cascade" of biochemical reactions that way.

Chen and Berckman have found an improved way to control the construction and placement of those scaffolds, as well as the cascade of reactions they produce, using the revolutionary new genetic technology known as CRISPR/Cas9.

CRISPR is an acronym (clustered, regularly interspaced palindromic repeats) that describes DNA sequences used in the immune system of certain bacterial cells.



BUILDING A FAT-FREE CELL

A dream team of scientists from across the country is building and studying synthetic, fat-free cells that could someday be used to advance biotechnology, tissue engineering and—perhaps most importantly—to further our understanding of the rules of life.

Millicent (Millie) Sullivan, a professor of chemical and biomolecular engineering, is part of the transdisciplinary team, which also includes researchers from Arizona State University, Michigan State University, Penn State University, the University of California at Santa Barbara and the University of Minnesota-Twin Cities. Sullivan will contribute her expertise in biomaterials and tissue engineering, especially in peptide design and assembly and subcellular processing mechanisms.

The research team received a $3.9 million grant from NSF in September 2019. Their work will continue through August 2022.

The team is building cells without lipids, using polypeptides in their place. Polypeptides can assemble into large proteins, act as enzymes to catalyze chemical reactions and more. The team aims to use polypeptides to assemble and compartmentalize cells and also to replace the lipid bilayer.

These fat-free cells, once realized, could be useful in biotechnology and tissue engineering applications, said Sullivan.

Importantly, this fundamental research will also allow scientists to discover new insights about how cells come together.

"These synthetic cells could eventually allow one to mimic things like bacterial cell communities, enabling us to more systematically test how specific membrane components affect their organization and collective behavior," said Sullivan.

ADVANCING FUEL CELL RESEARCH

UD STARTUP W7ENERGY AWARDED $3.4M IN DEPARTMENT OF ENERGY FUNDING

W7energy, a startup company with roots at the University of Delaware, was recently awarded $3.4 million in new funding from the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) to advance and commercialize a new class of polymer membranes that will make fuels cells much more economical.

Coupled with an additional $1 million private investment, W7energy's research could bring zero-emission fuel cell electric vehicles within reach. Already, the startup's technology is projected to be one-third less expensive than traditional fuel cell systems.

The polymer membranes are a platform technology that will enable many other technologies, too, for clean hydrogen production, battery storage, removing carbon dioxide from the air and more.

W7energy grew out of UD-developed technology from the lab of Yushan Yan, Henry B. du Pont Chair of Chemical and Biomolecular Engineering.

AMMONIA FOR FUEL CELLS

PUSHING COST-EFFECTIVE FUEL CELL TECHNOLOGY FORWARD

UD researchers are working on technology to make fuel cells cheaper and more powerful so that fuel cell vehicles can be a viable option for all someday. Traditional fuel cell research involves hydrogen fuel cells, but the UD researchers are engineering fuel cells that utilize ammonia instead.

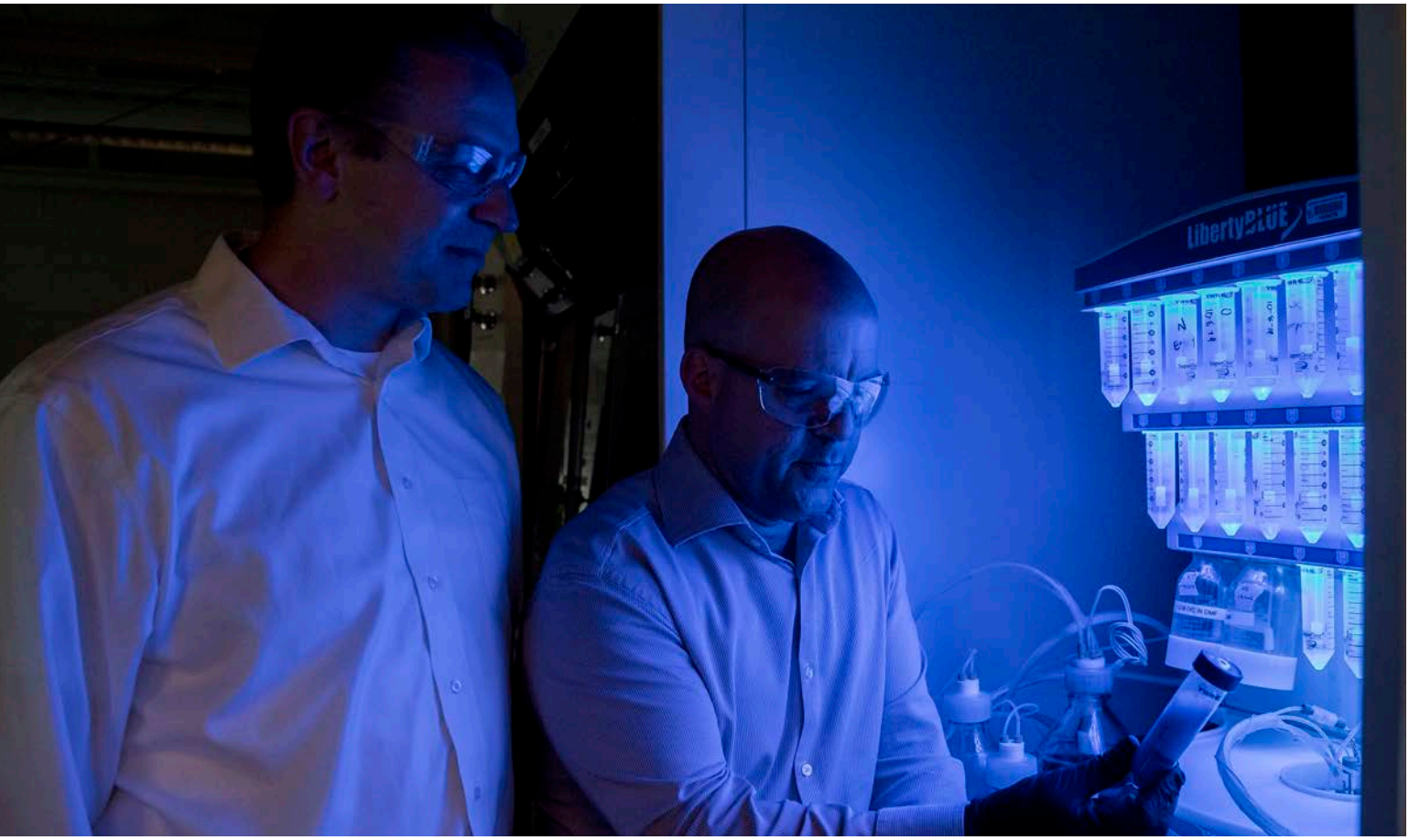
In an analysis published in *Joule*, the team found that among fuels produced from renewable energy, ammonia has the lowest cost per equivalent gallon of gasoline.

"As a nitrogen-based liquid fuel, ammonia is cheaper to store and distribute than hydrogen and avoids the carbon dioxide emissions of other liquid fuels, which are expensive to capture" said Brian Setzler, one of the lead authors and a postdoctoral associate at UD.

The challenges, however, are that ammonia does not work in a proton exchange membrane fuel cell; and that ammonia is more difficult to oxidize than hydrogen, which causes ammonia fuel cells to produce less power than hydrogen fuel cells. The team solved the first problem by using hydroxide exchange membrane fuel cells that have been studied for over a decade in the lab of Yushan Yan, a Distinguished Engineering Professor at UD. Assisted by a $2.5 million grant from the REFUEL program of the Advanced Research Projects Agency-Energy (ARPA-E) in the U.S. Department of Energy, the UD team engineered a fuel cell membrane that can operate at higher temperatures to speed up ammonia oxidation. They also identified catalysts that were not poisoned by ammonia.

"With these improvements, we have demonstrated a new direct ammonia fuel cell prototype with a peak power density of 135 milliwatts per square centimeter, which closes much of the performance gap compared to hydrogen," said research associate Yun Zhao, the lead author of the paper who has been working on direct ammonia fuel cells since 2016.

The research team, all from UD's Department of Chemical and Biomolecular Engineering, also includes research associate Junhua Wang, recent doctoral graduate Jared Nash, postdoctoral associate Teng Wang, assistant professor Bingjun Xu, and Distinguished Engineering Professor Yushan Yan.



BUNDLEMERS

NEW POLYMER UNITS CREATED BY UD, PENN RESEARCHERS COULD ENABLE MATERIALS BREAKTHROUGHS

"These are tools for anybody to use, whether you're a chemist, engineer, or physicist," said Darrin Pochan (right), chair of the Department of Materials Science and Engineering at UD. "It's hard to think of an equivalent material or experimental tool people use widely. It's like a toolbox for anybody to design future things."

A team of researchers from the University of Delaware and the University of Pennsylvania, with primary support from the U.S. Department of Energy Biomolecular Materials Program, has created a new fundamental unit of polymers that could usher in a new era of materials discovery.

The researchers designed and created rigid, self-assembling, customizable polymer chains by linking together new building blocks called bundlemers — a term coined at UD. They described their work in the journal Nature.

To create bundlemers, the team assembles four individual peptides, themselves short chains of amino acids, into nanoscopic cylinders. The bundlemer cylinders are then linked together, end-to-end, through a highly efficient and controlled series of chemical reactions known as "click" chemistry. The resulting polymer chains are rigid, rod-like molecules that are based in biology yet do not exist in nature. Bundlemer chains can then be modified with components such as synthetic polymers or inorganic nanoparticles to create new hybrid nanomaterials.

"There's a basic premise in materials that if you can control function and structure, then you can essentially build anything," said Chris Kloxin, study author and assistant professor of materials science and engineering and chemical and biomolecular engineering at UD. "We have a very well-defined structural unit, this bundlemer, upon which we have the ability to add chemical functionality at any location."

Because of their rigidity and customizability, bundlemers could be used to design new materials with a wide range of applications, from high-performance fibers to single-use plastics to biologics, medicines that employ biological components instead of traditional chemistries. The rigidity of bundlemers could also make these materials useful as substitutes for famously strong materials such as the steel in bridges, the silk in parachutes or the Kevlar in bulletproof vests.

University of Delaware chemical and biomolecular engineering professor and chair Eric Furst and a team of researchers from the Ecole des Ponts and University Paris-Est in France have discovered a process called contact-controlled aging that explains some age-related changes in paste materials.

WHY TOOTHPASTE AND CEMENT HARDEN OVER TIME

UD ENGINEER PART OF INTERNATIONAL COLLABORATION THAT EXPLAINS AGING IN PASTE MATERIALS

Many paste materials, also known as dense colloidal suspensions, stiffen as they age. Structural dynamics, or changes in the loads the materials undergo over time, are partly responsible for this change, but for decades, experts have suspected that there's more going on inside these materials.

Now, chemical and biomolecular engineering professor and chair Eric Furst and a team of researchers from the Ecole des Ponts and University Paris-Est in France have discovered a process called contact-controlled aging that explains some age-related changes in paste materials.

They found that contacts form between particles, stabilizing the microstructure of these materials. Then, those contacts stiffen, increasing the stiffness of the materials.

The team described their findings in a paper published in the journal Nature Materials.

"When people think about aging in materials and the mechanical properties of materials as they age, especially in rheology or the study of how things flow, this mechanism has been overshadowed by changes in the organization, or microstructure, of the material," said Furst.

Not only are the findings novel, they are likely to prove useful. By understanding how materials age, the people who use them can design better ways to predict and mitigate unwanted changes in materials performance. The experiments closely tie the chemistry of the particle surfaces, which can be tailored by chemical reactions or with additives like surfactants and polymers, to the bulk material properties.

APRIL KLOXIN WINS NIH DIRECTOR'S NEW INNOVATOR AWARD

Professor receives grant to accelerate the study of lung fibrosis

April Kloxin, Centennial Career Development Professor of Chemical and Biomolecular Engineering and associate professor of materials science and engineering, has been awarded a National Institutes of Health (NIH) Director's New Innovator Award from the NIH Common Fund's High-Risk, High-Reward Research program, which supports highly innovative research proposals.

With this five-year grant award, Kloxin aims to develop next-generation materials and tools to accelerate research in idiopathic pulmonary fibrosis—an incurable, fatal disease that leaves people with difficulty breathing and progressive lung scarring.

Kloxin's research group works at the interface between engineering, materials and biology and aims to push multiple fields forward in both the design and application of new molecular tools. Kloxin will use her expertise to uncover insights about the intractable problem of idiopathic pulmonary fibrosis, which affects more than 3 million people globally. About two-thirds of patients with this disease die within five years of diagnosis, and while existing pharmaceutical treatments for lung fibrosis can slow down the disease, there is no cure. Despite its devastating effects, the causes of idiopathic pulmonary fibrosis are still undetermined.

CATHY FROMEN SELECTED FOR NAE SYMPOSIUM

National Academy of Engineering event recognizes bright young engineers

Catherine (Cathy) Fromen, assistant professor of chemical and biomolecular engineering, was among 82 of the nation's brightest young engineers selected to participate in the National Academy of Engineering's (NAE) 25th annual U.S. Frontiers of Engineering (USFOE) symposium in 2019.

Early-career engineers who are performing exceptional engineering research and technical work in a variety of disciplines came together for the event, held from Sept. 25-27, 2019 in North Charleston, South Carolina. The participants — from industry, academia, and government — were nominated by fellow engineers or organizations.

Fromen seeks to advance understanding of the unique environment of the airways, from fluid dynamics to mucosal immunology. This will lay the foundation for the development of new therapeutics and analytical tools to treat a range of diseases specific to the lungs. In 2018, Fromen was named to the ACS Biomaterials Science and Engineering's Inaugural Early Career Editorial Board. Fromen joined UD in 2017 after a postdoctoral fellowship at the University of Michigan. She holds a doctoral degree in chemical engineering from North Carolina State University and a bachelor's degree in chemical engineering from the University of Rochester.

HONOR FOR LASHANDA KORLEY

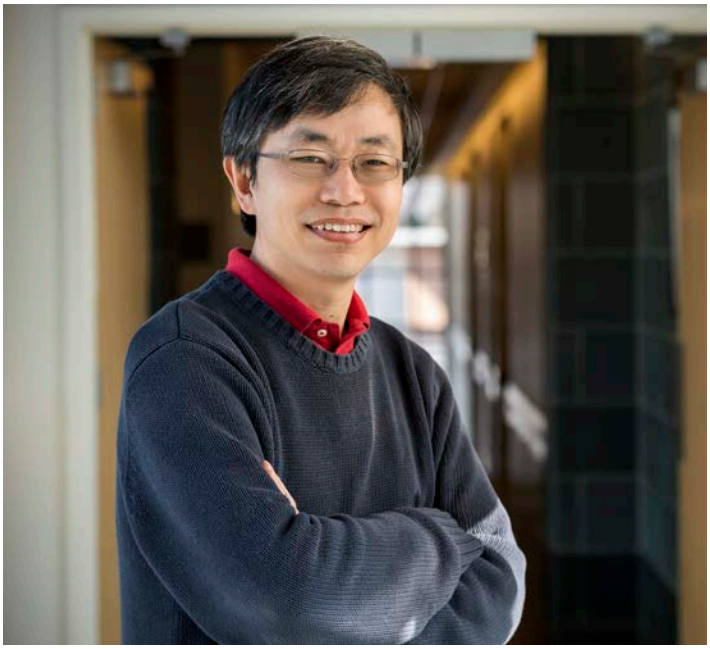
Professor named Fellow of American Institute for Medical and Biological Engineering

For outstanding contributions to bio-inspired materials design and manufacturing, Korley, Distinguished Associate Professor of Materials Science and Engineering and Chemical and Biomolecular Engineering at the University of Delaware, has been named to the College of Fellows of the American Institute for Medical and Biological Engineering (AIMBE).

Election to the AIMBE College of Fellows is among the highest professional distinctions accorded to a medical and biological engineer. The College of Fellows consists of the top two percent of medical and biological engineers. Korley is one of 156 new Fellows being inducted in 2020.

Korley leads a laboratory that focuses on the study of soft matter, polymers and bio-inspired materials — materials with properties like those found in nature.

Korley is well recognized as a leader in her field and received the 2019 Lloyd N. Ferguson Young Scientist Award for Excellence in Research from the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE).



HONORS FOR YUSHAN YAN

Professor honored by Electrochemical Society, American Institute of Chemical Engineers

Yushan Yan, the Henry B. du Pont Chair in Chemical and Biomolecular Engineering at the University of Delaware, was named a Fellow of The Electrochemical Society and received the Braskem Award for Excellence in Materials Engineering and Science from the American Institute of Chemical Engineers (AIChE).

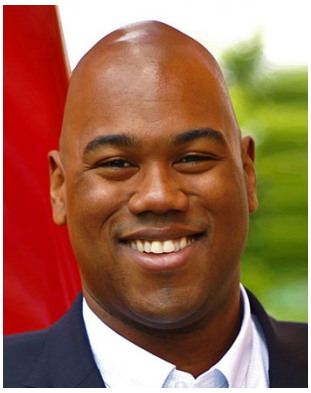
Fellows of The Electrochemical Society are recognized for advanced individual technological contributions in the fields of electrochemistry and solid state science and technology and service to the Society. Each year the society selects up to 15 fellows.

The Braskem Award for Excellence in Materials Engineering and Science is bestowed annually by AIChE to a leading researcher in recognition of outstanding contributions to the field of materials science and engineering.

Yan is an expert in electrochemistry and electrochemical energy engineering, the study and application of conversion between electrical current and chemical reactions. Much of his work focuses on the study of fuel cells. Yan leads and contributes to multiple projects funded by the Department of Energy.

NEW FACULTY

NEW HIRES JOINING IN 2021 BOLSTER RANKS IN SOFT MATTER, SYNTHETIC BIOLOGY



The University of Delaware Department of Chemical and Biomolecular Engineering will add three new faculty members in 2021: Alexandra Bayles, Mark Blenner, and Kevin Solomon

ALEXANDRA BAYLES

Bayles, a postdoctoral research fellow at ETH Zürich in Switzerland, is an expert in soft matter. She is currently pushing the boundaries of fractal processing, a fluidic technique used to structure soft materials.

"The basic idea of fractal processing is to use pressure-driven flows to repeatedly divide, rotate and recombine fluid streams so that you multiply the interfacial contact between different fluids while preserving their spacing and orientation," she said.

Fractal processing has been used to structure polymeric melts, but Bayles is working on adapting it for complex fluids and gels, which would enable improved control over the internal hierarchy and the characteristic size of products derived from these materials. This work could have applications in a variety of industries, such as food processing and 3D printing.

Bayles is joining UD's faculty because of the strength of the Department of Chemical and Biomolecular Engineering. The department's reputation also led her to Newark, Delaware back in 2009, when she joined UD as an undergraduate chemical engineering student. She did undergraduate research with Professor (and now-Department-Chair) Eric Furst and parlayed a summer internship with Procter & Gamble into a multi-year collaboration that resulted in two patents.

"UD is special—it is where I first concretely understood how advances in fundamental science facilitate new technology. I am thrilled to be joining a faculty with such expertise, creativity, and innate drive to continue that cycle of innovation," she said.

After graduating from UD in 2013, Bayles went to the University of California Santa Barbara, where she completed a doctoral degree in chemical engineering as an NSF Graduate Research Fellow in 2018.

KEVIN SOLOMON

Solomon, an assistant professor at Purdue University, is an expert in systems & synthetic biology and biomanufacturing.

He is working to utilize fungi found naturally in the guts of herbivorous mammals to break down renewable, sustainable materials for use

in new biomanufacturing processes. These fungi help animals such as horses, goats and sheep digest tough grasses and could be used in lieu of harsh chemicals or high-temperature processing methods to break down hardy plant material for new uses. Imagine making insulin from grass or gasoline from yard clippings, for example.

"My lab is interested in learning more about these non-model organisms that have this very good chemistry for breaking these things down and then very interested in developing new tools to control them so that we can manipulate them for use," said Solomon.

Solomon was drawn to UD for its reputation in chemical engineering and found that while the department's faculty are extremely productive, they are also collaborative and supportive instead of competitive and intense.

"In all my conversations with the faculty, there seems to be a very strong sense of community," he said.

Solomon received a bachelor's degree in chemical engineering and bioengineering from McMaster University in Canada in 2006, followed by a master's degree in chemical engineering practice (2008) and a doctoral degree in chemical engineering (2012) from the Massachusetts Institute of Technology.

MARK BLENNER

Blenner will join UD from Clemson University, where he is McQueen-Quattlebaum Associate Professor of Chemical and Biomolecular Engineering and a Visiting Scientist at NASA Ames Research Center. He was recently recognized with the Presidential Early Career Award for Scientists and Engineers (PECASE), the South Carolina Governor's Young Scientist Award for Excellence in Scientific Research and a DARPA Young Faculty Award.

Blenner will bring with him a Department of Energy grant to accelerate biomanufacturing by addressing common challenges in the reliability of industrial yeast fermentation, which is important for a wide range of products. The grant is part of the Agile BioFoundry consortium to conduct research and development that will accelerate the US biomanufacturing sector.

Yeast fermentation is a critical step in manufacturing a variety of products. Through the process of fermentation, yeast transforms sugars into alcohol and carbon dioxide; however, Blenner engineers yeast to use sugar and other lower value substrates to make a wide range of products beyond alcohol.

When yeast fermentation is used at an industrial scale, multiple challenges come into play. One problem is the loss of productivity – that the cells begin to make less product as the process scales, said Blenner. One reason this happens is genetic instability, and through the grant, Blenner will explore root causes of this genetic instability that arise from strain engineering, the process of designing efficient strains of yeast.

"We hope that by better understanding how genetic instability arises we can develop new strain engineering strategies less prone to productivity loss," said Blenner. "That would greatly speed and de-risk bioprocess development."

Blenner received a bachelor's degree in chemical engineering from Manhattan College in 2004, followed by a doctoral degree in chemical engineering (2009) from Columbia University.

EXCELLENCE THROUGH GIVING

Generous donations from alumni can help UD attract and retain talented faculty. Chemical engineering alumnus John Witheford established the John M. Witheford Faculty Recruitment Fund to help recruit faculty like Mark Blenner.

After graduating from UD in 1951, Witheford began a four-decade career with a major chemical company.

He fondly remembers how his UD professors, including the late Dr. Jack Gerster and the late Dr. Robert Pigford, helped him grow and learn.

Dr. Gerster taught Witheford's first chemical engineering course.

"He had a broad range of interests and from him I learned that with a rudimentary understanding of physical and chemical principles most problems could be solved by common sense and perseverance," said Witheford.

Dr. Pigford was the head of the department and in the summer of Witheford's junior year, when his own work plans went awry, Dr. Pigford employed Witheford to assist graduate students in data collection.

"Both professors I admired and respected," said Witheford. "They gave me lots of encouragement, most important for a youth."

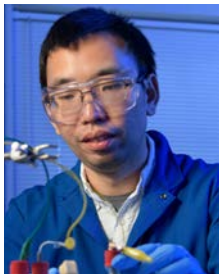
It is in appreciation of that and in the hope that it will always be so that Witheford made his contribution.

FACULTY HIGHLIGHTS












Joshua Enszer, associate professor, received the 2020 AIChE-DVS Outstanding Faculty Award.

Thomas H. Epps, III, Thomas and Kipp Gutshall Professor Chemical & Biomolecular Engineering and Materials Science & Engineering, received the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE) 2020 Percy L. Julian Award.

Catherine Fromen and Aditya Kunjapur, both assistant professors, were named to AIChE's 35 Under 35.

Shimshon Gottesfeld, an adjunct professor of chemical and biomolecular engineering and a member of the Center for Catalytic Science and Technology at the University of Delaware, received the 2019 Olin Palladium Award from the Electrochemical Society (ECS).

Arthi Jayaraman, Centennial Term Professor for Excellence in Research and Education, was named a Fellow of the American Physical Society.

Feng Jiao, Robert Grasselli Development Professor of Chemical and Biomolecular Engineering, was named a Scialog Fellow.

April Kloxin, Centennial Development Professor of Chemical and Biomolecular Engineering and Materials Science and Engineering, was named 15D/E Plenary Speaker of the Awards Symposium (Plenary Session) of Division 15 at the 2020 AICHE meeting

Raul Lobo, the Claire D. LeClaire professor of Chemical and Biomolecular Engineering, received the 2020 Catalysis Club of Philadelphia Award.

Terry Papoutsakis, Unidel Eugene du Pont Chair of Chemical and Biomolecular Engineering, received the 2020 American Society for Microbiology (ASM) National Award in Biotechnology.

Dionisios Vlachos, Allan & Myra Ferguson Endowed Chair Professor of Chemical and Biomolecular Engineering, received the Irving Wender Award for Excellence in Catalysis from the Pittsburgh-Cleveland Catalysis Society.

Norman Wagner, Unidel Robert L. Pigford Chair in Chemical Engineering, received the Francis Alison Award, UD's highest faculty honor.

MATERIALS TODAY

Poly(ethylene oxide) crystallite growth during solvent vapor annealing in block polymer thin films

–Kayl A. Lantz and Thomas H. Epps, III

ACS SUSTAINABLE CHEMISTRY & ENGINEERING

Aromatics from Lignocelluslosic Biomass: A Platform for High-Performance Thermosets

–Jignesh S. Mahajan, Robert M. O'Dea, Joanne B. Norris, LaShanda T. J. Korley, and Thomas H. Epps III

JOURNAL OF RHEOLOGY

Experimental test of a frictional contact model for shear thickening in concentrated colloidal suspensions

–Yu-Fan Lee, Yimin Luo, Scott C. Brown, and Norman J. Wagner

GOLDWATER SCHOLAR

LUCAS ATTIA RECOGNIZED FOR EXCEPTIONAL PROMISE

Undergraduate Lucas Attia has received the Goldwater Scholarship, one of the most prestigious scholarships in the natural sciences, engineering and mathematics in the United States.

Attia was recognized for his promise to become a leader in industrial pharmaceutical research. Attia has already demonstrated extraordinary potential in this area as an undergraduate researcher in the laboratory of Assistant Professor Cathy Fromen, where he studies aerosolized nanoparticle drug carriers, tiny particles that could deliver medicine to lung tissue in people afflicted with respiratory diseases.

"The Goldwater Scholarship is all about identifying really exceptional undergraduate researchers, and that's him to a T," Fromen said of Attia.

Attia joined Fromen's lab during the fall of 2017, his first semester at UD. It was Fromen's first semester at UD, too, and Attia was intrigued by Fromen's work in drug delivery and pharmaceuticals to treat lung diseases. He was drawn to the opportunity to improve lives and maybe even save them through research.

Within his first year, Attia began working on a project to characterize tiny metal organic framework nanoparticles and found that the tiny particles displayed unexpected fluorescence. There was a background spectrum of light the team hadn't expected to see.

"Then he kind of dove into why this happens, which has to do with the molecular orientation of the ligands and how electrons are moving around within this confined nanoparticle space," said Fromen. "Having not taken physical chemistry, quantum physics, or organic chemistry at that point, it was very outside the scope of what you would expect an undergraduate to do."

Attia was a co-author on a paper about this phenomenon that was published in 2019 in the journal Chemistry of Materials.

Before the pandemic temporarily closed the research lab, Attia was synthesizing more tiny particles and then studying how they would behave while carrying medicine in a model human lung.

This is the kind of experience he came to UD's world-renowned chemical engineering program for. When he graduates in 2021, Attia plans to pursue a doctoral degree.

"The chemical engineering curriculum really instills in you a strong work ethic, which is something I'm going to carry with me forever," said Attia. "Even if I don't use all of the information I learned, I'm always going to use that work ethic."

HELPING STUDENTS SUCCEED

SCHOLARSHIPS BOLSTER THE FUTURE OF CHEMICAL ENGINEERS

A retired mathematics professor and Director of the STEM Center at DePaul University, Lynn Colburn Narasimhan devoted much of her career to supporting women and underrepresented minorities in STEM fields. It's something she has been passionate about since her own days as a student studying mathematics. "When I came through, it seemed to me there was a kind of belief that some people were born good in science and math, and most people weren't, and the people who weren't eventually dropped out," she said. "And I think that there's been plenty of research now, in pedagogy, in learning, in cognitive science, in social psychology, that shows us that all people should have the opportunity to learn and can learn, and so it's really on us to make sure that the opportunities are there, and to make sure that we are providing those opportunities with a big focus on access and on changing the way we do things so that we don't inadvertently give people the message that they don't really belong in these fields."

Narasimhan has promoted STEM success through her work as well as through philanthropy, and she has chosen the University of Delaware Department of Chemical and Biomolecular Engineering as a recipient of her generous support. Narasimhan's family has a strong connection with the department—her father was renowned chemical engineer Allan P. Colburn. Dr. Colburn joined UD's chemical engineering department in 1938 and established an extensive research program, laying the foundation for the department's long-standing excellence in research. The department's home in Colburn Hall, which is named for the late Dr. Colburn.

In honor of her father, Narasimhan has funded scholarships for five undergraduate chemical engineering students at UD, including two first-year students, a sophomore, and two seniors.

It's rewarding to hear from students who are succeeding in part because of her contribution, and she looks forward to meeting then in person someday when COVID-19 subsides.

NSF GRADUATE RESEARCH FELLOWSHIPS

THE NATIONAL SCIENCE FOUNDATION (NSF) GRADUATE RESEARCH FELLOWSHIP PROGRAM (GRFP) HAS AWARDED FELLOWSHIPS TO TWO UD CHEMICAL ENGINEERING DOCTORAL STUDENTS.

Since 1952, the NSF has received more than 500,000 applications and funded more than 50,000 fellowships. Recipients have gone on to win 42 Nobel Prizes, while more than 450 awardees have become members of the National Academy of Sciences.

Focusing on electrochemical hydrogen production through water electrolyzers, Alexandra Oliveira is working on a pure water hydroxide exchange membrane electrolyzer that balances the low-cost benefits of alkaline water electrolyzers and the high performance configuration of proton exchange membrane electrolyzers. Oliveira plans to explore precious metal-free catalysts and membrane electrode assemblies to optimize cell performance and durability.

"Electrochemical engineering is a very interesting approach to the energy crisis," said Oliveira. "Hydrogen, in particular, has many unique benefits as an energy storage technology because it can be transported across continents and stored for long periods of time before being used in fuel cells. Perhaps more importantly, it can be used as a feedstock for many industrial processes, such as ammonia synthesis and steel refining, to replace more environmentally detrimental feedstocks. I find the use of the chemical engineering principles of thermodynamics, kinetic and transport together to provide solutions to energy problems very fascinating."

Yushan Yan, Henry B. du Pont Chair of Chemical and Biomolecular Engineering, is her research adviser.

"The University of Delaware has provided me with excellent resources and strong faculty in the area of electrochemical engineering and catalysis who can provide input and mentor me through my studies," said Oliveira, who earned her bachelor's degree at the University of Connecticut.

After she completes her doctorate at UD, Oliveira would like to do research and design in the field of electrochemical engineering, either for energy storage and conversion devices or in the area of electrochemical corrosion.

Brandon Vance, a chemical and biomolecular engineering doctoral student, is focusing on converting polyolefins — a type of polymer — into gasoline, jet and diesel-ranged fuels, and high-grade lubricants. His primary objective is to develop fundamental knowledge pertaining to the reaction network and catalysts that facilitate those reactions.

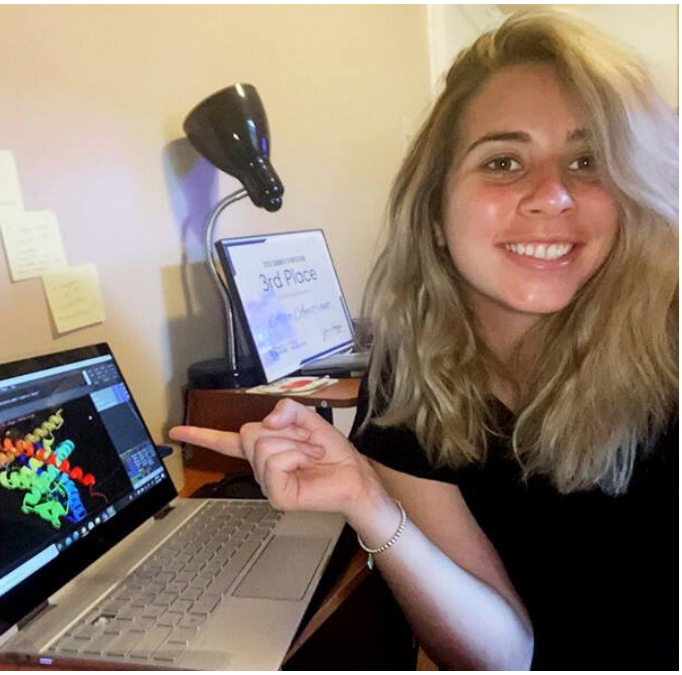
Vance is interested in this topic because it has massive impacts to society and the environment. He said many of the technical details and challenges are new and unique to the conversion of plastic wastes.

"The plastic industry is currently founded on a linear-life model where plastics are produced, then used — usually only once — and finally discarded in a landfill," said Vance. "This is a highly unsustainable practice that threatens the global environment and results in massive economic losses. Chemically recycling plastic waste is an effective solution to both of these problems because it converts the plastic-life model into a circular model while generating value from waste. However, chemical recycling is a young field with many challenges in its path to broad industrial implementation."

As an undergraduate at Iowa State University, Vance worked in the field of catalysis: a modification in the rate of a chemical reaction induced by material unchanged chemically at the end of the reaction. He participated in a NASA-funded project to develop catalysts for the generation of rocket fuel used in Mars exploration, conducted biomass conversion work as a visiting scholar in Beijing, and presented academic research to members of Congress at the Posters on the Hill conference sponsored by the Council on Undergraduate Research.

While Vance hopes to attain a chemical engineering faculty position at a high level doctoral research university, his overarching career goals are to generate knowledge capable of addressing the sustainability issues of the chemical industry and improve the diversity of STEM programs and higher education institutions.

Neil Butler, Morgan Sulzbach and Ian Woodward received honorable mentions.



PETROCHEMICAL REPLACEMENTS

UD STUDENT ALICE AMITRANO RESEARCHES PLANT-POWERED REPLACEMENTS FOR PLASTICS

Research, community service, internships and study abroad typically make summers memorable for many University of Delaware students. While the coronavirus (COVID-19) pandemic sidetracked some of these activities in 2020, UD students continued on with hundreds of remarkable projects remotely.

Alice Amitrano is a chemical engineering major from Rome, Italy. She also is working on a minor in chemistry and a minor in material science. Amitrano is on track to graduate from UD in spring 2021.

Q. What are you studying and with whom?

Amitrano: I am in the research group of Prof. Thomas Epps, III, in chemical and biomolecular engineering. My research focuses on 3D printing biobased materials derived from lignin, a complex polymer in the cell walls of plants that makes them rigid and woody. I also am investigating if these lignin-derived compounds can be suitable alternatives to BPA (bisphenol A), a chemical that's been used to make certain kinds of plastics and epoxy resins for decades. I'm assessing the toxicity of these lignin-derived compounds by modeling their binding within estrogen receptors via a molecular docking framework.

Molecular docking is a computational technique that allows me to study how two molecular structures (in my case, the biobased monomer and the estrogen receptor alpha) interact with each other. Thanks to molecular docking studies, we can analyze the toxicity of the ligand (the bonded molecule) when it interacts with the estrogen. This is really good because it all happens in silico (on the computer by simulations) and then can later be verified in vitro (experimentally).

Q. What inspired this project?

Amitrano: The inspiration for this research comes from the fact that our society needs renewable polymers to reduce the world's dependency on petrochemicals. The materials that we are studying are biobased, biodegradable, biocompatible and desirable alternatives for current materials in numerous applications in today's world.

For more, visit https://www.udel.edu/udaily/2020/august/alice-amitrano-frontiers-discovery-plants-replace-plastics/

STUDENT AWARDS

UNDERGRADUATE STUDENTS

Shannon McNaul, **Gabrielle Barone**, and **Benjamin Fisher** received the 2020 AIChE-DVS Zeisberg Laboratory Report Award.

GRADUATE STUDENTS

Zachary Stillman received UD's Saurabh A. Palkar Graduate Award for Mentoring.

Stillman and **Alana Szkodny** were named T.W. Fraser Russell Teaching Fellows.

Arijita Kulshreshrha received UD's Richard Wool Award for Women in Green Engineering.

Esther Roh, **Sam Cassel**, **Alana Szodny**, **Ian Woodward**, **Lucas Dunshee** and **Max Cohen** received TA Awards.

Bader Jarai and **Emily Kolewe** were named Department teaching fellows.

CONGRATULATIONS CLASS OF 2020

UNDERGRADUATES

Shuja Abbas
Alex Abbruscato
Nabeel Ahmad
Elizabeth Alban
Dan Anjelo Angeles
Gabrielle Barone
Alexander Barry
Andrew P. Bochnovich
Christine Marie Castagna
Michael Harrison Cerri
Wilson Chen
Justin Chernokal
Chaitanya M. Daksha
Andrew R. Dapper
Michael A. DeVito
Michael Edward Dillon
Andrew Ryan Ehmann
Benjamin Christian Fisher
Taylor N. Flynn
James Fostinis
Robert Michael Frascella
Sean Frazee
Tyler Gaeman
Alec Freeland Greco Agee
Dominick Guida
Charles S. Jabbour
Navya Jagarlamudi
Christopher William Johnson
Abhishek M. Joshi
Sean Kennedy
Alexander Legiec Kuczykowski
Zachary Thomas LaDuca
Steven R. Landes
Jacqueline Lang
Taylor Brandon Lebo
Emilia Agustina Leyes Porello
Linting Li
Emma Marie Lutus
Daniel Francis Lutz
Sean Ankit Mathur
Michael Liam McCloskey
Owen K. McNally
Shannon D. McNaul
Morgan Tyler Meyers
Kathryn Michael
Nicholas Ronald Minto
David Thomas Moglia
Nicholas Robert Monroe
Kyle Moskowitz
Sage Mosteller
Rohan Narayan
Quochung Nguyen
Ziyu Pan
Aaron Louis Parr
Daniel Pileggi
Nisha Raman
Jonathan Oliver Rego
Matthew O. Shaffer
Jeremy George Whitefield Shatley
John Arthur Sincak
Jacob Wharey Sitison
Joseph Smith
Mallory Smith
Kelly Nicole Summers
Shalini Sundar
Marisa N. Wildonger
Eric Wolfsberg
Dun Zhang
Jarrett Bender
Shan Ahmed Siddiqui

PhD Graduates

Camil C. Diaz
Thomas Gartner
Nicholas Gould
Amber Hilderbrand
Brian Oliver McConnell
Melody Morris
Jared Nash
Glenn M. Ferreira
Julia Rose Rohlhill
Hao Wang
Ziwei Cheng
Paige LeValley
Matthew Jouny
Jannatun Nayem
Katherine L. Wiley

M.Ch.E

Mohamed K. Agoub
Colleen M. Fridley
Sai Prasad Ganesh
Elvis O. Ebikade
Jason Lee
Johan Un McConnell
Akash Vaidya
Loic H. Van Hoeserlande
Hsuan-Lan Wang
Jordan Willie
Zixing Ye

WHERE DID THEY GO?

Graduate School

Stanford
University of Colorado Boulder
University of Delaware
University of Pennsylvania
University of Washington
University of Wisconsin

Industry

Agilent
Axens
ExxonMobil-Beaumont
GlaxoSmithKline
Harvard
Johns Hopkins Univ
JP Morgan
McDermott
Merck

ALUMNI SPOTLIGHT: LINDA BROADBELT

RENOWNED FOR KINETIC MODELING EXPERTISE, THIS NORTHWESTERN UNIVERSITY PROFESSOR GOT HER START IN RESEARCH AT UD

From research on biofuels to studies of polymer and nanocomposite materials, Linda Broadbelt has made a big impact on the world through chemical engineering.

Broadbelt, the Sarah Rebecca Roland Professor of Chemical and Biological Engineering and Associate Dean for Research at Northwestern University, received her doctoral degree in chemical engineering from the University of Delaware in 1994.

As doctoral student at UD, Broadbelt was advised by Michael Klein, now the Unidel Dan Rich Chair in Energy, and she developed expertise in kinetic modeling, which is used to understand the behavior of complex chemical systems.

Now, Broadbelt is one of America's most distinguished engineers in the field of kinetic modeling.

In October 2019, Broadbelt was inducted as a member 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. She was selected "for contributions to complex kinetic modeling, particularly for understanding the pathways by which hydrocarbons and polymers undergo pyrolysis," according to the NAE.

ALUMNI NOTES

'60s

LEE BROWN M'55 D'63 devotes a good deal of time these days to composing essays on intriguing topics, ranging from serious ("Scientific and Artistic Creativity") to ridiculous ("Gresham's Law of Staplers"). The number of completed essays now easily exceeds a hundred. Last year one of them earned second prize in the history class of a Prose and Poetry contest of Southwest Writers. This essay, which was reported on by UD's Alumni News, recorded a happening of universal significance that Lee witnessed and in which he was somewhat involved: "Neal Cochran, his SPPs, and the Nation's Nerve Agent Deterrence." Other essays have dealt with engaging instances during his extended periods at UD; a particular one of interest describes the serendipitous (thanks to Lee!) but seminal role played by BILL MANOGUE D'57 in the development of novel fluorine chemicals, a happening of international consequence. In pre-pandemic days Lee frequently attended University of New Mexico Professor Abhaya Datye's weekly catalysis group meetings, but still needs to get used to Zoom meetings to renew this activity.

BOB ZUMWALT M'60 D'66 was a part-time graduate student while still on active duty at the Army Chemical Center in Edgewood, MD, and enrolled full-time in January 1959. Bob was four years older than his cohorts due to having worked two years as a process design engineer and having served two years as a lieutenant in the US Army. Another difference was being at a coed campus, after graduating from all-male Texas A&M. In the student center's music room, he met a pretty senior, Doris Wild (BA59, MA61), who started their relationship with a memorable opening line: "Would you get mad if I sent you a dead mouse?" Later that year they became Double Dels and were among the first residents of Conover Hall, the married student apartments — called the "rabbit warrens" by Doris's political science professor. Jack Gerster and Art Metzner taught many of Bob's courses, and FRASER RUSSELL D'64 was a fellow grad student, whose mature advice helped Bob through some tough moments. Dave Lamb introduced Bob to analog computing, which proved important to his career, and Jon Olson was full of practical advice, especially near the end of Bob's studies. But Bob Pigford was the main inspiration for Bob, who was thoroughly fascinated and inspired by his course on Application of Differential Equations to Chemical Engineering Problems. After four years Bob ran out of funding and so left in 1963 without writing his dissertation but after much difficulty he completed his work and received his doctorate in 1966.

Bob enjoyed a wonderful 49-year career with ExxonMobil — 31 regular and 18 consulting — in dynamic simulation, computer process control, and technical supervision, developing fields in which he became one of their group of pioneering PhD engineers. His first assignment at the Baytown, TX, refinery was the dynamic analog simulation and computer control of the refinery's cat cracker, the first of the company's cat crackers under computer control. He also did an analog computer simulation of a six-bed hydrocracker reactor, which tends to run away; Bob's simulation proved that bed inlet temperature control was far more stable than bed outlet control. Bob and family moved to Normandy, France, for two and a half years, where he was advisor to a computer control project, and then to the Bayway, NJ, refinery, where he supervised the computer control group. They also lived in London for five years, where he was consultant to the European refineries. Most of Bob's career was with ExxonMobil Research and Engineering (EMRE), in Florham Park, NJ, where he served as supervisor and consultant and presented a few papers at, and helped organize, professional meetings. After retirement in 1984 he continued part-time consulting with the company for 18 years. His main technical contributions for EMRE were developing and updating training simulations and material for teaching a "how-to" course in computer process control, which continues to be offered after more than thirty years, and writing and updating the company's computer control manual.

Bob and Doris live in the old family home in Hallettsville, TX, built by his grandfather in 1893. His interests include reading (mainly history), listening to classical music, creative writing, converting old photos to digital, and being a board member for a historical museum, Lavaca County Historical Commission.

IRA BERNSTEIN '65 graduated from Delaware when Drs. Pigford, Gerster, and Metzner were faculty and Jon Olson was just starting. Ira went on to Minnesota, where he earned a masters degree, and then went to work for Exxon in Texas. His career spanned process control, supervision, economics, and project and business planning and management. He worked in multiple US locations as well as in Europe and helped support operations in Asia. He retired ten years ago as the technical manager for ExxonMobil's Baytown Chemical Plant. Ira writes, "Delaware taught me to think broadly about solving problems and it taught me to be grateful - especially when half a problem correct on an Olson thermo test was worth an A." Ira and his wife, Jo Ann, live in Houston and vacation in New Mexico.

BILL LAMB D'65 spent most of his business career – 35 years – with the DuPont Company, in a wide range of mostly management positions. The initial stops were in research in DuPont's Packaging Film lab in Buffalo, customer-oriented product and machine development, and direct sales. The sales position, which involved calling on Nabisco and other large users of packaging films, was an interesting experience after Bill's having supervised chemists and engineers. After 9 months Bill moved to a technical management position in DuPont's cellophane

plant in Kansas, followed by various product management positions (packaging films, Teflon copolymers and wire and cable businesses). The position that was the most fun was when Bill led packaging sales for all of Latin America and was able to create a new type of sales team that handled sales and technical support for the entire region. He also used his film research background and cellophane technical experience to support manufacturing efforts in Argentina. Interesting tidbits included 31 trips to Buenos Aires and annual Latin America Packaging (LAP) team meetings in resorts throughout the region.

Bill's first wife passed away of lymphoma in 1994 after 33 years of marriage. During a year spent as western sales manager for packaging films in Illinois, he met his current wife, and they celebrated their 25th wedding anniversary this year. That is also how they came, despite Bill's having spent most of his career in Delaware, to move back to Illinois and "retire" in 2000. That retirement included moving into a new lakeside subdivision in 2001 and within 2 months becoming the president of a 215-unit HOA, for 12 years. In 2005 he was also appointed to a Village of Plainfield Trustee position and was subsequently elected to three 4-year terms. At one point Plainfield was one of the fastest growing town in the U.S., then the bottom fell out of the housing market in 2008 and they had to adjust to slower growth while still providing necessary services. Bill adds, "Challenging and enjoyable, but I am not sure this all counts as 'retirement'." Bill noted with sadness the passing of his classmate FRASER RUSSELL D'64 and recalled many good memories from the memorial service. Bill also saw a lot of another classmate, RON SIMPKINS D'66, until Ron's death in 2008.

'70s

KEVIN BRACKEN '70 went on from UD to the University of Rochester, where he completed a masters in 1972. After a period as a plant engineer at a DuPont paint facility in Philadelphia, he realized that this was not where he wanted to be, and a long search led him to a process engineer position at the Hyland division of Baxter in Los Angeles, where he spent almost 10 years. This plasma fractionation facility was Kevin's introduction to the biologics/pharma industry, where he spent the rest of his career. His UD education was invaluable in working on such processes as centrifugation, Cohn fractionation, thin film evaporation, ultrafiltration, process control, and many other separation processes. Starting in 1985 he spent almost 10 years at a startup biotech company, Vestar, which specialized in liposome drug delivery and introduced Kevin to work in a small company as well as to how a product gets from bench scale to commercialization. He supervised a small group of process engineers that developed all the scale-up methods necessary to help bring two novel products to market in a remarkably short time. His skill set expanded to include high-pressure homogenization, spray drying, aseptic processing, sterile filtration, and lyophilization, among others. Again, his UD education was invaluable in making him willing to try anything. His most useful book? Perry's, of course!

Vestar was followed by work for a variety of biotech companies in San Diego, including in ultrasound contrast imaging, preservation of sensitive biomolecules, and plasmid DNA for therapeutic purposes as well as for early-stage vaccines for malaria, HIV, dengue, West Nile virus, Ebola, CMV and influenza. He closed out his career with Verenium, an industrial enzyme company in San Diego, which was acquired by BASF. At Verenium all products were made by a CMO in Mexico City using 200 m3 fermentors with similarly scaled separation equipment.

Kevin has been married for 35 years, has one son and 3 daughters (one from a first marriage) and two grandchildren. He still lives in San Diego and does some minor consulting work in retirement. He road-raced Ducati motorcycles for 6 years in the early 80's, plays classical and improvisational piano and is an avid reader.

Along the way he was awarded 10 patents, which "I viewed as a testament to my excellent UD education. ... I was never bored and loved being a chemical engineer. The Delaware name on my resume opened many doors for me, providing for an ever changing and challenging career. ... When I was at Delaware the professors were like gods to me. Profs. Russell, Olson, Denn, Ferron, Metzner and so many others. I was in awe of their capabilities. I remember one of them telling us, 'We can't teach you everything in the short time we have you, but we can teach you where to look.' That might have been the best lesson. I used it extensively and it led me to many discoveries, as well as ways to solve seemingly intractable problems. I absolutely loved my time at Delaware and look back at it always with fond memories."

MICHAEL McCARTHY '70 says that he has come a long way from his childhood as a poor kid from a large dysfunctional family. Although poorly prepared for college life, he was accepted at UD based on very good high school and testing scores and with the help of financial assistance from UD. With the addition of employment every day and double jobs over summers, he graduated in 1970, a year after his class, with the delay due in part to the work and study regimen but exacerbated by a head injury early in his academic career. Mike says that while his preparation for academics was marginal, he was stimulated by chemistry and chemical engineering theory and by the minds and thought processes of a number of professors. He recalls particularly Drs. Olson, Pigford, Metzner, Schultz, Sandler, and Russell. His UD degree was the gateway to a career in manufacturing at Procter and Gamble, where he rose through manufacturing management, engineering and product development at increasing levels of responsibility. He moved to P&G Marketing as senior manager/ associate director of global strategic planning, laundry and household cleaning products, and then to Amoco as VP for business and commercial development, global gas, where he worked on international O&G, E&P and ultimately on mergers and acquisitions for BP Amoco. Mike returned to P&G global strategic planning as knowledge engineer and dean of competitive strategy development, from which he retired in 2003. Mike married Anne Evans, a theoretical metallurgist and engineering manager, and subsequently Marcia Myers, VP HR for global business sector, P&G. Their current and future focus can be seen at douglashouse.org, which is definitely worth a look.

RICHARD TIMMONS '70 was one of only 3 in his class who were in the 5-year liberal arts - chemical engineering program and so earned two full degrees. He began work with Diamond Shamrock and then spent 6 months on active duty in the US Army and 6 years in the National Guard (the military draft was involved). In 1986 Occidental Chemical, a unit of Occidental Petroleum, bought the company and Richard spent 38 years in manufacturing facilities producing chlorine, caustic soda, potassium hydroxide, and hydrogen, at plants in Delaware, Houston, and Mobile, AL. He says that he had a great career and loved working in manufacturing facilities in various roles – process engineer, production supervisor, production manager, maintenance manager, and especially technical manager, his final role, which he loved. He spent his last 2 years with the company performing operational audits of 15 of their US and Canada operations for upper management and then he retired from the facility in Delaware. It was a great career that enabled a secure retirement. Richard is married to Linda Watts (UD BS in education), and their two daughters both have masters degrees in education and work in Virginia. Richard enjoys his retirement by traveling (4 times to Europe so far), which provides plenty of opportunity for his passion, photography. Richard says that he enjoyed his time at UD and was always very proud to have degrees from a top university that was a true bargain – never more than $1,700 for a full year, including spending money – and had a beautiful campus. His favorite professors were Fraser Russell and John Burmeister (Chemistry). The toughest class was 2nd semester thermo, but Richard successfully did a research project with Stan Sandler on the thermal conductivity of gas mixtures, so maybe it wasn't that bad after all.

JAMES WYKOWSKI M'70 had a brief stint in the Air Force Reserves after graduation and then joined Exxon, initially at Exxon Engineering in Florham Park, NJ. However, he ultimately spent most of his career in Exxon Chemicals, with assignments in Baton Rouge, France, Houston, England and Baytown. It was a fulfilling career that included work in engineering technology, manufacturing, and marketing technical services, and he enjoyed the people he worked with and the challenges of the work. James retired from ExxonMobil in 2005 and he and his wife, Theresa, now live in Houston, where she continues to work as a management consultant and has co-authored 4 books so far. James does some volunteer work and they enjoy traveling, all of which is on hold now because of the pandemic.

FREDERIC R. MORRIS M'75 came to UD in 1967 after graduating from the University of Virginia with a plan to complete a PhD, but the Vietnam War changed that. After his first year of graduate study, draft deferments for graduate students were eliminated, so like many of his fellow graduate students in that situation, he accepted a job at DuPont but was also accepted by the US Air Force as a candidate for pilot training. He reported to a Philadelphia induction center but decided at the last minute to take his chances with the draft. At DuPont his first assignment was at Carney's Point across the Delaware Memorial Bridge in NJ, an explosives department site. As a new engineer he was assigned to supervise a shift of operators at a developmental nylon products test facility, for which the rotating shift work made continuing his UD education difficult. Although he was able to complete his masters requirements with the help of JOHN GAINER D'64, continuing towards a PhD was not possible. However, he had a long and successful career at DuPont, although his job at Carneys Point ended with a gunpowder storage facility explosion in 1969 that killed 7 workers and injured 70. His subsequent job assignments included computer modelling of chemical plants for design purposes, R&D for new fluorocarbons at Chambers Works, design of new facilities for the Savannah River Nuclear Plant (SRP), field engineer at SRP providing design and construction assistance, and engineering liaison leader and engineering design manager at Edgemoor Pigments Plant. He retired in 1999 after working a few years as a contract employee for DuPont. Fred and his wife currently live in St George, UT, where they enjoy the warm weather and exploring the many beautiful areas in their vicinity.

DAVE PRILUTSKI '75 worked from 1975 until 2008 with Arco Chemical, which became Lyondell Chemical and is today LyondellBasell. Along the way he also completed an MBA at Drexel. He finished his career as President, Lyondell Europe, and then spent from 2008 to 2011 as Chief Operating Officer at FXI. From 2012 through 2019 he taught in the business schools at West Chester University and Drexel as an adjunct professor, positions from which he recently retired.

'80s

DENNIS BRODERICK D'80 did his graduate research with Bruce Gates on a catalysis project related to coal liquefaction, supported by the US DOE. Dennis's research was disrupted by a H2S leak that shut down the lab for some months until an improved system for toxic gas handing was installed, but graduation came and he took a job with Chevron Research Company in Richmond, CA. After a dozen years working on refinery and synthetic fuels catalyst and process development, Dennis transferred to the Oronite Division of Chevron Chemical for the next 18 or so years, working in lubricating oil component development as a project lead, performance test engineer, and process improvement engineer. After 31 years with Chevron Dennis retired in January of 2011. During his time at Chevron his family increased from 3 to 6 children and in 1991 they moved from the Richmond area to the Walnut Creek/Danville area, where the children attended high school, graduated and went on Brigham Young University. Dennis also volunteered in the Richmond schools to offer science and engineering enrichment programs to local students.

After retirement Dennis and his wife started a second career serving in various parts of the world as missionaries for The Church of Jesus Christ of Latter-day Saints. Their six children all graduated from college, several worked for advanced degrees, married and started their own families, and served as missionaries for the church. Dennis and his wife started their missionary service with two years in Cape Verde, where they developed and ran projects to furnish clean water, wheelchairs, educational opportunities and materials, and other support for improved health. Their next assignment, starting in 2015, was to support church units in Portugal, including in the

Lisbon area, the Azores, and Évora in the interior of Portugal. The third assignment was an 18-month one to cover housing and health for 130 young full-time missionaries of the church in Rio de Janeiro, Brazil, mostly from Portuguese- and Spanish-speaking countries. Interspersed between these assignments were home stays to be more active parents and grandparents, work on genealogy and family history, and to prepare for the next missionary assignment. Another transition was a move from northern California to west of Portland to be closer to some of their kids and grandkids. The last assignment ended just as the COVID-19 pandemic was interrupting activities worldwide, and Dennis and his wife are now back home in Oregon to continue to support their family. Dennis says that both his careers have been most rewarding, but that "my time as a husband, father, grandfather, and missionary has been the most rewarding part of my life and I expect to continue to seek opportunities to serve during the remaining years of my life."

EDWARD GIUGLIANO '80 has had an Engineering (with a capital 'E') career for 40 years with chemical companies, electric power generators, and defense companies; he is now a senior engineer at Northrop Grumman's Allegany Ballistic Laboratory. Several times during his career, someone he has just met would say about UD, "Wow, that's a great school for chemical engineering." Ed himself says that his experience at UD was terrific, although the amount of work required for the ChE program kept him from enjoying several aspects of campus life that his cohorts had the pleasure of experiencing. He adds, "But it was a case of delayed gratification. I had Dr. Pigford and Dr. Sandler for several classes. After I graduated and compared notes with several other ChE's from different schools, I realized the UD ChE faculty was really special and I was privileged to learn from them. Most importantly, they instilled in me the power to look beyond what a textbook is saying and think it through for ourselves. I distinctly remember Dr Pigford giving us permission to do so!" Ed has been happily married for 37 years and has two grown children "who became a doctor and yes, a ChE (although he went to Ole Miss - he was an SEC fan)."

RAKESH GUPTA D'80 recalls coming to Newark in August 1975 as a new graduate student and choosing Art Metzner as his advisor. Art was known to be a strict disciplinarian, and Rakesh saw this first-hand when he asked about going home for Christmas at the end of 1976; Rakesh stayed put and continued working on polymer films made by the process of film blowing. Nevertheless, Rakesh remembers Art as an incredible teacher and human being and doesn't know how he found time to mentor all his students the way that he did. After UD, Rakesh worked for Monsanto, DuPont and Braskem America and taught at SUNY Buffalo, and he is now the Berry Chair of Chemical and Biomedical Engineering at West Virginia University, where he has been since 1991. His research is focused on polymer rheology, polymer processing and polymer composites. He is the author of Polymer and Composite Rheology, the co-author of Fundamentals of Polymer Engineering and the co-editor of Polymer Nanocomposites Handbook and Graphite, Graphene and their Polymer Nanocomposites. Rakesh is both an Honored Service Member and a Fellow of the Society of Plastics Engineers. Rakesh is married to Gunjan, a real estate agent, and they live in Morgantown, WV. Their older daughter, Deepti, became a biomedical engineer, and their younger daughter, Neha, became a chemical engineer, to please their dad, then they promptly turned to medicine. Deepti practices medicine in Ann Arbor, MI, while Neha is a second-year resident at Lenox Hill Hospital in Manhattan, NY.

PAM (ADAMS) LEHR '80 finds it hard to believe that it's been 40 years since she received her chemical engineering degree from UD. She met her husband (Sid Lehr, BS Chemistry '79) in John Burmeister's inorganic chemistry class and they were married a week after Pam's graduation in 1980. They moved to Ohio, where Pam worked for B.F. Goodrich, GE, and O.M. Scott for 8 years. They relocated to south Florida in 1988 where Pam spent 17 years in consulting (CH2M HILL). For the past 15 years, she has worked for the South Florida Water Management District as a section leader, project manager, and principal engineer. The District is the oldest and largest of the state's five water management districts, managing water resources in a 16-county region that stretches from Orlando to the Florida Keys, serving a population of 8.7 million. Pam is looking forward to retirement in a few years so that she can spend more time with her 2 grown daughters and grandchildren. "Life is good", she adds, in a telling and upbeat summary.

PETER MROZ '80 switched to computer science in the late 80s and was recently promoted to associate director of statistical programming in Global Medical Safety at Johnson & Johnson. Peter lives in Newtown Square, PA, and has 5 children, one grandchild and one grandchild on the way. Peter tells an interesting story of how, in 1980 after graduating, he and 3 other UD graduates, RAY SOWIAK '80, JAY MIERS '80 and Nick Koutrelakos, decided to bicycle across the country. The journey started in Washington state and took 2 months. The foursome initially travelled 50 miles a day and then got up to 75 miles a day in the Rockies. In the midwest they cruised up to 100 miles a day; one day they went 114 miles! Many flat tires and broken spokes later they dipped their wheels in the ocean at Rehoboth Beach, DE. All in all a trip of a lifetime.

MARGARET (O'MALLEY) MOORMAN '85 spent 17 years with the Eastman Kodak Company, focused in the motion picture industry, before retiring to start a family – "I transitioned from Director of Engineering to director of our household!" Her investment has certainly paid off as she is proud to report that, 18 years later, her son Zachary started at UD starting this fall in the Honors Program, majoring in computer engineering as a Delaware Innovation Fellow. Meg notes, "I'm sure my fond musings of my days at UD helped his decision, but it was an easy one due to being awarded the Eugene DuPont Distinguished Scholar Award – a full academic merit scholarship that covers all costs of attendance. Coincidentally, this was the scholarship that I was awarded when it was first initiated – which also made my decision to attend UD a clear choice."

SCOTT SACKINGER '85 has been living in the Seattle area and working for Philips in their Oral Health Care division as a senior project manager for the past seven years. Before this he and his family had lived in Portland, OR, since 2001, where Scott worked for a few companies in the medical device area. His wife of 28 years, Denise, is a nurse at Seattle Children's Hospital and they

have three children, of whom the oldest is studying neuroscience at Oregon State, the middle child is studying electronics and the youngest is a sophomore in high school. Scott would love to hear from any classmates or professors.

JOHN S. WALKER M'85 was a member of the largest-ever incoming graduate class of more than 40 students, in 1982. He recalls the terrific camaraderie of the group, notably many Thursday nights at the Deer Park and the Stone Balloon. He still enjoys get-togethers with fellow alumni JOHN FREY '81 and BETH COOPER FREY M'84. He also learned many good technical lessons from his advisors, Bill Manogue and George Schuit, while working on a catalytic converter project funded by GM. He and RAJEEV JOSHI M'84 had to move their reactor from Colburn Lab to the newly-opened Spencer Lab and did so rather hastily, not wanting to lose lab time. John remembers Dr. Manogue pulling out a bottle of Snoop one evening after a research meeting to check for leaks around the fittings and John's heart sank as bubbles formed everywhere. While John's technical expertise led him to a position at Air Products starting in 1984, he went on to obtain a PhD in finance at Lehigh and is now a professor of finance at Kutztown University of Pennsylvania. However, his greatest source of pride is that he is a grandfather!

'90s

DAVE BIXBY '90 began his career in Rochester, NY, as a DuPont process engineer specializing in facility startup of automated process equipment. After enduring a few winters in western NY during the Super Bowl run of the Buffalo Bills, Dave "wised up and moved south to work at a beautiful DuPont site in western North Carolina on land bejeweled with a lake and three waterfalls. Alas, the DuPont site made medical imaging film and ultimately closed as digital imaging supplanted the use of medical imaging film by the end of the '90s." As a result, in 2000 Dave moved to the Raleigh, NC, area, where he lives in Cary with his wife, Lisa, and son, Hunter, a college sophomore; he also has 5 step-grandchildren by way of Lisa's 4 sons. The move to the Raleigh area started a career path from process engineer to automation engineer with GE Automation Services to project/validation engineer with GlaxoSmithKline. He is now a senior validation engineer with Compliance Technology Group (CTG), which specializes in the commissioning and qualification (C&Q) of equipment and computerized systems used in the biotech, pharmaceutical and medical device industries. During his time with CTG, Dave has encountered a surprising number of chemical engineering grads who likewise have found their way to C&Q, as it pays well and seems always to be in demand. Among Dave's most recent projects was the qualification of a new reagent filling line at Siemens Healthineers facility in Glasgow, DE, which brought Dave's career back full circle to his time at UD. Dave says that you won't find him on Facebook as he largely shuns social media, but he is on LinkedIn.

SARAH BANNISTER '95 went on from UD to attend graduate school at Illinois at Urbana-Champaign and then joined DuPont as a researcher. Law school beckoned but after six years of law firm life, she moved to Oregon to counsel law students on their job searches. In 2016 she joined the Foreign Service and worked in Dakar, Senegal, before starting her current role at the US Embassy in San José, Costa Rica, where she is a political-economic officer. Twenty-five years later she still credits her time at UD for instilling a lifelong appreciation of intellectual rigor and the necessity of teamwork and she conveys "a huge thanks to the professors and classmates who made those four years so memorable".

CHRISTINE GOLDSCHNEIDER '95 says that her dream was always to be in biotech, an interest that started at UD in Prasad Dhurjati's lab. Although she can't believe that it happened so quickly, she now has had more than 20 years of experience in biologics operations, working in areas of increasing responsibility. She initially worked at Abbvie as a process engineer and at Hercules as a research engineer. At Lonza Biologics, a contract manufacturing organization, she had roles in manufacturing operations and in program management, culminating as site head of Manufacturing Science and Technology. For the past 7 years she has been at Sanofi in their Sanofi Genzyme specialty care division in Massachusetts, supporting the Rare Diseases and Rare Blood Disorders operations as an industrial product leader. Her responsibilities are to create and drive the long-term industrial product master plan delivering technical improvements, cost-of-goods reductions, capacity builds, new delivery systems, and product launches, while working closely with the business unit to support the needs of the patients. Christine says that she is truly passionate about reducing the cost to manufacture biologic medicines and adds, "I love that I can have such a major impact on the direction and strategy for a product, ensuring long-term quality, performance and affordability for the patient." Others obviously value Christine's work too: In 2015 she received a Boston Business Journal's Woman to Watch Award and in 2019 she was promoted to Associate Vice President, Franchise Industrial Product Leader, and now works with others to deliver a global franchise-level strategy. Christine remembers many of her experiences at UD, often fondly and sometimes not so fondly (PChem), and is doing so more often now as she helps her son, Aidan, explore colleges. She enjoys the "more simple zen moments" of watching Aidan play rec basketball and watching the Celtics with him, boating with her husband, and gardening, but she laments having to find a new football team to root for since Tom Brady left.

MIKE LENNON '95 has spent the bulk of his career as a process control engineer for Applied Control Engineering (ACE), where he has had the pleasure of working with more than 50 UD chemical engineers. Mike says, "The background and knowledge we all received from UD has clearly paid dividends. I cannot thank our faculty enough, especially Dr. Olson, for pointing me in a direction that has provided such a fulfilling career." In recent years Mike has moved into senior management and he is now one of six principal partners at ACE, along with STEVE MONAGHAN '97, with whom he looks forward to meeting current Delaware students in the years to come. Mike lives in Wilmington with his wife Carey Manza – a UD class of '98 graduate of whom Mike says, "She's great even though she is not a ChemE."

THOMAS SKOURLIS D'95 has worked for a few different companies, always in R&D, either in new process or new product development functions and with an emphasis

on process modeling and pilot plant and lab operations. He is currently the director of Polymer R&D for the Okonite Company, a US-based wire and cable company. Throughout this time Thomas has lived and worked in central NJ; he, his wife, Angela, and their sons Peter (18) and Gerard (16) have lived in Basking Ridge, NJ, for the past 23 years. Peter started at Rutgers Business School this year and Gerard is a high school junior. Thomas remembers a remarkable early success from his UD career, namely winning the NCAA Tournament graduate student pool the first time he ever filled out a bracket in his life, without knowing much about the teams or the tournament and having gone to college overseas. This was a big surprise for everyone, including Thomas, who has never won an office pool in any sport since. Perhaps this success is what inspired Thomas's Greek countryman, Giannis Antetokounmpo, who was born while Thomas was at UD.

'00s

JASON BAXTER '00 went on from UD to grad school at UC Santa Barbara, where he received his PhD in 2005 and, more importantly, met his wife, Joy, who was also a PhD student in chemical engineering. They married in 2003 and after grad school moved to Connecticut, where Joy worked at Unilever and Jason was a postdoc at Yale. Their daughter, Lauren, was born in February 2007 and they moved to the Philadelphia area (Havertown) that August so that Jason could begin his faculty position in chemical engineering at Drexel. Their son, Ryan, was born in 2009. Jason has moved up the ranks from assistant to associate and now full professor, with a research program that focuses on solar energy conversion, an interest that derives from his undergraduate research experience at the UD Institute of Energy Conversion. In fact, Jason has two funded collaborative research projects with IEC with his research mentor, Brian McCandless. Jason, Joy and family enjoy traveling and the outdoors, and in summer 2019 went to Alaska. With both parents being chemical engineers they made their pilgrimage to see the pipeline in Fairbanks along with seeing the beautiful natural sites. During the recent time of isolation they have had lots of family fun by alternating between board game night and movie night.

BRIAN GRAFTON '00 celebrates 20 years with ExxonMobil this year, although he says it doesn't feel that long ago that he was struggling through fluid dynamics at UD and spending long hours in the Colburn computer lab. He and his family are currently in Brussels, Belgium, in his role as the Europe-Africa-Middle East Fuels Lead for ExxonMobil Research and Engineering - Fuels Process and Optimization Technology. Brian's wife, Dr. Heather Hartline-Grafton (UD nutrition '99) has been active in the field of public health nutrition and research since graduate school. Most recently she worked as a senior researcher for the Food Research and Action Center in Washington, DC, where she focused on federal nutrition programs and policies. Their children are enjoying the new experience of living abroad. While moving overseas during a global health pandemic is not something that Brian and his family would recommend to others, they are trying to make the best of the unusual circumstances as well as exploring their new home country and neighboring countries as restrictions allow.

JASON ROBINETTE '00 went on from UD to earn a PhD in chemical engineering from Drexel with a focus on polymer science. He began a post-doctoral fellowship at the US Army Research Lab (ARL) at Aberdeen Proving Ground, MD, in 2005 and was hired as a permanent Army civilian in 2007. During his time at ARL he has led Army- and Department of Defense (DoD)-level research programs as the principal investigator in the areas of vehicle armor, energetic materials, and additive manufacturing (or 3D printing). He is currently the program manager of ARL's additive manufacturing essential research program for munitions technologies. Jason lives in north Wilmington with his wife of 13 years, Maureen, and three children, Matt (9), Drew (8), and Sarah (5). Jason enjoys coaching his children in soccer, basketball, and baseball, and is an active board member on the Delaware Statewide Programs Association (DSPA) for the Deaf and Hard of Hearing and the Immaculate Heart of Mary Athletic Association. Jason's most unforgettable memories at UD were the late night/early morning group sessions trying to finish a project, J-lab report, etc., "only to have your whole life depend on how motivated the 3 am shift at Kinko's was to print and bind your masterpiece! Somehow we got the reports in on time and survived."

JOSHUA SAMON D'00 joined Ethicon Inc., a Johnson & Johnson company, straight out of UD and spent nearly six years supporting the development of biomaterials and disposable medical devices (wound care, cardiovascular surgery and women's health). During this time he earned his MBA part-time from NYU-Stern with a focus on strategy and corporate finance, after which he transitioned to leadership roles in management consulting firms, including Quintiles, IQVIA and Syneos Health, supporting the strategic and operational needs of life sciences clients. Another transition was in location, namely to the west coast in 2012, where Josh is currently a managing director within Syneos Health's Advisory Services group. He lives in San Carlos, CA (Bay area) with his wife, Audrey, sons Eli (12) and Isaac (10), a miniature Schnauzer named Oscar and a Yorkiepoo named Rocket. Josh still has vivid memories of his time at UD and at times still hears the strumming of Professor Jerry Schultz's banjo.

MATT WOOLLEY '00 went on from UD to UNC-Chapel Hill, where he received a PhD in financial econometrics in 2005 that has led him to an exciting international career with Moody's Investors Service. He started in New York in July 2005 and worked in various research and review functions until moving to London in 2010. In 2014 he moved back to NYC to take up a role as the credit officer working on global derivatives (e.g., CLOs, CDOs, etc.). The return to the US wasn't a solo one as he came back with an adventurous French woman named Caroline whom he managed to convince that life on the other side of the Atlantic was worth a shot. They married in 2015 and in 2018 they moved to Paris, where they still live and both work for Moody's. Matt is now managing director in charge of review and validation of all the company's credit rating methodologies, and the EU group head. Matt says that his French is coming along, slowly, to the extent that he can manage to sort the shopping for the house without too much trouble. He also

says that despite their reputation, he finds the Parisians to be kind and tolerant even with his mangling of their language. He thinks sometimes they even feel sympathy.

DAN SAFFER M'00 D'03 has been with Arconic (formerly Alcoa) since 2005, where he's developed and maintained model-based control solutions and data systems across the aluminum manufacturing flowpath, consulted on developing Alcoa's smart manufacturing strategy, and developed content for leadership training on automation and smart manufacturing. He is currently the manager of Arconic's Global Rolled Products and Extrusions Smart Manufacturing and Automation team with global responsibility for deployment, utilization, and lifecycle management across the business. In addition to his day job Dan teaches process control theory as an adjunct professor at Saint Vincent College in Latrobe, PA. The class leverages a semester-long project where the students learn to model, simulate, and control a process of their choosing. Dan is married to UD alumna Deb Saffer (BA '99, MEd '04) who is an assistant director in Duquesne University's Center for Career Development, where she serves the Science, Engineering, and Health Care Colleges. Dan and Deb live in the Pittsburgh suburbs with their 10-year-old daughter, Willa. In their spare time they enjoy attending NHL games and spending time with their family, including trips back to the Newark area.

VASSIA TEGOULIA D'00 recalls that her PhD research with Stuart Cooper on cell and protein interactions with self-assembled monolayers provided the key knowledge that catapulted her into a position in the Bioprocess Department at Genentech in California straight after her PhD defense – the beginning of a fulfilling career in a pioneering research-driven biotechnology company. As an engineer, Vassia worked on process development and manufacturing technology transfers of many recombinant proteins that are now available as medicines. In 2008 she moved from Technical Development to Technical Regulatory as a purification expert and worked on health authority submissions to enable either clinical trials or new product market entries. Genentech became a member of the Roche group in 2009 and Vassia's domain expanded to international submissions. She was the technical regulatory lead for a breast cancer drug approved in 2012, leading a global team responsible for approvals all over the world. After this she built the Tech Regulatory Biologics Portfolio and Project Management Office, overseeing filing activities and timelines for the Biologics Regulatory portfolio in Roche. The scope of her team expanded to include small molecules and she became global head of the Biologics and Small Molecule Portfolio and Project Management. After having her second daughter, however, Vassia decided to reduce travelling and around the clock teleconferences and returned to Technical Development, where she currently leads a team whose vision is to pioneer drug product development and successfully enable new technologies to ensure availability of novel medicines that help patients. She loves supporting young female scientists and engineers through the Genentech Women in Science & Engineering (gWISE) efforts and mentorship programs. Vassia lives in the Bay area with her husband, COSTAS DIMITROPOULOS D'99, and their two daughters, aged 9 and 7. Vassia writes, "Coming to the US as an international student, UD provided me a great education and enhanced my resilience. It prepared me well to rise to the opportunity to touch and improve the lives of so many people through my work."

JOHN HRYCUSHKO '05 has been living in Texas for about 9 years, of which 8 years were in the Non-Metallics Materials and Process Engineering Group at Bell Flight, working on certification of composite materials, structures and suppliers all over the world. John and his wife had a baby girl last April and it seemed a good time to settle down in one place for a while, so in December they packed up and left for a new opportunity with Firefly Aerospace just north of Austin. Firefly is a startup rocket company that is developing composite structure launch vehicles for satellite delivery. John's role here is to build a new M&P engineering organization and test laboratory that will be responsible for all aspects of material development and use. In their free time John and his wife are enjoying exploring the Texas hill country and spending time together with their little girl.

JESS PENETAR '05 currently lives in Corvallis, OR, where her family, including their two children (3 and 5), loves spending time outdoors, hiking, biking, camping, and on the coast. Jess works as an environmental consultant at Cascade Earth Sciences, where her projects focus mostly on stormwater and potable water treatment systems.

CHIRAG RAVAL '05 went on from UD to doctoral studies at City College of New York, where he worked with David Rumschitzki. Especially in the wake of Prasad Dhurjati's passing, Chirag acknowledges the tremendous impact that Prof. Dhurjati had on his career and on his integration into American society as a first-generation Indian-American. This included a senior project that leveraged Chirag's interest in pharmaceuticals in studying the pharmacokinetics of a drug candidate to investigate toxicological properties. Ultimately this experience guided Chirag to CCNY and even in some of his post-doctoral experience. He recently started a new role as Director of Business Development for Wnt Scientific, a biotech spin-off from Columbia University that targets endogenous stem cells for therapeutic regeneration of joints. The company was recently awarded a Phase II STTR grant ($2M) and they are performing studies that should lead to clinical trials. Chirag recently bought an apartment in Manhattan and continues to teach biomedical engineering and biology at CUNY as an assistant professor. However, he still has local connections: he was one of the company personnel who were invited guests at the opening ceremony for UD's biopharmaceutical innovation center..

W. BENJAMIN ROGERS '05 sees his career trajectory as an example of the flexibility that comes with a firm foundation in mathematics, scientific computing, transport phenomena, and thermodynamics, which together are the hallmark of chemical engineering at UD. After undergraduate research in catalysis at UD, Ben switched directions and earned a PhD in chemical engineering with John Crocker at Penn, working in the area of single-molecule biophysics. In 2012, he took another left turn and went to Harvard for a postdoctoral position in physics with Vinothan Manoharan, studying colloidal self-assembly and light scattering in cosmetics. Ben is now an assistant professor of physics at Brandeis, where he has an experimental

research program focused on understanding the physics of self-organization in soft matter, including crystallization, liquid-liquid equilibrium, membrane fusion, and biomolecular folding. Ben has won numerous awards, including the Smith Family Award for Excellence in Biomedical Research and a Human Frontiers Science Program grant. He has also now taught more physics classes than he ever took as a student.

COLLEEN (RODGERS) SNOW '05 has been a patent examiner for the US Patent and Trademark Office since she graduated. She examines applications at the intersection of chemical and mechanical engineering, mainly the chemical methods used to manufacture semiconductor devices. Colleen lives in northern Virginia with her husband, Michael, and their four kids, Keira (7), Declan (5), Liam (3), and Callum (1), and she says, "every day is an adventure!"

'10s

COLIN HEBERLING '10 went on from UD to receive a master's in bioinformatics from Johns Hopkins and now works at Vedanta Biosciences, a biotech startup in the Boston area. Vedanta is a pioneer in human gut microbiome research and is developing probiotic therapeutics to treat disease indications like C. difficile infection, cancer, and decolonization of multi-drug resistant organisms. Colin has been doing metagenomics and genomics analyses to support the company's efforts. Colin acknowledges UD professors who helped him get here: Prasad Dhurjati, who first introduced him to microbiome research and helped him with his first publications; Maciek Antoniewicz, who first exposed Colin to bioinformatics in his course on metabolic engineering; and David Colby, who gave Colin hands-on experience in microbial fermentation to round out his wet-lab knowledge base and skills. Colin is excited to hear more about his former classmates too!

JASON McMULLAN D'10 recently celebrated 10 years with ExxonMobil, where he currently manages a large, diverse team (> $10M/yr) working on technology scale-up and commercialization in his role as a project lead in the R&D division. He has enjoyed remaining engaged with UD through his role as ExxonMobil recruiting team captain. Jason and Jessi live in the Lehigh Valley with their two kids, and Jason's complex fluids research has shifted to the science of home brewing (with apologies to his advisor, Norm Wagner).

MATTHEW ARMSTRONG D'15 has been teaching undergraduate chemical engineering and chemistry at the United States Military Academy since graduating from UD. For his first three years back at USMA he served as the Deputy Chemical Engineering Program Director but in 2018 he was promoted to Program Director and to Associate Professor. The program is a small but growing ABET-accredited program that graduates 20-25 chemical engineers each year, with 90-100 total chemical engineers during the average year. Matt's family is also flourishing. Yvonne is a chemical engineering senior at RPI, after completing an internship at Chemours in NJ; Arthur is a high school junior and Eagle Scout who does cross country and tennis and has STEM interests in environmental sustainability; Bruce is a freshman at the same high school who does cross country and baseball and is interested in military history and STEM; and Lillian is in 8th grade, runs cross country and track, and is interested in math and art.

MARIANNA FLEISCHMAN '15 is enjoying her new position as the lead automation engineer at the Vaccine Production Program (VPP), part of the NIH's National Institute of Allergy and Infectious Disease (NIAID) located in Gaithersburg, MD. She moved to this role after 4 years as an associate formulation and stability scientist, where she worked on projects including vaccine candidates for HIV, universal flu, and the mAb114 vaccine that was sent to combat the Ebola outbreak in the DRC. In her new role, Marianna works primarily with the process engineering group's high-throughput Tecan robotics systems, developing assays and integrating other instrumentation to grow the group's automation capabilities. She is very happy to be back to her engineering roots, although "if you had told me back in undergrad that I would be willingly seeking out opportunities to learn more coding I wouldn't have believed you!"

Outside of work, Marianna has taken up competitive sailing in the Baltimore harbor, Chesapeake Bay, and beyond. Last year she even combined her two new interests, programming a raspberry pi to sync lights to music aboard a 45' sailboat in Baltimore's Annual Parade of Lighted Boats.

ROBERT KASPAR D'15 went on from UD to a postdoc at Hewlett-Packard in San Diego, CA, where he studied the dielectric breakdown of polymer composites in strong electric fields (used to direct ink inside printers the size of semi trucks). He then pivoted to become a data scientist at Lyft, and now at DoorDash, where he optimizes spending of a $100M+ marketing budget – not exactly where he expected to end up... Robert lives in Oakland, CA, with his brother, a software engineer at Lyft, but since COVID hit he has also spent more time with family in Santa Cruz, CA, and rural Panguitch, UT. Robert notes, "I'm an introvert but this experience has shown me that my mental health depends on 'socializing' – even something as prosaic as sitting in a cubicle farm with coworkers". He backpacks in the Sierra Nevada with friends whenever he can, fires permitting. Although he lives in an environment very different from UD, he is reminded of a severe blizzard in Newark during graduate school. Just before it hit, advisor Yushan Yan instructed his research group to place safety first and stay home from work. However, as he scanned the room to make sure that everyone understood, his eyes paused on Robert and JARRID WITTKOPF D'17, who lived on Haines Street just across the parking lot. "Except you two – I'm sure I'll see you in the lab bright and early as usual."

JASON LOILAND D'15 joined SABIC at their Technology Center in Sugar Land, TX, in December 2015 after graduating from UD. He is now a senior scientist leading projects in several areas related to heterogeneous catalysis research, with other duties that include coordinating the visiting professor lecture series and serving on the emergency response team. Jason and his wife, Stephanie, bought a home in Sugar Land a few years ago and had their first child, a girl named Rosalie, in March 2020, just at the start of the COVID-19 pandemic. They have enjoyed this time working from home and being close to her.

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