

UNIVERSITY OF DELAWARE

ENGINEERING

MATERIALS SCIENCE & ENGINEERING

WINTER 2020

MATERIALS MATTERS

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WINTER 2020

MATERIALS SCIENCE & ENGINEERING NEWS

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ON THE COVER

Diffusions Will Tell a Crystal Heart Made of a Soft Soul

By Changhao Liu, Winner
Art In Materials 2020 Winner

Description: Diffusion control polymer crystallization



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DEAR UD MSE COMMUNITY,

I hope this edition of *Materials Matters* magazine finds you and yours healthy and safe. Milestones hit this past 2 years, the 21st and 22nd years of the existence of the MSE department at UD, show a department that has come into its own as a nationally and internationally known center of materials research and education. MSE, along with collaborators across UD, was successful in landing our long-sought goal of a Materials Research Science and Engineering Center, or MRSEC, from the National Science Foundation. This is the premier center mechanism at the NSF in fundamental materials research. Importantly, the UD center has two independent research groups (IRGs) with one focused on soft materials and one on hard materials. This clearly shows the deep expertise and exciting research in MSE that spans all aspects of materials science. And while I would leave the introduction to focus on the MRSEC, I also need to highlight a new Energy Frontier Research Center, or EFRC, from the Department of Energy, that began in 2020. This interdisciplinary research center is also based in MSE with collaborators across campus and industry with a focus on green polymer materials, again highlighting the breadth and depth of materials research. These exclusive research centers place the department in the upper echelon of MSE departments nationally and portend to the amazing things to come in the near future.

The new research centers, along with significant success of the entire faculty in research and graduate education, will fund many new graduate students as well as undergraduate experiences in our laboratories. Importantly, we are now able to have our very own MSE undergraduates within our labs! This year is the second year of the new MSE undergraduate program. We are immensely proud of our graduate and undergraduate students, several of which are highlighted in interviews later in the magazine. Put succinctly, these students are the reason for the success of the department, not only in research and in the classroom but also in the flourishing of our collegial, inclusive departmental culture. The people from all walks of life, gender identity, and nations around the world make MSE at UD an amazing place to work and to explore materials. On behalf of all of us, now spanning undergraduate through full professor, I welcome you to experience what we are about and what success looks like at UD in this edition of *Materials Matters*.



DARRIN POCHAN
Department Chair



DARRIN POCHAN

DEPARTMENT CHAIR
& PROFESSOR



UD MAKES MATERIAL IMPACT WITH NEW MRSEC FROM THE NSF

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.

NATIONAL SCIENCE FOUNDATION-FUNDED MATERIALS RESEARCH SCIENCE AND ENGINEER- ING CENTER (MRSEC) TO ADVANCE MATERIALS RESEARCH

A new center at the University of Delaware is advancing research to transform the way materials are made. It is one of 11 Materials Research Science and Engineering Centers (MRSECs) across the country funded by the NSF in 2020.

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 a joint appointment in the Department of Materials Science and Engineering, with \$18 million in funding from the National Science Foundation. LaShanda Korley, Distinguished Professor of Materials Science and Engineering and a joint appointment in Chemical and Biomolecular Engineering, will co-direct and coordinate operational aspects of the center.

The MRSEC consists of two Independent Research Groups (IRGs), the first led by Darrin Pochan (Professor of Materials Science and Engineering) and April Kloxin (Professor of Chemical and Biomolecular Engineering with a joint appointment in the Department of Materials Science and Engineering) and the second led by Joshua Zide (Professor of Materials Science and Engineering) and Matt Doty (Professor of Materials Science and Engineering). IRG1 will focus on the design of new, synthetic materials using biological molecules, primarily peptides and proteins. IRG2 will involve the design and creation of new quantum materials relying on excitation transduction across designed material interfaces.

Regional research partners in the UD-led center include the University of Pennsylvania and the National Institute of Standards and Technology (NIST).

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 industry 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 research and education opportunities in materials science for students from underrepresented groups, in partnership with Delaware State University and Claflin University, 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 post-doctoral 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.



The Center for Plastics Innovation (CPI), led by Professors LaShanda Korley (left) 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.

TAKING AIM AT PLASTIC WASTE

UD WINS FEDERAL GRANT TO ESTABLISH CENTER FOR PLASTICS INNOVATION

Think about how the entire planet would benefit if more plastic could be recycled or reimaged instead of trashed.

The Center for Plastics Innovation (CPI), a new research center at the University of Delaware, is now 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) established across the U.S. to accelerate scientific breakthroughs in critical areas.

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, with a joint appointment in Chemical and Biomolecular Engineering, leads the effort. Thomas H. Epps, III, UD’s Thomas and Kipp Gutshall Professor of Chemical and Biomolecular Engineering and jointly appointed in Materials Science and Engineering, serves as co-director.

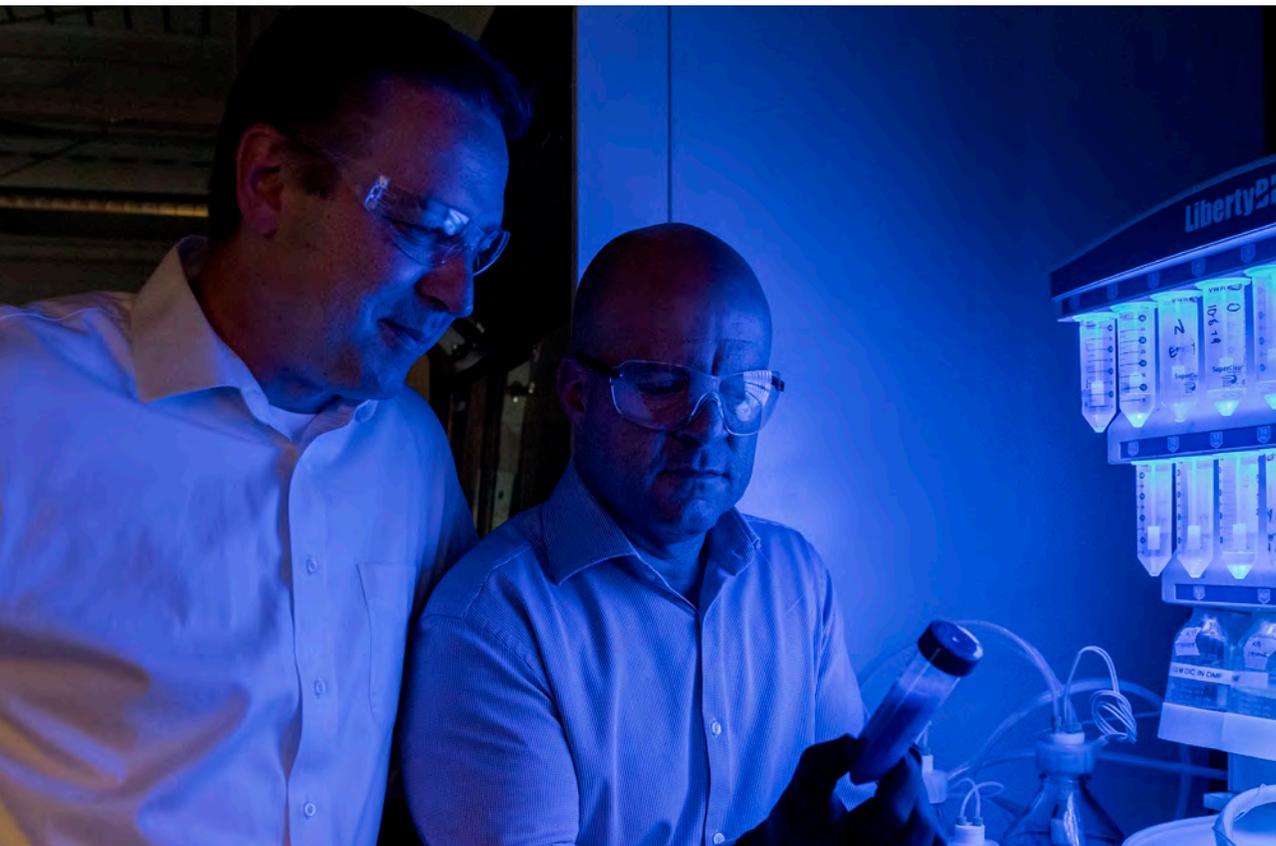
As an Energy Frontier Research Center, UD’s Center for Plastics Innovation will play an important role in advancing the nation’s energy future.

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.”



The researchers designed and created rigid, self-assembling, customizable polymer chains by linking together new building blocks called bundlemers — a term coined at UD.

BUNDLEMERS

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

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 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.”

Bundlemers could be used to design new materials with a wide range of applications, from high-performance fibers to single-use plastics to biologic medicines. Biopharmaceutical research and development is a growing area of expertise at UD, home to the National Institute of Innovation in Biopharmaceutical Manufacturing (NIIMBL).

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.

“Our idea is that these bundlemers truly are building blocks in every sense of the word,” said Darrin Pochan, chair of the Department of Materials Science and Engineering. “We are going to build many, many materials and technologies out of these building blocks.”



As part of a National Science Foundation initiative to advance the quantum technology revolution, University of Delaware researchers will explore a new approach to making quantum devices, 10,000 times smaller than the width of a human hair, in UD's Nanofabrication Facility, shown behind them. Project leader Matthew Doty (center) is flanked by team members Stephanie Law and Joshua Zide. All are professors in UD's Department of Materials Science and Engineering.

QUANTUM MOMENTUM

UD TEAM GETS \$1 MILLION FROM NSF TO HELP RESEARCH QUANTUM TECHNOLOGY

A technology revolution is coming, and UD is on the leading edge as the recipient of a \$1 million grant from NSF to help develop the quantum electronics of the future.

“The power of quantum science is that it offers totally new ways to develop electronic devices — from computers to medical sensors — with the promise of processing information faster and with greater accuracy and security than ever before,” said Matthew Doty, Professor in UD’s Department of Materials Science and Engineering and lead investigator on the project.

A WHOLE NEW SET OF RULES

This new age of electronics will operate on a different set of rules than today’s computers and smartphones.

Today’s electronics are based on data encoded in bits that exist in one of two states: 0 or 1. In the hardware of traditional electronics, the 1 state is represented by a high voltage, and

the 0 state by no voltage. Transistors manipulate these bits, for example, flipping the state of bit A if bit B is in the 1 state, but leaving bit A alone if B is in the 0 state.

Quantum devices are based on quantum bits, or qubits, which can exist in “superposition states” that are a mixture of both 0 and 1 at the same time. This would make a quantum computer essentially capable of processing many possible scenarios simultaneously instead of just one at a time.

TOWARD QUANTUM COMPUTING

The potential of quantum computing has been known for decades, but scientists face two extremely difficult fundamental challenges in building the hardware for quantum computers with thousands of qubits, Doty said. First, because the superposition states of the qubits are so fragile, they can “collapse” due to interactions with the atoms in the environment around them. Second, while conventional computers have tools to deal with inevitable errors, quantum computers can’t use such tools because each qubit state is a little bit different.

Doty will lead a research team from UD, Virginia Tech and Stanford in exploring a new

approach to making a quantum device. Their approach is based on “inverting the design paradigm.” Instead of trying to create thousands of identical qubits, they are redesigning the hardware so that each qubit is tunable from the get-go.

The researchers are using gallium arsenide as their platform. Embedded within the gallium arsenide will be indium arsenide quantum dots, each one like a teeny container that can hold a single electron. The spin of that electron will be the logical basis (0 or 1) of the qubit. The interactions between the qubits will be controlled by light propagating in tube-like waveguides on a chip.

In addition to Doty, the UD team includes Joshua Zide, Professor of Materials Science and Engineering, and Stephanie Law, Associate Professor of Materials Science and Engineering. Zide is an expert in growing the gallium arsenide crystals that serve as the foundational material, and Law has expertise in developing semiconductor meta-materials that will be used to create the waveguides.

All of the device fabrication will be done in the UD Nanofabrication Facility, which provides world-class capabilities for developing technologies at the atomic level.



UD-BROOKHAVEN RESEARCH

NEW AREAS OF COMPLEMENTARY STRENGTH AND STRATEGIC IMPORTANCE

UD researcher, Stephanie Law is involved in the UD-Brookhaven National Laboratory collaborative.

The U.S. Department of Energy's (DOE) Brookhaven National Laboratory and the University of Delaware have begun a two-year joint initiative to promote collaborative research in areas of complementary strength and strategic importance. Though Brookhaven Lab and UD already have a tradition of collaboration, especially in catalysis, this initiative, which began in 2019, encourages partnerships in strategic areas where that tradition did not yet exist.

A committee from Brookhaven and UD selected two projects—one on rice soil chemistry and the other on quantum materials—for the new initiative. For each project, one graduate student based at Brookhaven and one graduate student from UD will work with and be supervised by a principal investigator from each respective institution.

The quantum materials project, "Growth and characterization of quantized antimony-based topological insulators," is co-led by Peter Johnson, group leader of the Electron Spectroscopy Group in Brookhaven's Condensed Matter Physics and Materials Science Division, and Stephanie Law, Associate Professor of Materials Science in UD's College of Engineering.

When materials have nanoscale dimensions, their electrons can only occupy specific energy levels. This phenomenon, called quantum confinement, occurs when the

nanostructures—for example, wires or dots—are smaller than a critical length scale. The unique properties of such nanostructures are of interest for many applications, including quantum computers.

To date, much of the research on quantum confinement has focused on semiconductor materials, which have an electrical conductivity in between that of conductors (high conductivity) and insulators (low conductivity). But recently, scientists have been turning their attention toward a new class of materials that behave as insulators internally but conductors on the surface (i.e., electrons can only move along the surface). The surfaces of these topological insulators are special because they are protected from backscattering, which occurs when electrons hit atomic defects or other imperfections in a crystal structure or move in response to vibrations of the atoms. The scattering of electrons is problematic because it interferes with the flow of electric current, causing energy dissipation and thus loss.

Some scientists have theoretically proposed that the surfaces of topological insulators should also have electrons of discrete energy levels that are "topologically" protected. Law and Johnson will test this theory by growing self-assembled quantum dots from a topological insulator made of the elements bismuth, antimony, and telluride and measuring the dots' energy level spectrum.

"Topological insulators are already known to be interesting materials from both a physics and an engineering perspective," said Law. "What isn't known is how they behave when confined to extremely small scales. The collaboration between UD and Brookhaven will allow us to address these questions directly, and in so doing, uncover new physics and discover new applications for these materials."

At UD, Law will grow samples of varying size and chemical composition with a thin-film deposition technique called molecular beam epitaxy and characterize the structure of the samples using x-ray diffraction and microscopy techniques. Then, at Brookhaven, Johnson and team member Dario Stacchiola—group leader of the CFN Interface Science and Catalysis Group—will measure the samples' energy spectra through scanning tunneling spectroscopy (STS) and angle-resolved photoemission spectroscopy (ARPES). In STS, a voltage is applied between a sharp metallic tip and a sample, allowing electrons to tunnel between the two. The amount of electrical current is proportional to the density of states—the number of electrons per unit volume over a given energy level. In ARPES, x-ray or ultraviolet light is directed on the sample, and the energy and momentum of the emitted electrons are measured.

NEW UNDERGRADUATE MAJOR

IN 2019, WE LAUNCHED A BACHELOR'S DEGREE PROGRAM IN MATERIALS SCIENCE AND ENGINEERING. TWO STUDENTS SHARE THEIR STORIES.



GIORDANA DANIELS

For Giordana Daniels, it was the intrigue of a new undergraduate degree program backed by the reputation of an outstanding graduate degree program that pushed her to pursue an education in Materials Science and Engineering at the University of Delaware. Now a sophomore in the program, Giordano says she found UD attractive knowing that the birth of the undergraduate program would be guided by the established faculty in the graduate program and “knowing I would be part of the very first cohort of Materials Science and Engineering at the University of Delaware was something I loved and could not give up.”

With faculty that are accessible, open to student feedback and eager to implement change when needed, Giordana feels this will help grow Materials Science and Engineering into a successful and highly regarded undergraduate degree program. In addition to her studies, Giordana rounds out her college experience by competing on the Club Equestrian Team and as a contributing member of Alpha Omega Epsilon – a professional sorority for women in STEM.

EDUARDO NOMBERA-BUENO

The undergraduate Chemical Engineering program's reputation was what first attracted Eduardo Nombera-Bueno to the University of Delaware. However, his plans changed slightly when he heard about the newly launched Materials Science and Engineering undergraduate degree. Now a sophomore, Eduardo is part of the inaugural MSEG graduating class of 2023 and he's also the first Chemical Engineering and Materials Science and Engineering double major at UD. He feels fortunate to be guided by amazing faculty and have access to “some of the best undergraduate research positions available in a wide range of subjects, from sustainability, to pharmaceuticals, to 3D printing and microelectronics.”

Eduardo keeps busy and has been involved in many organizations outside the classroom, including SAMPE (the Society for the Advancement of Material and Process Engineering), AIChE (American Institute of Chemical Engineers), Engineers Without Borders and Chem-E-Car. Organizations and activities like this along with his work with the Korley Research Group serve to enrich Eduardo's overall academic experience and prepare him for his professional future.



Two unlikely UD collaborators — an engineer and a journalist — teamed up to develop a program that helps UD students explain their research in terms mere mortals might understand.

BRINGING IT DOWN TO EARTH

UD'S 'WORDS FOR NERDS' HELPS GRAD STUDENTS BRING COMPLEX RESEARCH TO THE MASSES

Maybe you will discover the biochemical key that locks cancer out forever. Maybe you will find a way to turn down the global thermostat so Planet Earth doesn't drown in its own oceans. Maybe you will figure out what "dark matter" really is.

But Ernest Rutherford, considered the father of nuclear physics, demands more of you, ever so much more.

"An alleged scientific discovery has no merit unless it can be explained to a barmaid," the 1908 Nobel Prize winner once said. That's no small feat, of course, and it's not the barmaid's fault. Researchers and scientists — steeped as they are in the technical language and shorthand of their specific disciplines — develop a level of expertise that is not easily translated.

In a national study, the Pew Research Center showed increasing public confidence in research scientists and more than 70 percent of those surveyed reported a good opinion of those researchers. But in the same study, almost half of those surveyed said research scientists were not good communicators. They need help with messaging.

"I enjoy science communication," said Lauren McCabe, while pursuing a doctorate in materials science at the University of Delaware, focusing on such things as nanotechnology, molecular beam epitaxy, quantum dots and photonic crystals. "But it is one thing a lot of us aren't very good at."

McCabe found something at UD that helped — the five-part "Words For Nerds" seminar developed by two unlikely UD collaborators to give graduate students training and practice in the art of explaining complex ideas to street-level audiences.

"Historically, this is something engineers and scientists are not too good at," said Joshua Zide, Professor of Materials Science and Engineering and an expert

in nanotechnology. "And when you're bad at it, bad things happen."

Zide discussed this a few years ago with Dawn Fallik, Associate Professor of English, who teaches journalism and writes about medicine and science for major outlets, including *The Wall Street Journal* and *The Washington Post*.

And — on their own time — they built this program.

They enlisted the help of expert presenters, including Gene Park of *The Washington Post*, UD alum Charles Bergquist of NPR's *Science Friday*, Dr. Dara Kass, creator of the FemInEm campaign, and UD marine scientist Danielle Dixson, all of whom have significant track records as effective communicators.

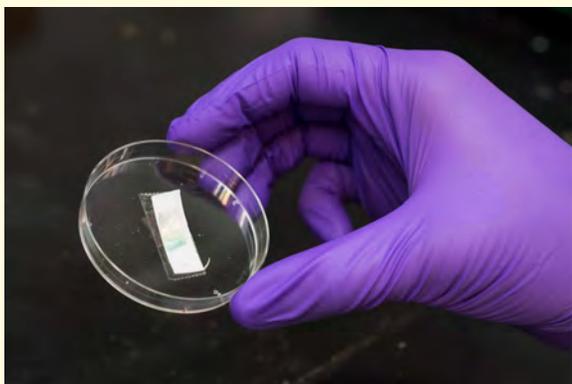
As an expert in nanotechnology, a field that makes machines out of tiny particles you can't even see with your eyes, Zide understands it's hard for most of us to grasp such work. He also knows it's important to find effective ways to connect the dots for people.

"There is no big science lobby," he

said. "And people are not particularly well-informed. Scientists speak a different language, a very, very precise language."

Strong communication skills are a super power for those who hope to have effective interactions with lawmakers, grant officers, business leaders, taxpayers, other researchers, even family and friends. Such skills often translate to greater opportunity, increased financial support and stronger partnerships.

"If you try to speak in broad enough terms to be generally understandable, often it starts to sound generic," Zide said. "People may understand the idea of solar energy, but that subject can very quickly get into detail that is less accessible.... Is the specificity important? People in general care about the application of the work rather than the details. That creates a challenge for work that is more fundamental.... I think people want to be understood and there is no shortcut, no magic way to do it."



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.



NATURE MEETS SCIENCE IN MUSEUM EXHIBIT

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

When kids visited the Delaware Museum of Natural History in early 2019, they had an opportunity to play with and learn from an educational kiosk developed by Associate Professor April Kloxin. The station centered on biomimicry, using nature as inspiration to

develop new technology. Visitors could hold sealed tubes containing burrs attached to felt, similar to how Velcro attaches to materials. They could build models of the human heart or lungs with Legos to see how synthetic tissues are built from the bottom up.

Kids also visualized how bioinspired materials work. Sealed tubes contained diaper particles soaked with different amounts of water. These materials are hydrogels, materials used by scientists such as Kloxin to study cells outside the body for use in developing disease treatments.

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

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

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

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

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

FACULTY HONORS

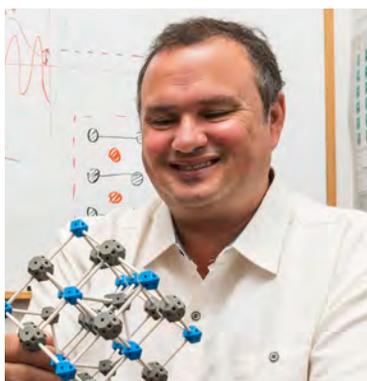


THOMAS H. EPPS, III

Epps is the 2020 recipient of the Percy L. Julian Distinguished Award from the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE).

Considered the professional organization's most prestigious honor, the award recognizes achievements in pure and/or applied science. It acknowledges Epps' dedication to research, as well as his commitment to enhancing the STEM community.

Epps is the Thomas and Kipp Gutshall Professor of Chemical and Biomolecular Engineering and a professor in UD's Department of Materials Science and Engineering.



ANDERSON JANOTTI

Associate Professor Anderson Janotti was named to the Clarivate Analytics list of Highly Cited Researchers for 2018. This list identifies scholars whose publications are in the top 1% for citations by other researchers via Web of Science, a scientific citation indexing service. He made the Highly Cited Researchers list in the Cross-Field category. Janotti's most cited works are related to the development of oxides as semiconductor materials, focusing on the role of intrinsic defects and impurities in controlling their electrical conductivity.



ARTHI JAYARAMAN

Arthi Jayaraman, Professor of Materials Science and Engineering and Chemical and Biomolecular Engineering, was named an American Physical Society (APS) Fellow in 2020. The APS Fellowship Program was created to recognize members who may have made advances in physics through original research and publication, or made significant innovative contributions in the application of physics to science and technology.



In 2019, Jayaraman joined the editorial board of *Macromolecules*, a peer-reviewed journal

published by the American Chemical Society. *Macromolecules* publishes original research on all fundamental aspects of macromolecular science including synthesis, polymerization mechanisms and kinetics, chemical modification, solution/melt/solid-state characteristics, and surface properties of organic, inorganic, and naturally occurring polymers. The papers showcase innovative concepts, experimental methods/observations, and theoretical approaches.

KRISTI KIICK

Kiick, Blue and Gold Professor of Materials Science and Engineering, was named a Fellow of the American Association for the Advancement of Science (AAAS). AAAS Fellows are a distinguished cadre of scientists, engineers and innovators who have been recognized for their achievements across disciplines, from research, teaching, and technology, to administration in academia, industry and government, to excellence in communicating and interpreting science to the public.

In addition, she was named a Fellow of the National Academy Inventors in 2019. The NAI Fellows Program highlights academic inventors who have demonstrated a spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on quality of life, economic development and the welfare of society.

From July 2019 through July 2020, Kiick studied in the United Kingdom through a Leverhulme Visiting Professorship, which provides funds for eminent scholars to visit the UK, and a Fulbright Award, one of the most prestigious international scholarship opportunities.

APRIL KLOXIN

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) Direc-

tor'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.

LASHANDA KORLEY

For outstanding contributions to bio-inspired materials design and manufacturing, Korley, Distinguished Associate Professor of Materials Science and Engineering and Chemical and Biomolecular Engineering, 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.

STEPHANIE LAW

Associate Professor Stephanie Law received a Presidential Early Career Award for Scientists and Engineers (PECASE) for her pioneering research and leadership in materials and engineering. The PECASE is the highest honor given by the U.S. government in recognition of early-career scientists and engineers with exceptional promise as leaders in science and technology.

She also received the Peter Mark Memorial Award from the *American Vacuum Society* in 2019. This award was established in 1979 in memory of Dr. Peter Mark, who served as Editor of the *Journal of Vacuum Science and Technology* from 1975 to 1979.

DARRIN POCHAN

Department Chair Darrin Pochan's term is being extended through June 30, 2022. Pochan has served as chair of the Department of Materials Science and Engineering since 2014. Under Pochan's leadership, the Department of Materials Science and Engineering has expanded and launched an undergraduate degree program in materials science and engineering. Pochan also holds appointments in the Delaware Biotechnology Institute and UD's Department of Chemistry and Biochemistry.

WELCOME TO OUR NEWEST FACULTY



IN 2018, WE WELCOMED SHELDON HEWLETT TO OUR FACULTY.

Hewlett is a Continuing Track Associate Professor in the Department of Material Science and Engineering. He has a B.S. in Material Science and Engineering from MIT, and an M.S. in Material Science and Engineering from Northwestern University. He received his doctorate in the Science of Advanced Materials from Central Michigan University, where he investigated solution-processed gold disordered metamaterials with high (> 90%) broadband optical absorption. Currently his primary focus is teaching, recruiting, and developing curricula for the new undergraduate MSEG major.

IN 2019, WE WELCOMED ASSISTANT PROFESSORS LAURE KAYSER AND CHARLES DHONG TO OUR FACULTY.



Kayser's research is focused on developing and understanding the next generation of soft organic electronics (conjugated polymers) to study or repair the nervous system. She is the leader of an interdisciplinary research group working at the intersection of organometallic chemistry, polymer synthesis, and materials and device engineering. She has a B.Sc. in Chemistry with honors and an M.Sc. in Molecular and Supramolecular Chemistry from the University of Strasbourg in France. She holds a Ph.D. in Chemistry from McGill University in Canada.



Dhong's research is interested in measuring or controlling the mechanical forces at biological interfaces. Biological interfaces, ranging from cells to the human sense, are complex because they are soft and patterned. Although they are complex, controlling these biological interfaces are important in a range of applications, including basic biology, cancer detection, and virtual reality for the sense of touch. To achieve these goals, he builds devices, performs simulations and modeling, and incorporates new materials including conductive polymers

and graphene sensors. He has a B.S. in Chemical and Biomolecular Engineering from the University of California, Berkeley and a Ph.D. in Chemical and Biomolecular Engineering from Johns Hopkins University.



IN JANUARY 2021, WE WILL WELCOME ASSISTANT PROFESSOR CHITRALEEMA (A.K.A. CHITRO) CHAKRABORTY TO THE FACULTY.

Chakraborty's research seeks to elucidate the functionalities of solid-state quantum emitters for applications in quantum information processing and nanoscale sensing from both a theoretical and experimental standpoint. She plans to combine her expertise in Computational Materials Science and Experimental Quantum Optics to predict, fabricate, and image quantum emitters for integration with photonic and nano-mechanical devices. Her research will focus on developing quantum materials including 2D materials, semiconductor quantum dots, and hybrid quantum systems that are relevant for applications in quantum computation, communication, and quantum sensing-based technologies. She obtained a Ph.D. in Materials Science in 2018 from the University of Rochester. She obtained a dual MS and MTech in Nanophysics and Nanostructures from the University of Delhi, India, and Joseph Fourier University, Grenoble, France. She obtained her BSc Honors in Physics in 2009 at Jadavpur University, Kolkata, India.

MATERIALS SCIENCE AND ENGINEERING FACULTY

ELISE CORBIN

Assistant Professor

CHRISTOPHER J. KLOXIN

Associate Professor

XI WANG

Assistant Professor

CHARLES DHONG

Assistant Professor

LASHANDA KORLEY

Distinguished Professor

JOSHUA M. O. ZIDE

Professor

MATTHEW DOTY

Professor

STEPHANIE LAW

Associate Professor

 NEW PROFESSORS STARTING
IN JANUARY 2021
THOMAS H. EPPS, IIIThomas and Kipp Gutshall
Professor**MICHAEL E. MACKAY**

Distinguished Professor

CHITRALEEMA CHAKRABORTY

Assistant Professor

JOHN W. GILLESPIE, JR.Professor; Director, Center
for Composite Materials**DAVID C. MARTIN**Karl W. and Renate Böer Chaired
Professor; Associate Dean,
Research and Entrepreneurship,
College of Engineering**MARK KU**

Assistant Professor

SHELDON HEWLETT

Assistant Professor

CHAOYING NIProfessor; Director, W. M. Keck,
Center for Advanced Microscopy
and Microanalysis**ANDERSON JANOTTI**

Associate Professor

ROBERT L. OPILA

Professor

ARTHI JAYARAMAN

Professor

DARRIN J. POCHAN

Professor; Department Chair

XINQIAO JIA

Professor

LAURE KAYSER

Assistant Professor

JOHN F. RABOLT

Karl W. and Renate Böer Professor

KRISTI L. KIICKBlue and Gold Distinguished
Professor**WILLIAM SHAFARMAN**Professor; Director, Institute
of Energy Conversion**APRIL KLOXIN**

Associate Professor

S. ISMAT SHAH

Professor



NEW NAE MEMBER

SELF-HEALING MATERIALS INNOVATOR PROF. NANCY SOTTOS RECOGNIZED FOR HER INFLUENCE

Materials scientists and engineers have developed materials with the ability to heal themselves from damage by closing up tiny cracks before they become deep fissures. These materials can be used to protect infrastructure, military equipment, industrial machinery and more.

One of the pioneers behind the development of these self-healing materials is Nancy Sottos, a University of Delaware alumna.

For her impact and influence, Sottos, the Department Head, Professor and Swanlund Chair of Materials Science and Engineering at the University of Illinois at Urbana-Champaign, was recently selected as a member of the National Academy of Engineering (NAE).

This is among the highest honors an engineer can receive. “Election to the NAE is an honor and wonderful recognition by my peers,” said Sottos. “I feel very proud and humbled to have the opportunity to participate in the NAE.”

Sottos received a bachelor’s degree and doctoral degree in mechanical engineering from UD in 1986 and 1991, respectively. She received the Department of Mechanical Engineering’s Distinguished Alumni Award in 2007 and is an external advisory council member for the Department of Materials Science and Engineering, which was founded in 1998.

“While at UD, one of the most important things I learned for my future career was how to work as part of a collaborative team,” said

Sottos. “All of my current research is part of a collaboration with chemists, materials scientists and aerospace engineers. UD also gave me a strong foundation in mechanics and materials.”

Her doctoral advisor and a founder of UD’s Center for Composite Materials, the late Roy McCullough, helped Sottos think outside the box. Mechanical Engineering Professors Tsu-Wei Chou, Mike Santare, Mike Greenberg, and co-advisor Selcuk Guceri—the latter now a professor at Worcester Polytechnic Institute—were also instrumental to her education, said Sottos.

Today, Sottos conducts research centered on polymers and composite materials capable of self-healing and regeneration, mechano-chemically active polymers, and materials designed for reliable energy storage.

With her collaborators, Sottos co-founded a company, Autonomic Material Inc., that has commercialized self-healing coatings and paints based on their research. “Future applications may involve composite structures that can self-heal or self-report damage—for example—a space structure that can autonomously heal damage from the environment,” she said. “Use of self-healing strategies in solid state batteries is another promising application.”

Sottos has previously been recognized with the Office of Naval Research Young Investigator Award, Scientific American’s SciAm 50 Award, the Hetényi Best Paper Award in Experimental Mechanics, the M.M. Frocht and B.J. Lazan Awards from the Society for Experimental Mechanics, the Daniel Druckner Eminent Faculty Award, an IChemE Global Research Award and the Society of Engineering Science Medal. She is a Fellow of the Society of Engineering Science and the Society for Experimental Mechanics.

ALUMNI NEWS

XINRAN ZHOU (PHD, 2014)

Materials Science and Engineering alumna and postdoctoral researcher Xinran Zhou left UD's campus with a sense of pride, confidence and an overwhelming feeling of empowerment. Now a Process Engineer with Lam Research Xinran recalls how the research opportunities at UD set her up for success, "I started my research with a comprehensive project that helped me to understand the world from a quantum level, which was more than helpful when I became a process engineer in Lam Research."

Xinran also credits the chance to join organizations such as Women in Engineering which "helped many female students to develop their career and life goals." The MSEG department's collaborative research environment stretching out across many different fields was also impressive and beneficial for Xinran.

BO TEW (PHD, 2019)

"I came to the Department of Materials Science and Engineering expecting to only gain a degree in materials science; instead, I left having gained experiences as a leader and a well-rounded person ready to contribute to our society," said Tew, who is now a process engineer at Intel Corporation. Tew knew he would learn from world-class professors and work with state-of-the-art equipment.

However, he found that the department empowers every student by providing opportunities within and outside of research, challenging them to explore our potential and grow into excellent, well-prepared scientists. "My horizons widened as the department grew - as the scope of research expanded to encompass the burgeoning creative impetus of new professors, so did the exchange of ideas within the department as well as the attention from an increasing number of collaborators eager to work with us," said Tew.

"Moreover, students' ideas are respected and cherished, used as a bottom-up approach to mold the direction of the department. Most MSEG students feel encouraged to engage with developing their professional and social circles, and as a result, have actively spearheaded highly visible initiatives at the departmental, the college, the university and the community level, with the support and encouragement by professors." For example, students lead programming of the annual MSEG Career Day, which cultivates a network between local research professionals and students who present their work. "Overall, the high expectations and genuine encouragement among everyone in the department makes this the perfect place to kick start any engineer's career," said Tew.



RECENT GRADUATES

MMSE GRADUATES

2018

FRANCIS KLINCEWICZ
CHRIS LEE
GEOFFREY MERRITT
CHINMAY PAWAR
ZACHARY SHEFFIELD
DAVID WOODS

2019

REID BREMBLE
JOHN OBAMEDO
ZHIKANG WANG
YICHEN YAO
CHUN-HAO YEH
XUYANG ZHANG
ZHENHUA ZHANG

2020

MOOSA HUSAIN ALHARTHE
HUSAM OMAR ALSALMI
ADA ANYANWU
COLIN PATRICK DELUCIA
SONGHEE HAM
COLLEEN MURRAY
GREGORY ZADOR

PH.D. GRADUATES

2018

GLENN CATLIN
Advisor: Opila
Structure-Property Relationships of Printed Bismuth Telluride Thermoelectrics

ERIC CHEN

Advisor: Doty
Characterizing Semiconductor Upconverter Nanostructures Using Optical Spectroscopic Techniques

KEVIN THOMAS DICKER

Advisor: Jia
Interfacial Bioorthogonal Crosslinking for the Fabrication of Functional Hydrogels

MICHAEL HAIDER

Advisor: Pochan
Computationally Designed Coiled Coil Peptides for The Solution Assembly of Nanostructured Materials

KEVIN JONES

Advisor: Opila
Single-Stage Co-Evaporation and Surface Characterization of (Ag,Cu)(In,Ga)Se₂ Semiconductors for Solar Cell Application

HANG KUEN LAU

Advisor: Kiick
Resilin-Like Polypeptide-Based Microstructured Hydrogels via Aqueous-Based Liquid-Liquid Phase Separation for Tissue Engineering Applications

MATTHEW LEWIS

Advisor: Zide
Growth and Characterization of Lanthanide Pnictide Nanoparticles by Pulsed Laser Ablation for Incorporation into III-V Semiconductor Nanocomposites

HSIANG-YU LIU

Advisor: Birkmire
Silicon Defect Passivation by H₂S Reaction and Patterning Process of Interdigitated Back Contact Silicon Heterojunction (IBC-SHJ) Solar Cell

ABHISHEK SHETE

Advisor: C. Kloxin
Photopolymerization of CU(I)-Catalyzed Azide-Alkyne Cycloaddition (CUAAC) 'Click'-Based Networks for New-Age Materials

YU TIAN

Advisors: Pochan & Kiick
Programmable Nanomaterials Development via Kinetically Controlled Self-Assembly of Computationally Designed Peptides

SHUYU XU

Advisor: Rabolt
Fabrication and Environmental Applications

of Silver Coated Gold Nanorods/ Electrospun Polymer Fiber Matrix for Use as Surface Enhanced Raman Scattering Substrates

XIAOYU ZOU

Advisor: Jia
Mechanically Strained Culture of Human Mesenchymal Stem Cells

2019

SARAH GEIGER

Advisor: Jia & Hu (MIT)
A 3D Photonic Sensor-Integrated Tissue Model for Strain Sensing

THERESA GINLEY

Advisor: Law
The Van Der Waals Epitaxy of Bismuth Chalcogenide Topological Insulators for Terahertz Plasmonic Applications

CHUN-YEN HSU

Advisor: Ni
In-Situ Mechanical Properties of Reaction Bonded Silicon Carbide/Silicon and Multi-Walled Carbon Nanotubes Reinforced Polymer Composites at the Nanoscale

CHANGHAO LIU

Advisor: Rabolt
Understanding Crystallization Mechanisms of a Biodegradable Copolymer Poly [R-3-Hydroxybutyrate-CO-R-3-Hydroxyhexanoate] (PHBHX) and the Inhibition of Its Crystallization Using Aluminum Oxide and Pseudoboehmite

ANITHA RAVIKRISHNAN

Advisor: Jia
Regulating Cell Phenotype and Function Using Custom-Designed Synthetic Matrices

BRYAN SUTHERLAND

Advisor: C. Kloxin
Design, Synthesis, and Assembly of Sequence-Defined Vinyl Sulfonamide Click Nucleic Acids (VS-CNAs)

BO TEW

Advisor: Zide
Properties of Lanthanide Monopnictide Nanocomposites and Study of Liquid Phase Epitaxial-Grown Thin Films

TIANSHI WANG

Advisor: Ni

*Electronic and Thermal Properties of Wide Bandgap Materials from Density Functional Theory***DONGXIA WEI**

Advisor: Law

*Semiconductor Hyperbolic Metamaterials for the Infrared***2020****TYLER CROSS BAZZOLI**

Advisor: Mackay

*Nucleation and Particle Growth Phenomenon of Potassium Trans-(Dioxo) Tetra (Hydroxo) Osmate***MICHAEL A. LLOYD**

Advisor: Birkmire

*Single-Crystalline Kesterite Photovoltaics Routes Toward Improvement in Open Circuit Voltage***PAUL EMERSON PARSONS II**

Advisors: Opila & Mirotznik

*Material Development for Functional Additive Manufacturing***NAIRITI J. SINHA**

Advisor: Pochan

*Programmable Nanomaterials Via Hybrid Assembly of Computationally Designed Coiled Coil Bundlers***VIVEK SUBRAMANIAN**

Advisor: Martin

*Operando Liquid-Cell Electron Microscopy of the Electrochemical Polymerization of Beam-Sensitive Conjugated Polymers***CHASE BYRON THOMPSON**

Advisor: Korley

*Utilizing Self-Assembly and Additive Manufacturing to Control Mechanics and Stimuli-Response in Structured Polymer Networks***YONG WANG**

Advisor: Law

*Bridging Between Plasmonics and Spintronics The Spin Plasmons in Topological Insulators***YUEJING WANG**

Advisors: Zide & Law

*LN-V/III-V Material Platform for Mid-Infrared Plasmonics***YUYING ZHANG**

Advisor: Ni

Structural, Thermal and Mechanical Properties of Reaction Bonded Silicon Carbide/Silicon and Diamond/Silicon Carbide Composites



EMPOWERING FELLOW GRADUATE STUDENTS

When considering the next step in his educational and professional journey, Igor Evangelista felt he was ready for something new. Having already obtained a bachelor's and master's degree in physics, Igor felt drawn to the field of engineering and specifically the MSEG program at UD because, "it mixes different fields within hard and soft material sciences." The program's reputation and researchers were also attractive, ultimately giving Igor the opportunity to work with his current advisor Dr. Anderson Janotti.

As an international student from Brazil, Igor knows first-hand how difficult it can be to branch out and meet new people when you're far from home. His personal experiences are what inspired Igor to get involved with EmPOWER – the College of Engineering's graduate student peer mentoring program. Igor recognizes that EmPOWER helped him make new friends and grow as a person and by becoming a mentor himself, Igor feels he can be a "good resource for new students" embarking on their own journey



BUILDING A STRONGER WORLD

AFTER AN EARLY LOOK AT UD, COLLEEN MURRAY RECOGNIZED FOR EXCELLENCE IN COMPOSITE MATERIALS RESEARCH

Many people spend years searching for their calling, but Colleen Murray was only 12 years old when she discovered her passion for materials engineering. She was fascinated by the surprisingly strong materials, such as fiberglass and carbon fiber laminates, that she was given to build a miniature bridge during a University of Delaware K-12 Engineering summer camp.

"I thought it was just so incredible that something so lightweight, when combined the right way, could end up creating such a stiff material that could be used for all different applications," said Murray.

A decade later, Murray developed sensors to keep real bridges safe as a graduate student in materials science and engineering and a researcher at UD's renowned Center for Composite Materials (CCM).

Murray received the 2019 Harold Giles Memorial from the Society of Plastics Engineers (SPE) Composites Division. At the 2019 Society for the Advancement of Material and Process Engineering (SAMPE) University Research Symposium, which sponsors selected SAMPE student members to present the results of their technical research at the Composites and Advanced Materials Expo (CAMX) each year, Murray

won first place in the MS category. At the CAMX 2019 Technical Paper Award and Poster Session, Murray was the second runner-up in the poster session.

After Murray's introduction to materials engineering as pre-teen, her interest only grew. In high school, Murray — a Delaware native — interned at CCM through the UD K-12 Engineering High School Internship Program. Later, as an undergraduate and then graduate student at UD, she continued to study composites.

With Shridhar Yarlagadda, Assistant Director of Research at the Center for Composite Materials, Murray worked on an ankle-foot orthotic and an exoskeleton to help soldiers carry heavy bags. With Erik Thostenson, Associate Professor of Mechanical Engineering, Murray studied carbon nanotube-based sensors that can be used to monitor crack growth in infrastructure.

Murray appreciates working on materials with apparent real-world applications. "I want to know the purpose of what I'm doing and how it's going to affect the world around me," she said. "Being able to work on projects that have a real application in the world makes a world of a difference to me and keeps me motivated day to day."

MATERIALS RESEARCH SOCIETY OFFICERS 2020-2021

Tory Welsch, President

Derek Bischoff, Vice President

Jill Cleveland, Treasurer

Tasnim Kamal Mouri, Secretary

Vidhika Shashikant Damani and Wilder

Acuna Gonzalez, MRS Representatives

Sampanna Mhatre and Shagorika

Mukherjee, First Year Representatives

We'd also like to recognize the following students who served as 2019-2020 MRS officers: James Bork, President; Tory Welsch, Vice President; Jill Cleveland, Secretary; Luisa Palmese, Treasurer; Sai Patkar, Brandon Chen, and Vivek Subramanian, MRS Representatives; and Derek Bischoff and Tasnim Mouri, First Year Representatives.

STUDENT AWARDS

DEPARTMENTAL AWARDS

CHAIRPERSON'S OUTSTANDING GRADUATE STUDENT AWARD

Iflah Laraib; Jenna Harris;
Nicole Halaszynski

OUTSTANDING GRADUATE STUDENT RESEARCH AWARD

Yuejing (Crystal) Wang; Bryan Sutherland;
Hang Kuen Lau

OUTSTANDING GRADUATE STUDENT TEACHING AWARD

Nicole Halaszynski; Nicholas Valdes;
Sarah Geiger; James Hack; Kyunghye Kim;
Bryan Sutherland; He Zhang

OUTSTANDING GRADUATE STUDENT SERVICE AWARD

Jill Cleveland; Joanne Norris; Bo Tew;
Chase Thompson; Austin Kuba;
Matthew Lewis; Lauren Nowicki; Nicholas Valdes

ART IN MATERIALS WINNERS

Changhao Liu
"Diffusions Will Tell a Crystal Heart Made of a Soft Soul"

Description: Diffusion control polymer crystallization

BRYAN SUTHERLAND *"Ombre"*

Description: Solutions of synthesized monomeric compounds separated by flash chromatography

MRS MSEG STUDENT SYMPOSIUM AWARD – OUTSTANDING PRESENTATION

Quintin Baugh, Hanyuan Gao, Faheem Muhammed and Joanne Norris - 2020

UNIVERSITY AND GRADUATE AWARDS

UNIVERSITY DISSERTATION FELLOWSHIP AWARD, GRADUATE COLLEGE

Patrick Sohr; Eric Fowler

GEORGE W. LAIRD MERIT FELLOWSHIP AWARD

Prashant Ramesh

DENIN RESEARCH AWARD

Joanne Norris

NASA DELAWARE SPACE GRANT COLLEGE PROGRAM

Theresa Ginley

UNIDEL AWARDS

Prashant Ramesh; Francis Klinecicz

UNIVERSITY DOCTORAL FELLOWSHIP AWARD

Olivia George; Jiyeon Song;
Anitha Ravikrishnan; Abhishek Sharan (Physics); Tianshi Wang

UNIVERSITY GRADUATE SCHOLARS AWARD Victor Font Bartumeus

R. L. MCCULLOUGH SCHOLARS AWARD - CENTER FOR COMPOSITE MATERIALS

Paul E. Parsons II

CENTER FOR COMPOSITE MATERIALS ACHIEVEMENT AWARD

Colleen Murray
Paul E. Parsons II

EXTERNAL AWARDS

ACS POLYMER CHEMISTRY DIVISION (POLY), EXCELLENCE IN GRADUATE POLYMER RESEARCH SYMPOSIUM
Nairiti Sinha; Bryan Sutherland – Outstanding Poster Award

COMPOSITES ADVANCED MATERIALS EXPO

Colleen Murray – First Runner Up
"In Situ Sensing of Damage Progression in Composites Using Glass Fibers with Electrophoretically Deposited Nanotubes"

BRANDYWINE ASM BIRCHENALL PAPER AWARD

Yu Tian
"Transition from Disordered Aggregates to Ordered Lattices: Kinetic Control of the Assembly of a Computationally Designed Peptide"

SOCIETY OF PLASTICS ENGINEERS (SPE) COMPOSITES DIVISION - HAROLD GILES MEMORIAL AWARD
Colleen Murray



QUANTUM DOTS AND CLASSIC ROCK

ENGINEERING DOCTORAL STUDENT RECOGNIZED

Prashant Ramesh is living out his childhood dreams.

As a kid, Ramesh devoured books about modern physics and idolized Albert Einstein. He took piano lessons and singing lessons and listened to classic rock with his Dad.

Today, as a doctoral student in the University of Delaware Department of Materials Science and Engineering, Ramesh uses the principles of modern physics to study quantum dots, tiny nanoscale semiconductors that could someday enable faster computing, more precise medical imaging technologies and more. Outside the lab, he plays guitar in a band composed of fellow engineering students.

For his well-rounded contributions to the

College of Engineering and his potential to make an impact on the world, Ramesh was selected as the 2020 winner of the Laird Fellowship, an annual award that helps one first-year engineering graduate student at the University of Delaware pursue interests beyond his or her field of study.

FROM THE LAB TO THE STAGE

Ramesh does cutting-edge research in the University of Delaware Nanofabrication Facility. Ramesh is co-advised by Matt Doty, Professor of Materials Science and Engineering, Physics, and Electrical and Computer Engineering, and Joshua Zide, Professor of Materials Science and Engineering.

Ramesh's research intrigues him deeply, harkening back to his early days of reading biographies of famous physicists. "On a very practical side, being in the cleanroom is a lot of fun," he said. "I like tinkering with things, working with equipment and getting things to work a certain way, and so this is just that at an extremely cutting-edge level. On the more theoretical side, I've always been really curious about quantum physics, and it's just so interesting how things at a small scale diverge from all properties that we see at a macro scale."

The researchers are using molecular beam epitaxy, which allows you to deposit materials in

very thin (atomic scale) layers to create semiconductor devices. Another graduate student primarily grows the materials, and Ramesh fabricates devices and does optical characterization—using lasers and other components to examine the material's properties.

UD's resources in this area drew Ramesh to Delaware. He did undergraduate research in quantum materials at Penn and has industry experience working on novel solar devices. "I was looking for schools that had invested a lot into nanotech and fabrication, because I knew that I wanted to do that kind of work, so I searched for schools that have really nice, robust nanofabrication and characterization centers," he said.

Another thing Ramesh wanted to pursue? His passion for music.

"Music has been a big part of my life, but in very different ways throughout different phases of my life," said Ramesh.

Growing up, Ramesh studied Carnatic singing, a classical Indian musical genre. When he attended the University of Pennsylvania for his undergraduate studies, he joined Penn Masala, a premier South Asian a cappella singing group. With Penn Masala, Ramesh performed all over the world and even appeared in *Pitch Perfect 2*, where the group sang "Any Way You Want It" by Journey.

After graduating from Penn, where he received a bachelor's degree in chemical engineering and a master's degree in materials science and engineering, Ramesh started playing guitar just about every day. He also writes some of his own songs.

Ramesh joined UD in fall 2019, and at a materials science and engineering department get-together, he connected with the members of a student-led band playing at the event. He asked if he could jam with them, and before long, they had invited him to join the band. They practice about once a week.

SUPPORT THE DEPARTMENT

As the department continues to succeed in graduate education and research, and continues to grow with the addition of our new undergraduate program, we invite you to make a gift to help strengthen and sustain the Materials Science and Engineering Department. We are working to establish long-term financial resources in support of graduate student research fellowships, undergraduate fellowships, and named professorships. Your gift will ensure that the people who make up our MSE family will be as successful as possible during not only these current, unprecedented times but for years to come.

**YOU CAN GIVE ONLINE AT
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You can also give by check; indicate the department name in the memo line and mail the check to:

**Development and Alumni Relations
83 E. Main Street, 3rd Floor
Newark, DE 19716**

If you have any questions or would like to learn more, please call Kris Graves at 302-831-4703 or gravesk@udel.edu.

Thank you for supporting the Materials Science and Engineering Department at the University of Delaware and ensuring the continued success of the excellent group of faculty and students at the heart of 21st century materials research and education at UD!



Materials Science &
Engineering

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