Institute of Materials Science Newsletter 2022

IMS INSTITUTE OF MATERIALS SCIENCE

UCONN UNIVERSITY OF CONNECTICUT

Director
Dr. Steven L. Suib

Associate Director
Dr. Rainer Hebert

IMS Polymer Program
Dr. Kelly Burke, Director

Materials Science and Engineering Department
Dr. Bryan Huey, Department Head

IMS Industrial Affiliates Program
Dr. Paul Nahass, Director
Dr. Hatice Bodugoz-Senturk, Associate Director

IMS Contributing Writers
Kaitlyn Cullen
Osker Dahabsu
Rhonda Ward

Additional Contributions
UConn Communications
UConn Today
Texas Advanced Computing Center
Materials Science and Engineering Dept.

Design and Layout
Rhonda Ward

Institute of Materials Science
97 North Eagleville Road, Unit 3136
Storrs, CT 06269-3136
Phone: (860) 486-4623
Fax: (860) 486-4745

On the Cover:

Our cover comes from the research of James N. (Nate) Hohman, assistant professor of chemistry. The image represents the liquid jet of sample in which the sample is suspended, the beam of the X-ray free-electron laser (XFEL), and the diffraction data resulting from the interaction of the beam with individual crystals in the jet. Every time the beam "hits" a crystal, a diffraction pattern is projected onto the detector. These are collected, and from this information the orientation of the individual crystals may be determined. A single-crystal structure can be determined by normal methods after merging 105 "hits."

Read more about Dr. Hohman's research on page 23.

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MESSAGE FROM THE DIRECTOR

Welcome to this year's edition of our annual IMS Newsletter. We trust that you are all well during these very challenging and unusual times. We are particularly grateful for the outstanding support we have received from all of you.

Our labs remain fully engaged, faculty and staff are excelling in their positions, and we are particularly excited about our move into Science 1, a new state of the art facility for materials research. While we look forward to the move, we will always have fond memories of the IMS Gant North wing. We will cherish our experiences with the people who have come and gone, and we cannot forget all the great work that has been done there over so many years. The last stage of the Gant Complex will be the renovation of the IMS wing for new occupants after our move to greener pastures. In fact, Science 1 will have all the colors of nature, including a Woodland Walkway with plenty of flora. Please stop in and visit us in our new home later this fall.

We offer our congratulations and best wishes to those who have retired during this academic year: Richard Parnas, Roger Ristau, and JoAnne Ronzello. We thank them for their service and will miss them. We welcome Sarah Moore, a new administrative assistant in the Materials Science and Engineering Department. There are more new staff and faculty to come and we thank the administration for their continual support of IMS.

In this issue, you will notice a number of significant activities, new and ongoing. Long-time IMS members have been promoted to positions of major importance at UConn, including Interim President Radenka Maric and Interim Vice President for Research, Innovation, and Entrepreneurship Pamir Alpay. We wish them our best in such vital positions. And there has never been a stronger supporter of IMS than Provost Carl Lejuez who has provided sound guidance through several challenging years.

Our graduate programs continue to progress as we experience advances in the sciences. New IMS courses have been added to strengthen our educational program for an impressive group of student researchers. Our outreach program is also expanding as we create deeper ties to industry and community partners. Grant support remains a sustaining force for our researchers, and you can read about several new endeavors within these pages.

Materials are central to our existence. Our materials programs have resulted in major impacts in the areas of energy, new materials, medicine, pharmaceuticals, biomedical, and many other areas. Much of our equipment is state of the art and available to both internal and external users. Service is a central core mission of IMS and we continue to grow in that area.

Buildings are buildings and equipment are machines and labs are facilities. But key to our Institute are people. Our people have worked very hard and safely during the past few years, and we are grateful to every member of our dedicated community for their role in keeping IMS strong.

Wishing you all the best,

Steven L. Suib

Steven L. Suib, Director
Institute of Materials Science

Notable Appointments

Radenka Maric Named UConn Interim President

excerpted from a story from UConn Today

Dr. Radenka Maric

For me, the students are everything. That is very personal to me and very important. I want them to know that whatever struggles they may have, the University is here to support them and to prepare them with the skills they will need in order to succeed.

As UConn's incoming interim president, Radenka Maric brings a background of talents and interests that are as multi-faceted as the University itself, but with the same cardinal commitment to place students at the center of its efforts.

Maric is UConn's vice president for research, innovation, and entrepreneurship, and has been a faculty member and researcher since 2010 at the University, where she also is a Board of Trustees Distinguished Professor. She will serve as interim president starting Feb. 1 to succeed Dr. Andrew Agwunobi, who is leaving for private industry.

Maric's accomplishments could fill many pages: she holds multiple patents, has been elected to prestigious professional organizations, published hundreds of scholarly works, received more than $40 million in research grants, and is fluent in four languages with a working knowledge of others.

But what has always been most important to her is the process of mentoring students and ensuring their wellbeing, helping them discover their academic passions and create professional and personal lives in which they, too, make their mark on the next generation as mentors.

"For me, the students are everything. That is very personal to me and very important," Maric says. "I want them to know that whatever struggles they may have, the University is here to support them and to prepare them with the skills they will need in order to succeed."

"I'm truly honored and humbled," she says of her selection as the interim leader. "As former President Susan Herbst says, the institution is much larger than any one of us and it is a privilege to be asked to serve."

Maric says the first order of business will be working with others throughout UConn to return to in-person learning on its campuses as planned in early February, doing so in the most safe and healthy manner possible for its students, faculty, and staff amid ongoing COVID concerns.

"It is equally important to ensure the well being of our faculty and staff so they can ensure a successful semester," she says. "We will continue to all work together to find creative ways in this uncertain time to continue our support of our students, our community, and our state."

Maric was born and raised in the former Yugoslavia and earned her bachelor's degree at the University of Belgrade in Serbia before moving to Japan to earn her master's and Ph.D. in materials science and energy at Kyoto University.

Her time in Japan was critical not only professionally, but also personally. She was studying at Kyoto University when Yugoslavia broke up in the early 1990s, seeing her scholarship disappear and eventually finding herself with so few resources that even affording food became a challenge.

But with the support of her mentor, she was able to overcome that challenge; in fact, she and that mentor stay in touch with regular emails. The experience was so impactful that she has committed to assisting students herself as well; she has personally established more than $100,000 in fellowship funds through the UConn Foundation to assist students.

"Giving to the university has been very important and very personal to me because I do know what it is like to be without funds. I was one of those students."

"And I now also know how much joy and pleasure one can get from giving (them) support financially as well as through your time and mentorship," Maric says, noting that encouraging philanthropy will be an important focus of her time as interim president.

Having lived and worked in several countries, her international experience also will be a boon to UConn, which has a strong focus on preparing its students to live and compete in a global economy and to celebrate other cultures and traditions.

Like UConn itself, Maric has multi-faceted interests and skills.

She came to UConn as a faculty member in 2010 after an accomplished career in private industry and research. In addition to being vice president for research, innovation, and entrepreneurship, Maric is the Connecticut Clean Energy Fund Professor of Sustainable Energy in the Department of Chemical & Biomolecular Engineering and Department of Materials Science and Engineering.

After graduation from Kyoto University, she stayed to work in Japan for about a decade before moving to Atlanta to work for a fuel cell research company in 2001. She transitioned in 2004 to become a group leader and program manager for Institute for Fuel Cell Innovation in Canada, then joined UConn in 2010 as a faculty member in the departments of Chemical & Biomolecular Engineering, and Materials Science and Engineering.

She is an elected member of the Connecticut Academy of Science and Engineering and a Fellow of the American Association for the Advancement of Science, and has also earned many other professional honors and designations for her work.

Maric has admirers at all levels, from first-year UConn students fresh out of their high schools to the hallways of the state Capitol.

Gov. Ned Lamont has praise for Maric, noting he had appointed her to serve on the Connecticut Innovations Board of Directors because of "her incredible contributions to improve and strengthen UConn's prowess in research."

"UConn is incredibly fortunate to have the talented and unflappable Dr. Radenka Maric to steer UConn on an interim basis," Lamont says. "Our Huskies will remain in good hands."

While scientific pursuits and mentorship are at the root of her academic and research careers, Maric has personal pursuits as diverse as the University's portfolio itself, particularly in humanities realms.

She is a talented painter and pianist, an amateur chef, and speaks four languages fluently (Croatian, English, German, and Japanese), with a working familiarity with Italian. She also designs and makes much of her wardrobe, first inspired by receiving a sewing machine as a birthday gift when she was a child.

"My philosophy about life is that we should explore who we are and discover ourselves," she says, noting she was always strong in science but also liked music, and did not feel she had to give up one for the other.

"You have to strive for excellence and that is what I teach my students. That is what I will continue to do to serve UConn.

"Everybody has talents to discover as part of knowing who you are. I support every student in learning who you are – through your whole life, you learn," she says.

"When I compete, I don't compare against other people. I compete against myself," she adds. "I ask myself, 'Am I, Radenka, better today than I was one month ago or even yesterday? Did I learn something new?' You have to strive for excellence and that is what I teach my students. That is what I will continue to do to serve UConn."

Interim UConn President Radenka Maric in her lab with graduate research assistant Alanna Gado, left, and Ph.D. student Jiale Xing (UConn Photo).

Pamir Alpay Appointed Interim Vice President for Research, Innovation, and Entrepreneurship

excerpted from UConn Today

Dr. S. Pamir Alpay at speaks at opening of IPB Tech Park

S. Pamir Alpay was appointed interim Vice President for Research, Innovation, and Entrepreneurship (VPRIE) by Interim President Radenka Maric. Prior to the appointment, Pamir, a Board of Trustees Distinguished Professor, served as the executive director of the UConn Innovation Partnership Building (IPB).

"He is well known throughout UConn for his tireless work in supporting faculty research, fostering industry partnerships, and setting an example of innovation with his own work in smart/functional materials and multi-scale materials modeling," President Maric noted in announcing the appointment.

"In an institution that is fortunate to have so many talented faculty researchers, Pamir is particularly impressive and well suited to take on this important leadership role," Maric said.

Pamir came to UConn in 2001 from the University of Maryland, where he received his PhD in materials science and engineering in 1999 and worked as a postdoctoral researcher for the next two years, specializing in modeling of functional materials systems.

He joined the UConn School of Engineering as an assistant professor in the Department of Materials Science and Engineering, moving to the rank of associate professor (with academic tenure) in 2007 and then to full professor in 2010. He also served as MSE's department head from 2013-17.

Pamir distinguished himself quickly and consistently in those roles, earning a National Science Foundation Faculty Early Career Development Award in 2001 and the School of Engineering's Outstanding Junior Faculty Award in 2004.

He was named General Electric Endowed Professor in Advanced Manufacturing in 2017, and is a Fellow of the American Physical Society, ASM International, and the American Ceramic Society.

He has authored more than 180 peer-reviewed journal publications and conference proceedings, four invited book chapters, and an invited book co-authored on compositionally graded ferroelectric materials.

He was selected in 2017 as executive director of the IPB at the UConn Tech Park and has done outstanding work managing that state-of-the-art facility and coordinating associated industry partnerships. He has also continued to innovate in his field, including as the lead researcher on an $8 million project with the Air Force aimed at improving aerospace manufacturing processes.

Pamir's skills in leadership, creativity, and collaboration make him an ideal fit for the interim position leading UConn's burgeoning research enterprise.

Kelly Burke Appointed Director of IMS Polymer Program

from the Institute of Materials Science

Dr. Kelly Burke

Associate Professor of Chemical and Biomolecular Engineering, Kelly Burke, has been appointed Director of Polymer Program at the Institute of Materials Science (IMS). Kelly joined the UConn faculty in 2014 as an assistant professor with an appointment in IMS. She earned her Ph.D. in macromolecular science and engineering from Case Western Reserve University in 2010.

Since her arrival at UConn, Kelly has distinguished herself with an impressive array of honors including UConn's Research Excellence Program (REP) Award, the National Science Foundation's (NSF) Graduate Assistance in Areas of National Need (GAANN) Award, and the NSF CAREER Award. She has also collaborated with UConn colleagues on projects including the CT Regenerative Medicine Research Fund Award collaboration with Professor of Chemical and Biomolecular Engineering, Anson Ma, and the National Science Foundation's Emerging Frontiers in Research and Innovation (EFRI) with Professor and Head of Marine Sciences, J. Evan Ward. Kelly was also honored as Faculty Mentor to the 2017 UConn SURF Award winner.

Her research interests include synthesis and structure-property relationships of multifunctional polymeric materials, stimuli responsive polymers and networks, natural and synthetic biomaterials, and the design and application of polymeric systems to modulate inflammation and promote healing.

IMS Director Steven L. Suib announced the appointment noting that, "Kelly brings a lot of new ideas, energy, and support for this program." She succeeds Luyi Sun in the position.

Climate and Energy From Research to Solutions

Yang Cao is Working to Eliminate the Most Potent Greenhouse Gas

Sulfur hexafluoride is used to prevent fires in the electrical grid, but the gas is a major contributor to global warming, leading to a new research project to replace it.

from UConn Today

The gas sulfur hexafluoride (SF6) has been keeping our electrical grid safe from dangerous arcing and explosions since its introduction to the public in the 1930s. Developed in a General Electric lab, sulfur hexafluoride is one of the most widely used insulation gases by electrical utility companies because of its reliability and safety, but remains relatively unknown by the general public.

Starting in the 1960s, as greenhouse gases and their effect on the environment became more widely known, sulfur hexafluoride has been identified as one of the largest causes of global warming. While most educational and legislative efforts have been focused on CO_2 or carbon dioxide, emissions as a big offender, sulfur hexafluoride has flown under the radar despite its staggering global warming potential: 25,200 times that of carbon dioxide.

Because of that, University of Connecticut Electrical and Computer Engineering Professor Yang Cao has been selected to receive $2.7 million in funding over three years from the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) to develop a lifecycle management framework, with innovations in physics based aging modeling, aging byproducts fixation, and a low-cost, high-fidelity multi-gas leak sensor with GE Research, to help utilities make a smooth transition to a new, SF6–free electrical grid. Cao will be working with Institute of Materials Science Director Steven Suib, as well as scientists Radislav Potyralio and Karim Younsi from GE Research and others from GE Grid Solutions.

According to Cao's research, the biggest barrier to utility companies switching to alternative insulating gases is the uncertainty regarding their decomposition characteristics and potential toxicity. Up until recently, companies have found it technically challenging to develop a new, alternative gas, until the recent development of alternatives from 3M and GE Grid Solutions. These new gas families have shown promise, and when mixed with buffer gases like carbon dioxide and nitrogen, have shown a keen ability to hold up in cold environments.

But even with the promise shown, there have been hurdles. Studies, which have been done exclusively outside the U.S., have seen some decompositions and some discrepancies in byproducts. With that uncertainty, and questions on lifecycle management, U.S. utilities have not yet adopted these new gases.

Over the next three years, Cao and his team will be focused on leaks, aging byproduct detection, and fixations for g3 TM (GE's gas product). Through their development of sensing technologies and life cycle management approaches, U.S. utilities will be able to implement their technology on all types of equipment and be certain of the behaviors of these new gases. With minor adaptations, the technologies can be implemented on all types of SF6-free equipment and can be extended to retrofit in existing assets for SF6 leak detection and end-of-life fixation during the transition towards a sulfur hexafluoride-free green power network.

Dr. Yang Cao is Director of the Electrical Insulation Research Center (EIRC) at the Institute of Materials Science.

UConn's STEAM Team and Solar Tree

How Jasna Jankovic's idea to raise awareness about clean energy sources led to a diverse collaboration.

from UConn Today

Prototype of UConn STEAM Tree

Most Americans are familiar with the sight of a solar panel on a house or in a field. They know what solar power is, but may not really have a direct experience with using it. An interdisciplinary group of UConn faculty and students are looking to change that by constructing a "solar tree" and installing it on campus.

A solar tree usually consists of a metal base that supports panels to look like an actual tree. The solar power generated from the panels is stored in batteries, which allows users to charge personal electronic devices, like mobile phones. The technology is common in Europe and Asia, with growing numbers of solar trees in the US.

Known as the "STEAM Tree" due to the collaboration of Science, Technology, Engineering, Arts, and Mathmatics, the UConn solar tree is currently being constructed at the School of Fine Arts while a site for the tree is determined. The tree will have a dozen USB ports, and is almost completely made up of structural aluminum.

"We see this solar tree as a combination of artistic design, engineering design, and a social gathering place," says Jasna Jankovic, an assistant professor in the Department of Materials Science and Engineering, who initiated the idea of a solar tree on the UConn Storrs campus.

"The biggest attractor of this project for me is getting to work with a group of people that I really didn't know before and to work with people across different divisions," says Chris Sancomb, an assistant professor in the newly created Industrial Design program in the School of Fine Arts. "Work like this was one of the reasons I came to UConn as a faculty member."

Although there are a few other solar trees on university campuses, it is believed that UConn's solar tree will be the first on a college campus in the United States constructed solely by university faculty and students. It will also be the only portable solar tree that can be fully disassembled and reassembled, to be placed in various locations on and off campus.

"We are building the tree by cutting, welding, and bending, and using a lot of different kinds of fabricating," says Sancomb. "We are also using 3-D printing here and there for samples, and proof concepts that will later be manufactured out of aluminum. It is all made here on campus and the material has been sourced locally."

"Sunlight is not all that consistent to provide electricity, so we store energy to batteries and the electricity to the charging ports," says Sung Yeul Park, an associate professor in the Department of Electrical and Computer Engineering.

UConn graduate student Michelle Skowronek '20 (CLAS) is currently working on her masters of public administration degree, and did research into criteria like visibility, accessibility, walkability, the number of people that would pass the tree, and traffic flow.

Members of STEAM Team work on Solar Tree

"A group of us got together and identified probably half a dozen good sites on campus," says Cindy Jones, a professor in the Department of Ecology and Evolutionary Biology.

The professors believe that a collaborative project like the solar tree will be the start of more projects like it at UConn, and will assist in their teaching and research. The tree will serve research as a "living lab," and will enable the faculty and students to perform research with the tree – in areas like materials science, arts, biology, engineering, and social science.

"We imagine that the tree will be both a gathering place, and also a place where outdoor lectures can happen or even virtual lessons, where students can access their lessons through solar power," says Jankovic. "The education and research component are, beside the social place-making, the most important aspect of the tree."

Funding for the solar tree came from a UConn STEAM Innovation Grant, while batteries and solar panels were donated by Renogy.

Members of STEAM Team with Solar Tree

Jasna Jankovic is Recipient of NSF CAREER Award

from UConn Today

Dr. Jasna Jankovic

The National Science Foundation (NSF) Faculty Early Career Development (CAREER) Program awards competitive grants to support the research programs of early-career faculty who demonstrate remarkable potential to become leaders in their field.

Jankovic is working to increase the durability of electrodes in zero-emission energy systems. These systems include fuel cells, electrolyzers, batteries, and supercapacitors.

Jankovic will pioneer a never-before-tested comprehensive method to study and test these systems on a micro- and nano-level.

Historically, scientists have lacked advanced characterization methods, meaning degradation mechanisms were misinterpreted or simply not understood.

For her NSF CAREER project entitled "Understanding Degradation Mechanisms in Sustainable Energy Electrochemical Systems Using Advanced Characterization Approaches," Jankovic will investigate what undiscovered mechanisms and changes occur on the nano- and micro-level when an electrode degrades and how they impact how the device performs. She will also look at distinguishing the effects of each electrode component on the degradation process.

Better understanding of the degradation process will allow engineers to develop better, more durable sustainable energy systems.

Jankovic will develop an educational virtual reality program to attract young people to STEM and careers in clean energy. She will also develop an entrepreneurship and research training program for undergraduate and graduate students.

Science and Art Combine on Microplastics Research Effort

Heidi Dierssen is conducting research to improve remote sensing of microplastics on the ocean's surface.

from UConn Today

Our world is filled with plastics. From packaging around the food we eat to the clothes we wear, plastic is all around us, and, unfortunately, much of that plastic makes its way into the ocean.

Since the 1950s, when plastic became a major part of consumers' lives, plastics have been accumulating on the ocean surface, transported by currents, wind, and waves.

A significant amount of this plastic is composed of what are known as microplastics. Microplastics are plastics smaller than 4.75 millimeters, about the size of a red ant, that have broken from larger plastics or come from tiny plastic materials. The ocean is filled with trillions of these microplastics.

Scientists know these plastics often concentrate along convergence zones where warm and cold surface water come together. Yet, there has never been a comprehensive analysis of the spatial and temporal distributions of microplastics. Furthermore, the monitoring tools for this task are not well-developed, as they have mainly focused on larger macroplastics.

Professor of marine sciences and geography, Heidi Dierssen, has received a nearly $577,000 grant from NASA to study better methods for remote sensing of surface microplastics using satellites. The project will involve a collaboration with a visual artist to advance community understanding of this problem.

Dierssen's lab, Coastal Ocean Lab for Optics and Remote Sensing (COLORS),

Dr. Heidi Dierssen

conducted previous research on the optical properties of microplastics, providing the necessary background information to determine the best approaches for remote detection. Understanding the optical properties of microplastics is the first step in determining whether satellites can detect and quantify floating microplastics from space.

Dierssen has assembled a diverse scientific team of experts from NASA Goddard Space Flight Center, Colombia University, University of Maryland, Baltimore County, and Terra Research Inc.

The team will evaluate the geospatial and temporal trends from existing studies of ocean color across hot spots that they suspect may be related to increased reflectance from accumulated plastics.

They will then produce estimates of surface reflectance under on different microplastic concentrations and atmospheric conditions. Dierssen's team will simulate the observations that new satellite sensors, such as hyperspectral imagers and polarimeters, could make under these different environmental conditions.

The researchers will then assess how well satellites could detect microplastics based on current and future instrument characteristics, microplastic quantity and nature, and external conditions such as atmospheric state.

They will evaluate the implications of the results of these analyses and make recommendations for the development of new algorithms and instrument designs.

The research team will work with visual artist Oskar Landi to produce an unconventional exhibit on microplastic pollution. This exhibit will be hosted at the Alexey von Schlippe gallery on the Avery Point Campus.

"This project will help advance the community's understanding of how floating microplastics can be detected and quantified with novel remote sensing technology under different environmental conditions and establish a unique partnership between science and art to add value and exposure to our study," Dierssen says.

Even in Retirement Richard Parnas Continues Environmental Work

from the Institute of Materials Science

Dr. Richard Parnas

Dr. Richard Parnas's UConn spinoff company, REA Resource Recovery Systems, broke ground in March 2021 on a first-in-the-world, FOG-to-Biodiesel production plant at the John Oliver Wastewater Treatment Facility in Danbury, CT. The City of Danbury contracted with Veollia North America to perform a 70 million dollar plant upgrade, and the REA FOG-to-Biodiesel system is included in the overall project.

The REA system makes use of a licensed UConn patent for a novel biodiesel reactor developed by Parnas and colleagues several years ago. REA sponsors work at UConn to continue development efforts on several aspects of the process including novel methods of sulfur reduction using protein/polymer conjugate gel adsorbents.

Dr. Parnas retired in 2020 after 19 years as a Professor of Chemical and Biomolecular Engineering and faculty member of the Institute of Materials Science (IMS) Polymer Program.

Making Strides in Medical Research

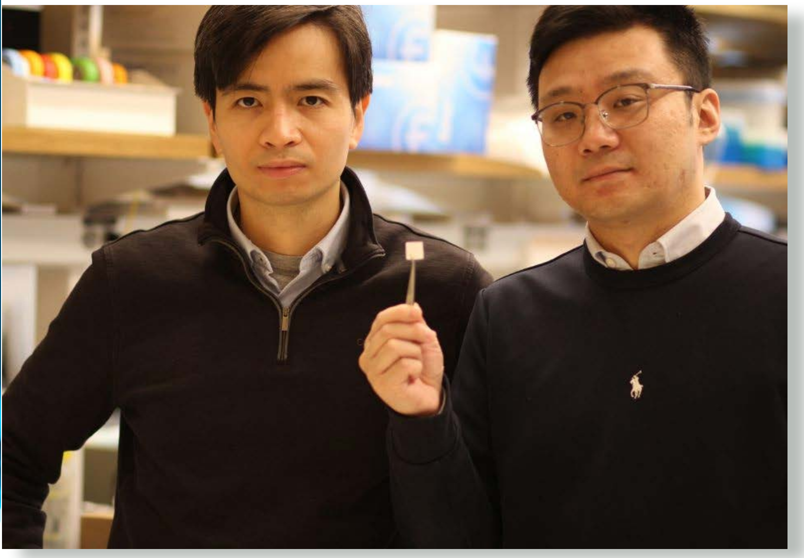
Regrowing Cartilage in a Damaged Knee Gets Closer to Fixing Arthritis

from UConn Today

The tissue scaffold (courtesy of Thanh Nguyen)

UConn bioengineers successfully regrew cartilage in a rabbit's knee, a promising hop toward healing joints in humans, they report in the January 12 issue of *Science Translational Medicine*.

Arthritis is a common and painful disease caused by damage to our joints. Normally pads of cartilage cushion those spots. But injuries or age can wear it away. As cartilage deteriorates, bone begins to hit bone, and everyday activities like walking become terribly painful.



UConn researchers Drs. Thanh Nguyen, left, and Yang Liu, with the tissue scaffold made out of a biodegradable polymer that they say holds promise for treating ailments like arthritis (courtesy of Thanh Nguyen).

The best treatments available try to replace the damaged cartilage with a healthy piece taken from elsewhere in the body or a donor. But healthy cartilage is in limited supply. If it's your own, transplanting it could injure the place it was taken from; if it's from someone else, your immune system is likely to reject it.

The best possible treatment would be to regrow healthy cartilage in the damaged joint itself. Some researchers have tried amplifying chemical growth factors to induce the body to grow cartilage on its own; other attempts rely on a bioengineered scaffold to give the body a template for the fresh tissue. But neither of these approaches works, even in combination.

"The regrown cartilage doesn't behave like native cartilage. It breaks under the normal stresses of the joint," says UConn bioengineer Thanh Nguyen, an assistant professor in the Department of Mechanical Engineering.

Nguyen's lab has also been working on cartilage regeneration, and they've discovered that electrical signals are key to normal growth. They designed a tissue scaffold made out of nanofibers of poly-L lactic acid (PLLA), a biodegradable polymer often used to stitch up surgical wounds. The nanomaterial has a neat property called piezo-electricity. When it is squeezed, it produces a little burst of electrical current. The regular movement of a joint, such as a person walking, can cause the PLLA scaffold to generate a weak but steady electrical field that encourages cells to colonize it and grow into cartilage. No outside growth factors or stem cells (which are potentially toxic or risk undesired adverse events) are necessary, and crucially, the cartilage that grows is mechanically robust.

The team recently tested the scaffold in the knee of an injured rabbit. The rabbit was allowed to hop on a treadmill to exercise after the scaffold was implanted, and just as predicted, the cartilage grew back normally.

"Piezoelectricity is a phenomenon that also exists in the human body. Bone, cartilage, collagen, DNA and various proteins have a piezoelectric response. Our approach to healing cartilage is highly clinically translational, and we will look into the related healing mechanism," says Yang Liu, a postdoctoral fellow in Nguyen's group and the lead author of the published work.

"The regrown cartilage doesn't behave like native cartilage. It breaks under the normal stresses of the joint."

~Dr. Thanh Nguyen

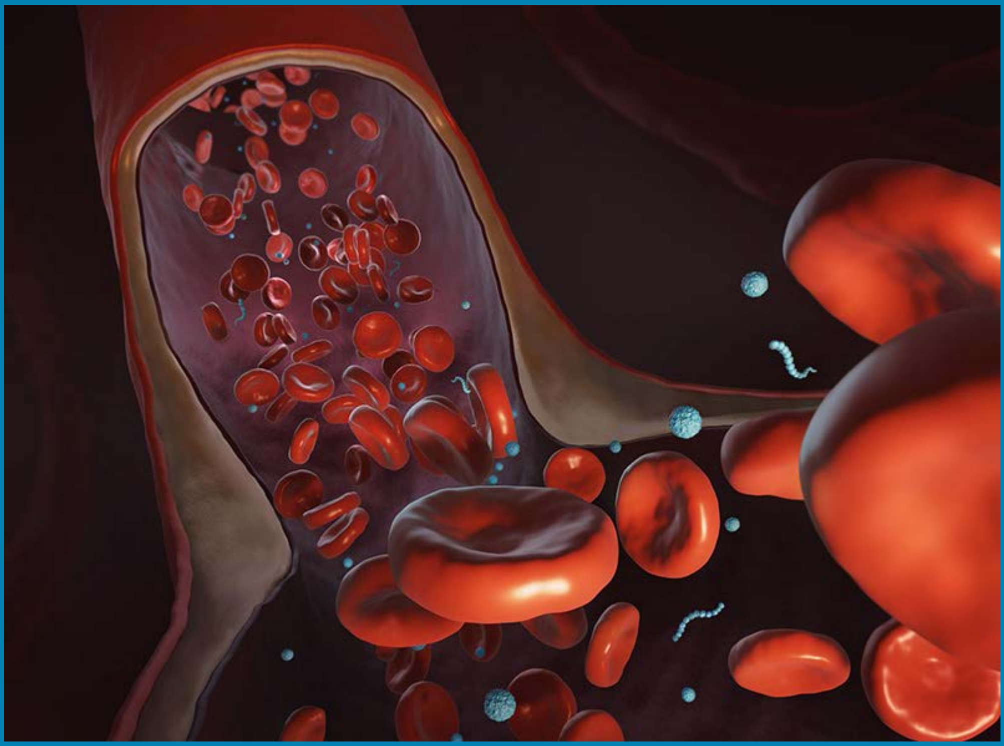
The results are exciting, but Nguyen is cautious.

"This is a fascinating result, but we need to test this in a larger animal, one with a size and weight closer to a human," Nguyen says. His lab would want to observe the animals treated for at least a year, probably two, to make sure the cartilage is durable. And it would be ideal to test the PLLA scaffolds in older animals, too. Arthritis is normally a disease of old age in humans. Young animals heal more easily than old—if the piezoelectric scaffolding helps older animals heal as well, it truly could be a bioengineering breakthrough.

Targeting Tumors with Nanoworms

Ying Li uses supercomputers and AI to improve delivery of nanomedicines for cancer.

from Texas Advanced Computing Center



Drugs and vaccines circulate through our vascular system reacting according to their chemical and structural nature. In some cases, their destination is diffuse. In other cases, like cancer treatments, the intended target is highly localized. The effectiveness of a medicine —and how much is needed and the amount of side-effects it causes —are a function of how well it can reach its target.

"A lot of medicines involve intravenous injections of drug carriers," said Ying Li, an assistant professor of Mechanical Engineering at the University of Connecticut. "We want them to be able to circulate and find the right place at the right time and to release the right amount of drugs to safely protect us. If you make mistakes, there can be terrible side effects."

Li studies nanomedicines and how they can be designed to work more efficiently. Nanomedicine involves the use of nanoscale materials, such as biocompatible nanoparticles and nanorobots, for diagnosis, delivery, sensing or actuation purposes in a living organism. His work harnesses the power of supercomputers to simulate the dynamics of nanodrugs in our blood stream, design new forms of nanoparticles, and find ways to control them.

"My research is centered on how to build high-fidelity, high-performance computing platforms to understand the complicated behaviors of these materials and the biological systems down to the nanoscale," he said.

Writing in *Soft Matter* in January 2021, Li described the results of a study that looked at how nanoparticles of various sizes and shapes —including nanoworms — move in blood vessels of different geometries mimicking the constricted microvasculature. Nanoworms are long, thin, engineered encapsulations of drug contents.

"We found that the transport of these nanoworms is dominated by red blood cells, which make up 40% to 50% of the flow," Li explained. "It's like driving on the highway — construction slows down traffic. Drugs are getting carried by individual red blood cells and dragged into narrow regions and getting stuck."

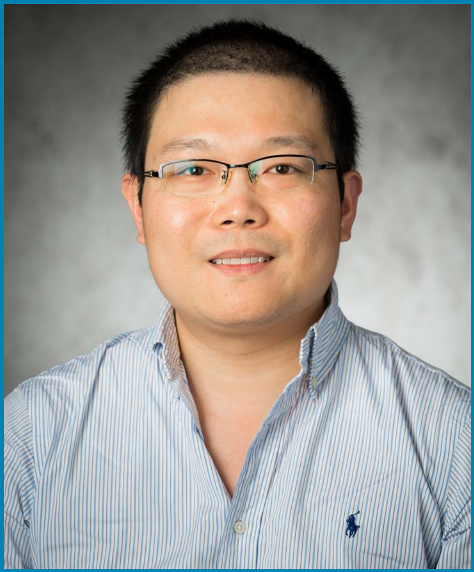
He determined that nanoworms can travel more efficiently through the bloodstream, passing through blockages where spherical or flat shapes get stuck.

"The nanoworm moves like a snake. It can swim between red blood cells making it easier to escape tight spots," Li said.

The first nanoparticle-based treatment to be FDA approved for cancer was Doxil — a formulation of the chemotherapy agent doxorubicin. Many more are currently in development. However, a 2016 study in Nature Material Review found only 0.7% of an administered nanoparticle dose is delivered to a solid tumor.

"We know that anti-cancer drug molecules are highly toxic," Li said. "If they don't go to the right place, they hurt a lot. We can reduce the dosage if we actively guide the delivery."

Tailor-made shapes are one way to improve the delivery of cancer drugs. (Currently 90% of administered nanoparticles are spherical.) Another way is to coax drugs to their target.



Dr. Ying Li

Li's team has computationally modeled nanoparticles that can be manipulated with a magnetic field. In a 2018 paper in the *Proceedings of the Royal Society*, they showed that even a small amount of magnetic force could nudge the nanoparticles out of the blood flow, leading to a far greater number of particles reaching the right destination.

Li's work is powered by the Frontera supercomputer at the Texas Advanced Computing Center (TACC), the ninth fastest in the world. Li was an early user of the system when it launched in 2019, and has used Frontera continuously since then to perform a variety of simulations.

"We're building high-fidelity computational models on Frontera to understand the transport behavior of nanoparticles and nanoworms to see how they circulate in blood flow," Li said. His largest models are more than 1,000 micrometers long and include thousands of red blood cells, totaling billions of independent ways that the system can move.

"Advanced cyberinfrastructure resources, such as Frontera, enable researchers to experiment with novel frameworks and build innovative models that, in this example, help us understand the human circulatory system in a new way," said Manish Parashar, Director of the NSF Office for Advanced Cyberinfrastructure.

Frontera allows Li not only to run computational experiments, but also to develop a new computational framework that combines fluid dynamics and molecular dynamics. IMS

Virus Expert Carolyn Teschke Awarded Fulbright Scholarship to Study in the UK

from UConn Today

Carolyn Teschke, professor and department head of molecular and cell biology at UConn, has been awarded a Fulbright Scholar Award to study virus assembly and evolution at the University of York, in the United Kingdom.

Teschke applied for the scholarship after talking with colleagues at the University of York for months about a collaborative project working on the process of virus assembly. The Fulbright, which is awarded by the U.S. State Department and international sponsors, will allow her to conduct research in the U.K. for four months.

"I am so pleased and excited to receive this prestigious award to study in the U.K.," says Teschke. "My hosts at the University of York, Professors Riedun Twarock, a mathematician who studies virus architecture, and Fred Antson, who studies large bacteriophages, will work with me to mathematically model how viruses assemble using experimental data generated in my lab."

Teschke's research focuses on understanding how a virus puts itself together inside an infected cell. Using a model system of bacteriophage P22, a well-known type of virus that infects bacteria, Teschke's lab group models how a herpes virus would attack, assemble, and replicate inside a human cell.

"Rather than studying a herpes virus, growing cell cultures and risking getting infected, we use this simple model system," Teschke says. "If we understand how our model system works, hopefully that information will assist scientists that study herpes viruses and help them develop antivirals."

An antiviral for the herpes virus might prevent it from replicating once it attacks a cell, thus reducing the chances of someone getting sick.

Teschke hopes to use her lab's data and Twarock's mathematics expertise in the geometry of virus capsids, or its outer protein-based shell, to understand on a more detailed level how the different proteins of P22 assemble.

"It's almost like a dance, the way the virus proteins have to come together in a specific order, with a particular affinity, or tightness, to make the capsid," Teschke says. "If we have an idea how tight the interaction between the proteins must be, we can make an antiviral that interrupts that process in the early stages."

By collaborating with Antson, Teschke hopes to understand how a virus evolves to grow bigger over time, and whether she can change the proteins in her model virus to become bigger, like the ones Antson works with. This would help her understand the process of virus evolution, where a virus accumulates mutations that affect the viral capsid geometry. IMS

Dr. Carolyn Teschke

Cato Laurencin is Only U.S. Professor Chosen as Royal Academy Fellow

from UConn Today

Dr. Cato Laurencin

UConn researcher, Dr. Cato T. Laurencin, has been elected an International Fellow of the United Kingdom's Royal Academy of Engineering, a prestigious distinction that this year was bestowed on just 69 people, with Laurencin the only U.S. professor to be elected.

Internationally renowned for his work in biomaterials, stem cell science, nanotechnology, drug delivery systems, and for pioneering a new field, regenerative engineering, Laurencin is Professor of Chemical Engineering, Professor of Materials Science and Engineering, and Professor of Biomedical Engineering. He is the University Professor and Albert and Wilda Van Dusen Distinguished Endowed Professor of Orthopaedic Surgery and serves as the Chief Executive Officer of The Connecticut Convergence Institute for Translation in Regenerative Engineering. He is the founder of the American Institute of Chemical Engineers' Regenerative Engineering Society.

Laurencin is an elected member of the National Academy of Sciences, the National Academy of Engineering, and the National Academy of Medicine. He is a Fellow of the National Academy of Inventors, the American Academy of Arts and Sciences, and the American Association for the Advancement of Science. He is the first individual to receive both the oldest/highest award of the National Academy of Engineering (the Simon Ramo Founder's Award) and one of the oldest/highest awards of the National Academy of Medicine (the Walsh McDermott Medal).

Internationally, he is an elected Fellow of the African Academy of Sciences, the India National Academy of Sciences, the Indian National Academy of Engineering, and the World Academy of Sciences. Laurencin also is an Academician and the 45th Foreign Member of the Chinese Academy of Engineering.

Laurencin earned his B.S.E. in chemical engineering from Princeton University; his M.D., Magna Cum Laude, from the Harvard Medical School; and his Ph.D. in biochemical engineering/ biotechnology from the Massachusetts Institute of Technology.

In 2016, Laurencin received the National Medal of Technology and Innovation from President Barack Obama in ceremonies at the White House. It is the highest honor bestowed in America for technological achievement. In 2021, he was awarded the Spingarn Medal, the highest honor awarded by the NAACP, for his work in Regenerative Engineering.

Alix Deymier is NSF CAREER Award Recipient

from UConn Today

Dr. Alix Deymier

Dr. Alix Deymier will work to elucidate the relationship between skeletal composition, structure, and physiological pH in terms of how it releases ions to regulate the body's pH.

Bone plays an important role in regulating the body's pH by releasing ions as it dissolves. Cases of bone loss and osteoporosis caused by pH balances are increasing. This phenomenon is also responsible for conditions like acidosis, which occurs when there is an excess of acid in bodily fluids.

The mechanism through which bones release ions and regulate pH is poorly understood due to a lack of transdisciplinary approaches to this complex problem.

Deymier will develop a laboratory that can apply transdisciplinary tools and investigative methods to address this question. This project will support Deymier's long-term career goal of integrating materials science, biology, and chemistry.

This grant will also allow Deymier to support and mentor female-identifying students in her lab through the self-efficacy education program (SEEP) and through a K-12 outreach program.

Tiny Bubbles: Treating Asthma with Gene Silencing Nanocapsules

Searching for a treatment to help asthma sufferers who don't benefit from existing therapies.

from UConn Today

Steroid-based inhalers deliver life-saving medication for millions of asthma sufferers, providing relief and the ability to simply breathe. Unfortunately, inhalers do not work for all patients and with rates on the rise for a disease that leads to hundreds of thousands of deaths worldwide each year, new asthma treatments and strategies are needed.

A team of UConn researchers – including Assistant Professor of Chemistry in the College of Liberal Arts and Sciences Jessica Rouge and Associate Professor of Pathobiology in the College of Agriculture, Health, and Natural Resources Steven Szczepanek – are collaborating to develop novel asthma therapeutics using gene-silencing nanocapsules in a bid to help patients who aren't benefiting from existing treatments. Their research was published in *ACS Nano*.

"When treating asthma, many people think of small molecule anti-inflammatory medications as the way to go, but there are plenty of patients who have asthma who do not respond to corticosteroids," says Rouge. "There's an unmet need for creating different therapeutics that can suppress asthma for this group of people."

Rouge's research group, including co-authors Ph.D. student Shraddha Sawant and Alyssa Hartmann '20 Ph.D., designs nanomaterials and targeted therapeutics that deliver gene silencing messages to cells. This paper details a nucleic acid nanocapsule (NAN) designed to selectively deliver an enzyme, called a DNAzyme, to silence a component of the immune response, called GATA-3, that leads to the over-expression of immune components that play a significant role in allergic asthma attacks.

Szczepanek explains there are different types of asthma, and this technology is designed to treat allergic asthma specifically, which constitutes about 50% of cases in adults and 90% in children. GATA-3-based treatments are already showing promise in clinical trials, and Rouge says that by pairing the sequence with nanotechnology, they hope to provide more efficient means of delivery and treatment straight to the source of inflammation.

"When using nanomaterials, we try to administer the therapy in a way that could allow us to use less material to get a bigger effect," Rouge says.

UConn researchers are working on producing treatments that could help some of the 25 million Americans who suffer from asthma (Adobe Stock).

Their system is based on surfactants that assemble into micelles, similar to tiny bubbles, and occurs in a stepwise process, resulting in each being around 60 nanometers in size.

"First, we synthesize something called a surfactant, it's much like soap and essentially forms a nanoscale bubble. Then we modify the surface chemistry of this bubble so it can conjugate or connect to DNA. The next step, and what's unique to our lab, is we use enzymes to build the next piece to attach the DNA sequence that essentially cleaves mRNA encoding GATA-3," Rouge says.

The nanocapsules were then characterized and checked if they could cleave the nucleic acid target cell lines in vitro and the results were promising.

"We showed these gene-silencing sequences were effectively delivered using our formulation and we saw that they knocked down the gene target of interest. That was an exciting first step," says Rouge.

Rouge brought the data to Szczepanek to see if his research group, including co-authors and graduate students Tyler Gavitt '21 Ph.D. and Arlind Mara '21 Ph.D., who study respiratory pathogens and disease pathology, would be interested in collaborating on the next steps of research to see how technology performed *in vivo* and if it could be of clinical relevance.

Having studied asthma as part of his post-doctoral research, and with his lab equipped for taking the next steps, Szczepanek says the collaboration was a natural fit.

"I thought this gene-silencing technology was a fantastic application for an asthma therapeutic."

The researchers tested the GATA-3 DNAzyme-NAN efficacy in an allergic asthma mouse model sensitive to house dust mites. The results showed the lungs of mice treated with the NANs had less inflammatory damage compared to the untreated control group. The treatment

continued on next page

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also reduced the presence of inflammatory immune cells, called eosinophils, which contribute to airway obstruction.

"Not only did we see a substantial reduction of asthma phenotypes in our mouse model, but we tested the GATA-3 DNAzyme-NANs in human white blood cells and saw both uptake of the nanoparticles and knock-down of expression of the gene of interest. This combination of data makes me really hopeful about the translational potential of the nanoparticles for human health," says Szczepanek.

Rouge points out another important detail: "Generally speaking, when putting nanoparticles in our lungs, you might think they could cause inflammation. However, we were really excited that at doses we used, the nanocarrier alone didn't cause inflammation."

"I believe our unique nanoconstruct holds great promise in the field of oligonucleotide delivery," says Sawant. "I am happy to be a part of this collaborative research as it marks the beginning of the development of the NAN as an effective *in vivo* nanocarrier."

Rouge says the next step is to hopefully get NIH funding to continue the research: "We want to figure out where these nanocapsules go? We need to do a biodistribution study and other logical next steps, like pharmacokinetics and determining how long these therapeutics last in an organism."

The researchers were recently awarded a patent for the nanocapsule formulation, and they hope to commercialize it. Szczepanek explains the team envisions that, eventually, the technology could be delivered to the patient via an inhaler, like current asthma medications are and, depending on exactly how it is formulated, that it could target active inflammation or act as a prophylactic measure.

Rouge adds that this technology has the potential to be customizable saying, "The major theme is that different people respond differently to diseases in general, so there is the potential for personalized medicine. We are looking toward a paradigm shift because if you know the genetics of somebody in terms of the intensity or overexpression of a particular gene or if it is upregulated, we could treat it or at least depress it."

Fusing Engineering and Precision Medicine with 3-D Tumor Model

from UConn Today

What if we thought about our bodies as materials?

This is the question Associate Professor Kazunori Hoshino in the Department of Biomedical Engineering raises in analyzing three-dimensional (3-D) tumor models to test potential cancer drugs.

This technology will help bridge the gap between in-vitro – or petri dish – testing and human subject testing for cancer drug development while cutting out the need for animal models by applying engineering methods to medical research.

Currently, cancer drugs are first tested on two-dimensional monolayers of cell cultures. While this is a necessary step in testing drugs, many drugs that are successful at this stage fail when they get to more advanced animal or human trials.

Next, scientists graft human tumor cells onto animal models. This allows them to see how the drug interacts with healthy cells as well as the tumor. However, it comes with its own set of challenges, including cost, time, and ethical considerations.

To address these issues, Hoshino's approach uses a 3-D model of a tumor in-vitro that can show how drugs will act in-vivo without the need of animal models.

"Testing an in–vitro model that mimics a tumor, rather than using animal models, is a recent trend in cancer studies," Hoshino says. "However, the question to me was: can we create a proper analytical method to study such a model?"

Hoshino's method uses materials science concepts to test the tumor like a material. Specifically, he tests for stiffness, or elasticity, a commonly tested property in engineered materials.

"If you're creating a new material, you need to know the properties," Hoshino says.

Hoshino hypothesizes that tumors will have different levels of stiffness. Scientists do know tumors have different properties from healthy tissue — often being significantly stiffer, for instance.

One possible reason for this stiffness is increased collagen production in tumors. They suspect this stiffness may protect the tumor by preventing drugs from reaching it.

Hoshino's method uses a series of polymer "chopsticks." These chopsticks have a specific, known stiffness, designated by number. If they bend, it indicates the tumor is stiffer than that number.

Read the full story at UConn Today


Excellence in
Materials Science

Polymer Program Faculty Members Collaborate on Department of Education GAANN Award

from the Institute of Materials Science


Dr. Kelly Burke


Dr. Rajeswari Kasi


Dr. Mu-Ping Nieh


Dr. Luyi Sun

Several faculty members from the IMS Polymer Program have been awarded the Department of Education's (ED) Graduate Assistance in Areas of National Need (GAANN) grant for their research entitled "Developing Sustainable Polymers for a More Sustainable World." The collaborators include Professor of Chemical and Biomolecular Engineering Luyi Sun; Professor of Chemical and Biomolecular Engineering Kelly Burke; Professor of Chemistry Rajeswari (Raji) Kasi, and Professor of Chemical and Biomolecular Engineering Mu-Ping Nieh. Each of the collaborators has served as IMS Polymer Program Director.

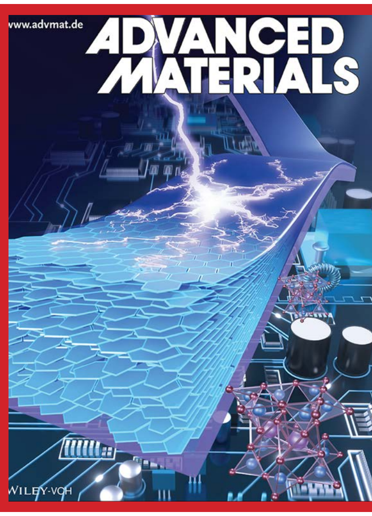
The goal of the proposed GAANN program is to provide fellowships to talented graduate students who demonstrate financial need and plan to pursue a Ph.D. degree in the field of Polymer/Plastics Engineering, with a research focus on sustainable polymers. Specifically, the collaborators will focus on increasing the number of highly trained graduate students, particularly those from traditionally underrepresented backgrounds and women, in science and engineering. The proposed GAANN program will be housed in the IMS Polymer Program.

The objectives of the GAANN program are highly consistent with the goals of the graduate program in IMS, which aims to offer students comprehensive training and to integrate state-of-the-art science and engineering into graduate education. By integrating polymers with several related disciplines, including materials science and engineering, chemistry, chemical engineering, physics, and biology, our GAANN program will provide fellows with training unified to advance our knowledge and application of sustainable polymers.

Five students will be sponsored each year and the collaborators anticipate approximately 15 students in total will benefit from this grant.

Yang Cao, Luyi Sun and Collaborators Receive Cover of Advanced Materials

In the August 26, 2021 issue of *Advanced Materials*, Yang Cao, Luyi Sun, and collaborators present a layered nanocoating comprising hundreds of highly oriented organic/inorganic alternating nanolayers on the polymer surface to revive the Schottky barrier for effective charge-injection blocking. The superior 2D assembly leads to a flexible material architecture at the electrode–dielectric interface, thus providing a novel design strategy for high-performance dielectrics for integrated flexible electronics.



IMS Faculty Awarded Funding for Excellence from V.P. for Research

Dr. Douglas Adamson received funding for his research entitled "Observing Nanoscale Interactions at the Filler-Matrix Interface During the Synthesis of Polymer Nanocomposites."

Dr. Volkan Ortalan received funding for his research entitled "Unraveling Ultrafast Dynamics: Bridging Atomic to Continuum Scales with Integrated Experimental and Computational Multimodality."

Dr. Xueju Wang was funded for her research entitled "Multifunctional 3D Bioelectronic/Microfluidic Hybrid Material System for Online Monitoring, Regulation, and Vascularization of Brain Organoids."

Bryan Huey and Lesley Frame Receive GAANN Award from Department of Education

from the Institute of Materials Science

With GAANN funding, Dr. Bryan Huey (l) and Dr. Lesley Frame will provide fellowships for Ph.D. candidates from underrepresented populations.

Drs. Bryan Huey (IMS/MSE) and Lesley Frame (IMS/MSE) are recent recipients of the Department of Education (ED) Graduate Assistance in Areas of National Need (GAANN) grant.

Drs. Huey and Frame collaboratively applied for the award which provides fellowships, through academic departments and programs, to assist graduate students with excellent records who demonstrate financial need and plan to pursue the highest degree available in their course study at the institution in a field designated as an area of national need.

Their Careers in Advanced Materials Engineering Research and Academia (CAMERA) GAANN program will provide world-class educational, research, advising, and professional training experiences and opportunities, beyond MSE courses and laboratory research taught by established experts in a range of materials engineering specialties. They will utilize the funding to support five Ph.D. fellowships focusing on increasing the number of highly trained Ph.D. scholars from populations traditionally underrepresented in STEM.

Drs. Huey and Frame plan to provide primary and secondary faculty advisors for candidates selected for the fellowship. Each Fellow will earn credits through a novel 'Academia Lab' created by MSE in conjunction with the school of engineering and the UConn Center for Excellence in Teaching and Learning in order to incorporate instruction and workshops in educational pedagogy and practice, scientific writing and presenting, and mentorship skills.

The grant of ~$760K will be supplemented by funding from the School of Engineering, the Office of the Vice President for Research, the Office of the Provost, and the Graduate School.

New X-Ray Technique Sees the Crystal in the Powder

from UConn Today

'Every single one of these is a special snowflake'

~Dr. Nate Hohman

(l - r) Ray Sierra, Nate Hohman, Elyse Schriber, Daniel Rosenberg, Brandon Hayes

Crystals reveal the hidden geometry of molecules to the naked eye. Scientists use crystals to figure out the atomic structure of new materials, but many can't be grown large enough. Now, a team of researchers report a new technique in the January 19 issue of *Nature* that can discover the crystalline structure of any material.

To truly understand a chemical, a scientist needs to know how its atoms are arranged. Sometimes that's easy: for example, both diamond and gold are made of a single kind of atom (carbon or gold, respectively) arranged in a cubic grid. But often it's harder to figure out more complicated ones.

"Every single one of these is a special snowflake—growing large crystals is really difficult," says UConn chemist physicist Nate Hohman. Hohman studies metal organic chacogenolates. They're made of a metal combined with an organic molecule holding an element from column 16 of the periodic table (sulfur, selenium, tellurium or polonium). Some are brightly colored pigments; others become more electrically conductive when light is shined on them; others make good solid lubricants that don't burn up in the high temperatures of oil refineries or mines.

It's a large, useful family of chemicals. But the ones Hohman studies—hybrid chalcogenolates—are really difficult to crystallize. Hohman's lab couldn't solve the atomic structures, because they couldn't grow large perfect crystals. Even the tiny powdered crystals they could get were imperfect and messy.

X-ray crystallography is the standard way to figure out the atomic arrangements of more complicated materials. A famous, early example was how Rosalind Franklin used it to figure out the structure of DNA. She isolated large, perfect pieces of DNA in crystalline form, and then illuminated them with X-rays. X-rays are so small they diffract through the spaces between atoms, the same way visible light diffracts through slots in metal. By doing the math on the diffraction pattern, you can figure out the spacing of the slots—or atoms—that made it.

Once you know the atomic structure of a material, a whole new world opens up. Materials scientists use that information to design specific materials to do special things. For example, maybe you have a material that bends light in cool ways, so that it becomes invisible under ultraviolet light. If you understand the atomic structure, you might be able to tweak it—substitute a similar element of a different size in a specific spot, say—and make it do the same thing in visible light. Voila, an invisibility cloak!

Hybrid chalcogenolates, the compounds Hohman studies, won't make you invisible. But they might make excellent new chemical catalysts and semiconductors. Currently he's working with ones based on silver. His favorite, mithrene, is made of silver and selenium and glows a brilliant blue in UV light or "whenever grad students are around," Hohman says, with a smile.

Elyse Schriber, a chemistry graduate student in Hohman's lab, convinced Hohman they should try illuminating some of the small, messy hybrid chalcogenolates in a high powered X-ray beam anyway. If they could figure out the math, it would solve all their problems.

While working at the Molecular Foundry at the Lawrence Berkeley National Laboratory in Berkeley, California, Hohman and Schriber teamed up with Aaron Brewster, a fellow scientist at the Berkeley Lab. Brewster mentioned he'd solved the math required to solve the crystal structure of difficult materials using serial X-ray crystallography, but he needed something to test it on.

A jet of liquid carrying nanocrystals of new materials (image courtesy of Dr. J. Nathan Hohman)

Hohman and Schriber had the material. They provided plenty of tiny, imperfect chalcogenolate crystals, which they mixed into water emulsified with Dawn dish soap (another indispensable item in Hohman's lab that glows blue) and shot jets of them into the beam at the Linac Coherent Light Source at the SLAC linear accelerator in Menlo Park, California. Each X-ray pulse illuminated the crystals incredibly brightly, allowing Brewster to capture a snapshot of the atomic structures of hundreds of tiny crystals. With

continued on next page

enough snapshots, Brewster was able to run the calculations and figure out how the atoms were arranged.

Not only did they solve the crystal structures—they also figured out that the previous best guesses of what those structures were had been wrong. In theory, the technique, called small-molecule serial femtosecond crystallography, or smSFX, can be used for any chemical or material.

Computer scientists Nicolas Sauter and Daniel Paley at Lawrence Berkeley National Laboratory also helped develop smSFX. When you have a true powder, Paley explains, it's like having a million crystals that are all jumbled together, full of imperfections, and scrambled in every possible orientation. Rather than diffracting the whole jumble together and getting a muddied readout of electron densities, like existing powder diffraction techniques, smSFX is so precise that it can diffract individual grains, one at a time. "This gives it a special sharpening effect," he said. "So that is actually the kind of secret sauce of this whole method. Normally you shoot all million at once, but now you shoot 10,000 all in sequence," Paley says.

"There is a huge array of fascinating physical and even chemical dynamics that occur at ultrafast timescales and this technique could help us to understand how these dynamic events affect the structure of microcrystalline materials. In a way, connecting the dots between a material's structure and its function," Schriber says. Hohman is equally excited about their success.

"Now that we can solve these hard to crystallize structures, we can design the best structures for our purposes," Hohman says. Often, a material will come close to having a certain desirable property, but its crystalline structure won't be quite right. Hohman hopes that with the data they can get from X-ray crystallography using Brewster's technique, they can design better materials from the ground up.

Now, Hohman and Brewster are collaborating with Tess Smidt, a machine learning specialist at MIT, to try to teach a computer to design materials with specific properties. The Department of Energy recently awarded the team a $15 million grant to pursue this and two other projects.

This work involves the use of the SACLA free-electron laser in Japan, the Linac Coherent Light Source at SLAC National Accelerator Laboratory, and the Molecular Foundry and National Energy Research Scientific Computing Centers, U.S. Department of Energy Office of Science user facilities located at Berkeley Lab.

Nate Hohman Receives Department of Energy Research Funding

from the Institute of Materials Science

Dr. J. Nathan "Nate" Hohman

The United States Department of Energy (DoE) Integrated Computational and Data Infrastructure for Science Research program has recently announced a $15M program providing funding for three multi-institution projects that "integrate artificial intelligence (AI) into flexible data and computer processing systems to support scientific processes." UConn has been selected to lead one of these efforts, with a $6M three-year program led by Dr. J. Nathan Hohman at the Institute of Materials Science and the Department of Chemistry on the topic, *AI Tools for the Characterization and Design of Achievable Hypothetical Materials*.

Hohman joined the UConn faculty in 2019 in the Department of Chemistry with an appointment in the Institute of Materials Science. His research interests are "devoted to the design and synthesis of nanomaterials and nanointerfaces for applications ranging from new semiconductors and superconductors to supramolecular coatings."

What is your goal for the collaborative research you are embarking upon with the Lawrence Berkeley National Laboratory?

Engineering a new hypothetical material today requires guesswork at every step. We guess what compounds might crystallize into a structure that may have a property of interest, hope we get the material we expected, and pray it has the properties we imagined. This is inefficient, labor intensive, and has a low likelihood of success. Our chances can be dramatically improved by using a combination of data science and machine learning. With a collaborative effort between the teams that make the materials, the data scientists that understand the characterization, and computational side that can bring the power of machine learning to bear, we will be well-positioned to have a transformative impact on how many new materials can be discovered and enable us to focus our efforts on the ones most likely to yield properties that will change the world.

What are some of the real-world implications of this research?

The big picture goal is we want to make new tools for material design. Every new technology has a new material at its core, and it will save a lot of effort if we can engineer real materials using computer aided design, and then actually build those compounds in the laboratory! In the meantime, we need to solve those structures, so core to our techniques is a new tool for characterizing material structures from nanocrystals.

You joined the UConn faculty a year before the COVID-19 pandemic. Has your research been affected by the pandemic? If so, how?

Great question! Academic renovations had just done a terrific job getting my laboratory ready- and it opened in March 2020. Oops! However, because the lab was small and we were just getting started, we were able to get back to work in July 2020 and have been working away ever since. The biggest impact is recruitment - it's hard to meet people these days and there are a few open positions!

You have been noted as saying that your first chemistry class in high school hooked you on chemistry, and now you are teaching chemistry. How do you create the same interest in chemistry in your students that was instilled in you at a young age?

I'm a bit of a structure nerd, if I do say so myself, so I get fascinated by the geometries of atoms and how those fit together into wider structures. Seeing how those structures translate into properties always fascinates me, so I try to instill in my students a sense of scale for atomic materials all the way up through carbon nanotubes and even more complex structures like human hair.

Where do you see the future of your research and the contributions of chemistry to the wider world?

This program is going to have an impact in combinatorial material synthesis. We can automate so much these days but until now, we haven't been able to automate characterization. This program promises to give a new tool to people who want to solve structures of complex materials and saves them all the trouble of growing large crystals. We want to use this technique to solve thousands of crystal structures each from milligrams of material, and then use that dataset to train the deep learning algorithms for new material prediction. If we are successful in this effort, we might be able to generate the next generation of catalysts and semiconductors for mitigating the climate crisis, accelerating quantum computing, or even making the next generation high-temperature superconductors.

Ying Li Is NSF CAREER Award Recipient

from the Institute of Materials Science

Dr. Ying Li

Assistant Professor of Mechanical Engineering Ying Li, will develop a machine learning model to better understand the properties of a promising sustainable material.

Biodegradable thermoplastic elastomers (TPEs) are a class of recyclable, sustainable polymers. TPE could be used to dampen sound or vibrations in products such as soft robotics or batteries. Unfortunately, TPEs are not yet widely used because scientists lack a solid understanding of the interplay between the synthesis, structure, and mechanical properties of TPEs.

Li's machine learning model will unravel this secret, opening promising avenues for understanding the mechanics of TPEs and bringing them closer to real-world application.

The fundamental knowledge base Li's work will create may have broad impacts for the study of soft matter in disciplines such as physics, materials science, and bioengineering.

Li will also develop a series of free educational movies to help the public understand the mechanics of materials as it relates to the pressing need for the development of sustainable materials.

2021-'22 IMMP Funding Awards

excerpted from UConn Today

With seed funds from the Office of the Vice President for Research (OVPR), the Office of the Provost, the College of Liberal Arts and Sciences (CLAS), the School of Engineering, and the Institute of Materials Science (IMS), the IMS Interdisciplinary Multi-Investigator Materials Proposal (IMMP) Award is a competitive process that provides funding for research projects that have at least two investigators, preferably from separate units. The research must be materials related and interdisciplinary.

Dr. Menka Jain

Dr. Alexandru Asandei

"Development of Ferroelectric-Magnetic Nanocomposite Films with Multicaloric Properties for New Cooling Technologies"

Traditional gas/vapor compression refrigerators that use volatile refrigerants such as hydrochlorofluorocarbons have environmental concerns due to greenhouse gas emissions and global warming. This current cooling technology is still energy inefficient and limits how small and cost-effective refrigerant units can be manufactured. The solid-state cooling technologies based on caloric effects in ferroics have advantages of higher mass density, low energy consumption, and have already shown higher energy efficiencies without any greenhouse gas emissions. This experimental project is motivated by the necessity to expand the benefits of artificial cooling in microelectronics (on chip) cost-effectively and potential to enhance energy efficiencies even further. In this proposal, the PIs proposed to develop and synthesize nanocomposite magnetoelectric multiferroic thin films for solid-state refrigeration of microelectronics in which the caloric effect will be realized with the application of electric and magnetic fields. Such materials are very promising and have potential to be used for the development of economical, efficient, noise-free and vibration-free refrigeration devices.

"This experimental project is motivated by the necessity to expand the benefits of artificial cooling in microelectronics.

~Dr. Menka Jain

Dr. Yuanyuan Zhu

Dr. Caiwen Ding

"Machine Learning-assisted Ground Truth Labeling for High-volume in-situ TEM Videos"

Electron microscopy is a cornerstone of materials science. In particular, the recent development of *in-situ* TEM, capable of capturing materials' dynamic evolution under realistic working conditions, plays a vital role in developing a comprehensive understanding of a wide range of material systems from bulk alloys to functional nanomaterials. However, this new tool begins to produce an 'avalanche' of *in-situ* TEM data. A pressing technical barrier for the implementation of machine learning (which has been successfully applied to many visual tasks such as sensing for autonomous vehicles) to the *in-situ* materials study domain is the lack of annotated ground truth (i.e., human expert-labeled *in-situ* TEM videos). With the support of this IMMP award, two groups from MSE and CSE teamed up and are working on establishing an automated ground truth labeling framework dedicated to *in-situ* TEM videos. Since the lack of annotated training database is a common and challenging problem, this new machine learning framework is likely to have a catalytic effect on other interdisciplinary programs, especially in collaborations between materials scientists and machine learning practitioners.

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The recent development of In-situ TEM plays a vital role in developing a comprehensive understanding of a wide range of material systems from bulk alloys to functional nanomaterials.

~Dr. Yuanyuan Zhu

Dr. Yao Lin

Dr. Jie He

Dr. Mu-Ping Nieh

"Developing 'Patchy' Metal Nanoparticles as Building Blocks for Supramolecular Assembly of Plasmonic Nanoprobes"

Supramolecular assembly of polymer-grafted metal nanoparticles (NPs) is a particularly powerful approach for large-scale and solution-based synthesis of plasmonics. In the process, symmetry breaking is of key importance to generate anisotropic interactions that guide the self-assembly of colloidal nanoparticles to mimic atomic bonding in complex molecules. With this IMMP grant, Profs. Jie He, Mu-Ping Nieh and Yao Lin will develop a general and facile methodology to synthesize asymmetric metal NPs with well-defined polymer patches on a large scale. This research will integrate the synthesis, characterization, and physics expertise from the three PIs to gain new insights into nanoscopic surface patterning on metal nanoparticles and provide tremendous opportunities to control the near-field plasmon coupling of metal nanoparticles with different sizes, compositions, and assembly pathways. The outcomes will be used as the preliminary results to support the applications for external multi-investigator awards.

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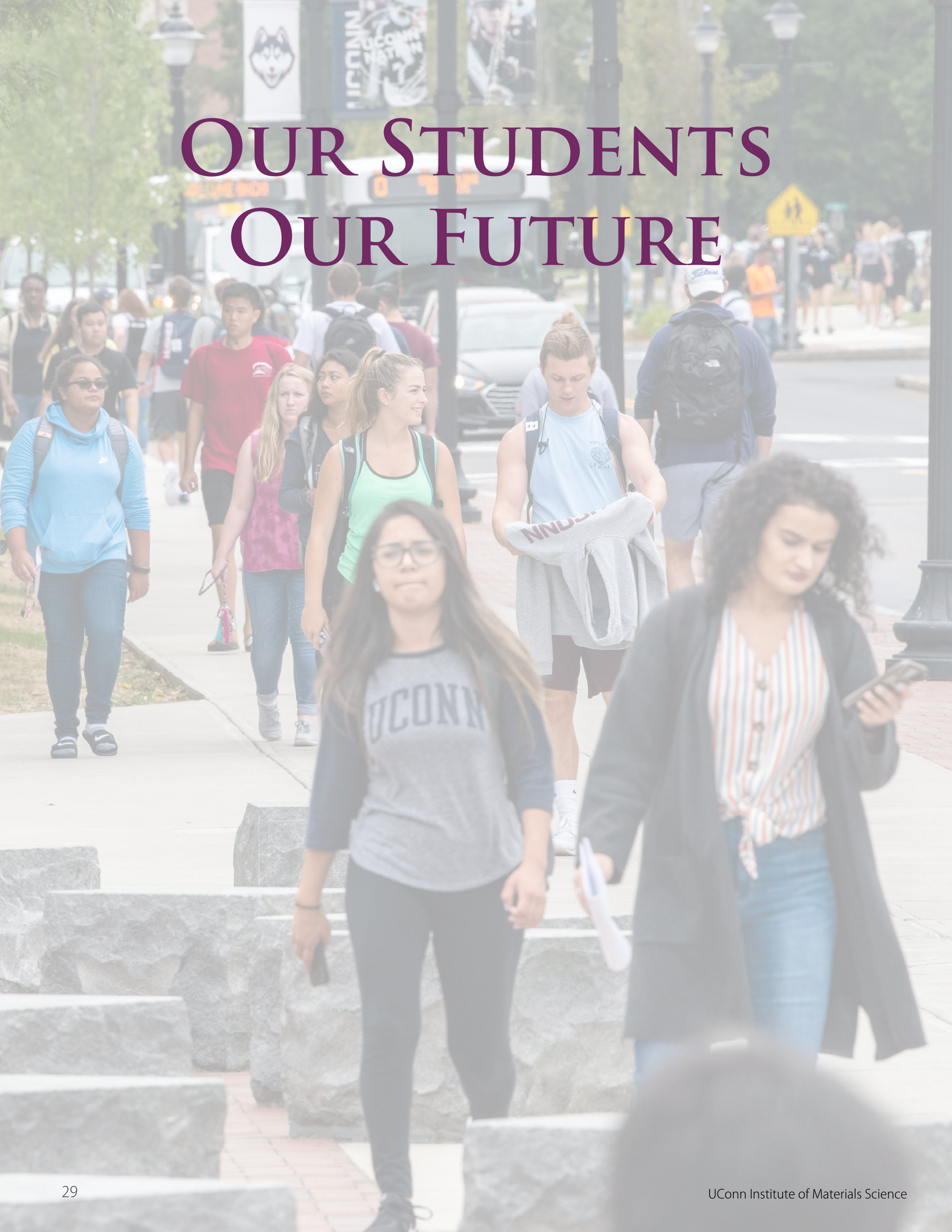
Symmetry breaking is of key importance to generate anisotropic interactions that guide the self-assembly of colloidal nanoparticles to mimic atomic bonding in complex molecules

~Dr. Yao Lin

Our Students
Our Future



Congratulations Graduates!

Dr. Abdullah Alamri, Ph.D.

Enhancing Energy Density and Energy Efficiency of Polyetherimide for High Temperature Capacitor Application

Advisor: Dr. Gregory Sotzing

Dr. Ajinkya Deshmukh, Ph.D.

Design, Synthesis, and Characterization of All-Organic Polymer Dielectrics for High Temperature Energy Storage Applications

Advisor: Dr. Gregory Sotzing

Dr. Alexis Ernst, Ph.D.

Effect of Atomization and Processing Gases on Microstructures in Additively Manufactured 17-4PH Stainless Steel

Advisor: Dr. Mark Aindow

Dr. Douglas Hendrix, Ph.D.

The Characterization and Optimization of Colloidal Nanosilica Dispersion in Ultra-High Performance Concrete

Advisors: Drs. Kay Wille and Bryan Huey

Dr. Hannah Leonard, Ph.D.

The Morphological Development and Mechanical and Thermal Behavior of Powder-Processed Icosahedral-Phase-Strengthened Aluminum Alloys

Advisor: Dr. Mark Aindow

Dr. Chinthani D. Liyanage, Ph.D.

Investigation of Graphene Stabilized Interfaces: Thin Film Composite Membranes to Microspheres

Advisor: Dr. Douglas Adamson

Dr. Thomas Moran, Ph.D.

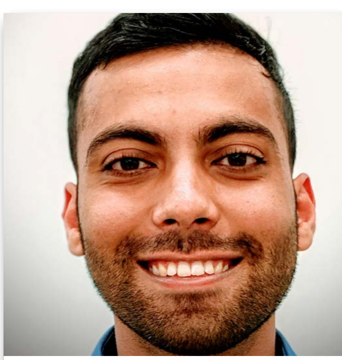
Nanoscale Thickness-Dependent Charge Dynamics and Domains Structure Properties in Dielectric and Ferroelectric Materials

Advisor: Dr. Yang Cao

Dr. Joel Reinbold, Ph.D.

Renewable Energy Storage with Hydrogen Blending in Natural Gas Distribution Systems

Advisor: Dr. Steven L. Suib



Dr. Sumit A. Suresh, Ph.D.

Mesoscale Modeling of Cold Spray Deposition of Metal Powders

Advisor: Dr. Avinash M. Dongare

Dr. Samiksha Vaidya, Ph.D.

Molecular Engineering of Rhodamine Dye Installed Polymers and Rhodamine Dye Installed Liquid Crystalline Polymers for Multi-Stimuli Responsive Properties

Advisor: Dr. Rajeswari Kasi

Dr. Junfei Weng, Ph.D.

Multifunctional ZSM-5 Nanoarray based Monolithic Catalysts for Low Temperature Emission Control and Utilization

Advisor: Dr. Pu-Xian Gao

UConn Student Research in Pharmaceutical Sciences

"Summer 2021's pharmaceutical-focused research projects highlight the diverse opportunities for undergrad research for students in the School of Pharmacy and across UConn."

excerpted from UConn Today

"The department of pharmaceutical sciences has a rich history of mentoring and training undergraduates in research. The multi-disciplinarily nature of our department provides a variety of options to students interested in research in areas such as drug discovery, mode of action, drug formulation and safety. Exposure to research in pharmaceutical sciences not only creates awareness among undergraduate students about the value of scientific inquiry, but also helps them explore career fields" says José Manautou, Department Head.

"Summer 2021's pharmaceutical-focused student research projects highlight the diverse opportunities for undergraduate students in the School of Pharmacy and across UConn," says Brian Aneskievich, Associate Professor of Pharmacology and Toxicology and undergraduate research coordinator. "Students work closely with faculty members in their labs benefiting from the experience, counsel and professional workplace."

IMS faculty members Xiuling Lu and Bodhi Chaudhuri served as mentors to three of these student researchers. Click the link for each student to view the presentation of their one-minute videos from both UConn's College of Liberal Arts and Sciences and School of Pharmacy.

Summer Undergraduate Research Fund (SURF) Awardee
Joshua Yu (Molecular and Cell Biology, CLAS, '23)
Project Title: *Overcoming Acute Myeloid Leukemia Resistance through Nanoparticle-Mediated Inhibition*
Faculty Mentor: Dr. Xiuling Lu, Pharmaceutical Sciences

"Joshua has a strong interest in integrating his background in molecular cell biology with our focused area of drug delivery. He is exploring to uncover the mechanism of effective leukemic stem cell inhibition using our developed nanoparticles carrying an anti-cancer drug, as an extension of his Holster Scholar project last summer. We look forward to the great outcome through Joshua's dedication, careful thinking and persistent effort into this work." – Dr. Lu

View Joshua's video here

UConn Holster Scholars
Ananya Aggarwal (STEM Scholar, Pre-Dental, CLAS, '24)
Project Title: *Synthesizing a Cisplatin Loaded Mesoporous Silica Nanoparticle for the Intraperitoneal Treatment of Ovarian Cancer*
Faculty Mentor: Dr. Xiuling Lu, Pharmaceutical Sciences

"As a highly motivated and dedicated young researcher, Ananya exhibited her maturity since she started her freshman year. This relatively independent research is built upon our lab's platform technology using tumor-specific nanoparticles to target peritoneal metastasis. Ananya proposed to optimize the preparation of drug loaded mesoporous silica nanoparticles for improving the delivery of the anti-cancer drug cisplatin. She has a thoughtful study plan and has been working diligently in the lab. I believe she will have a fruitful summer." – Dr. Lu

View Ananya's video here

Lyla White (STEM Scholar, Pharmacy Studies, '24)
Project Title: *Can 3D Printers Create Viable Personalized Therapy in the Treatment of Diabetes?*
Faculty Mentors: Dr. Bodhi Chaudhuri, Pharmaceutical Sciences and Dr. Anson Ma, CBE/IMS

"Lyla is exceptionally bright and very proactive. When she approached me as a potential mentor, she was prepared, knew the area of research I was involved in, and had a few possible ideas for where to go next. There are several unknowns in her project and she will have to troubleshoot the novel solutions that will extend the scientific underpinning of this 3D printing approach. I like the ambitiousness of the project and that it has real clinical implications for patients with diabetes while also being a model that can be applied to other active ingredients that could be incorporated into 3D printed tablets for other diseases." – Dr. Chaudhuri

View Lyla's video here

Read about all the student researchers here

"Students work closely with faculty members in their labs, benefiting from the experience, counsel, and professional workplace."

~Dr. Brian Aneskievich,
Associate Professor of Pharmacology and Toxicology

MSE Alumnus and NIST Scientist Reflects on His Passion for Materials and Rowing

from the Materials Science & Engineering Department

William Osborn working on a calibration system for picometer displacements measured with a customized laser Doppler vibrometer in the lab at the National Institute of Standard Technology.

UConn MSE alumnus William Osborn was drawn to materials science by the rowing shells he raced in for sport as a high schooler. From a young age, he was curious about what defined the boats' performance and how it related to the properties of the material the boat is made of. Now, as a scientist with the National Institute of Standard Technology (NIST), Osborn's job is rooted in the importance of answering questions about material measurements such as those he once asked about the shells.

"I learned to row in an old 1970s wooden boat that was so heavy that even eight high school freshmen struggled to pick it up," Osborn says. He recalls later stepping into a 1980s boat with a wooden skeleton and a single skin of Kevlar; it was light and delicate. Years later, he says he would race in even lighter shells built from unidirectional carbon fiber and honeycomb composites.

"The importance of what something is made from really sinks in when you lift it over your head every day. I didn't know materials science and engineering was even a field of study at that point, but I was already interested," Osborn says.

After discovering he could major in his passion, Osborn completed his bachelor's in 2004 with a degree in MSE from the University of Washington, Seattle. Just a year later, he moved across the country to continue his studies at UConn.

An internship during Osborn's undergraduate years did to him what first internships often do; it showed him what he liked and didn't like, narrowing down the question of what he wanted to do after graduation. "I enjoyed the testing work more, and it became clear I wanted to have a career where I could push the state of the art. In engineering fields, that generally means Ph.D.," he says. UConn became the place which led Osborn to do just that.

According to him, the academic quality of his work at UConn served his career as it encouraged both the applied and theoretical sides of the field. Aside from this, the social aspect of his degree impacted his career decisions. "Having a positive experience working with professors, technical staff, and other grad students in a research lab reinforced my decision to work in an R&D environment," Osborn says.

As a Ph.D. candidate, Osborn also worked as a teaching assistant for one semester. "I was surprised how few of the undergraduate students sought help when they needed it," he notes about the experience.

However, help from professors is what often propels students further in their career. It was one of his graduate professors, now-Department Head Bryan Huey, who suggested Osborn go for the National Research Council (NRC) Postdoctoral Fellowship with NIST. "It was great advice. The depth and breadth of scientific capabilities offered at NIST impressed me at the time and still does today," Osborn says.

Since earning his Ph.D. in 2009, he has worked for NIST as a bench scientist, spending most of his days in the lab. According to him, there have been opportunities to move into management or other roles that are less hands-on, but his partiality for the lab has kept him there. "I love being able to pick industrially relevant technical challenges and getting to develop new instruments, data analysis methods, or even reference materials to address the needs of other scientists in the U.S. and around the world," he says.

With NIST, Osborn works to improve the quality of measurements. A large portion of his current research is related to measuring strain in semiconductors. By developing and verifying the quality of measurements and systems of use, he creates valid and reliable measurement procedures.

Though nearly every day is spent in the lab, it never bores Osborn. "With very few exceptions, no one day is like the previous day—and I love that," he says. Though he does admit there are some days that are a bit more fun than others. "People bring us awesome metrology challenges! Companies or other government agencies ask us to help develop a way to measure things that are important to them, but only after a bunch of talented scientists in their own ranks have tried first," Osborn says.

Getting to do the work he does has made Osborn realize the importance of communicating with those around him. "Be willing to share your time and talents with colleagues and collaborators," he says. According to him, some of his most influential work has been a result of collaborations.

New Pratt & Whitney Scholars Program to Benefit UConn Engineering Students

from UConn Today

Pratt & Whitney announced a $1.25 million investment to help build a diverse workforce for the future, through the creation of The Pratt & Whitney Scholars Program to benefit University of Connecticut (UConn) Engineering students.

The Scholars Program, a scholarship designed for underrepresented minorities, will provide four cohorts of five students with $10,000 per year for four years; a summer internship opportunity at Pratt & Whitney after their sophomore year; a senior design project sponsored by Pratt & Whitney during their senior year; and professional development and mentorship opportunities.

Applications for the first cohort of students are open and can be found here. Awardees will be announced in early January 2022. Additional freshman cohorts will be identified each fall until 2024.

This new program builds upon more than 30 years of support that Pratt & Whitney and parent company Raytheon Technologies have invested in diversity programs at UConn, including the decades-long BRIDGE program, a five-week summer residential program designed to help women and underrepresented minorities entering their freshman year at UConn Engineering.

"The new Pratt & Whitney Scholars Program with UConn School of Engineering will serve the diverse communities and schools where we live and work," said Maureen Waterston, vice president and Chief Human Resources Officer at Pratt & Whitney. "With this scholarship, we look forward to providing mentorship and support to 20 diverse engineering students. At Pratt & Whitney we are committed to building a diverse workforce with access for all as we continue to inspire the future generations of innovators."

Kazem Kazerounian, Dean of the UConn School of Engineering, applauded Pratt & Whitney for their new investment and was excited for the future of the Scholars program.

"Pratt & Whitney has been a key partner with the UConn School of Engineering as we train and graduate the next generation of leaders," Kazerounian said. "These new Pratt & Whitney Scholars will be a shining example of the best and brightest our school has to offer."

The Scholars program will be embedded in the newly launched Vergnano Institute for Inclusion at UConn, launched in 2021.

Polymer Program Student Selected for 100Plus Scholarship

from the Institute of Materials Science

Polymer Program student, John M. Toribio was awarded this year's Student Scholarship from 100Plus, a US based organization that provides remote patient monitoring for chronic patients. Student applicants needed to submit a presentation answering the question, "How will remote patient monitoring technology advance in the future to provide better health for the patients?" John received a $2,000 prize and his presentation can be found on the 100Plus Website at this link.

John is a second-year Chemistry Ph.D. student in the Sotzing Research Group working on the development of wearable electronic devices for health applications as well as synthesis and applications of cannabinoid polymers.

IMS Polymer Program student John M. Toribio

MSE Ph.D. Candidate Encourages Other Female Researchers to Not Doubt Their Own Voices

from the Materials Science & Engineering Department

As of 2021, female Ph.D. researchers like Suman Kumari are welcoming the challenge of pursuing a passion in a still male-majority field. Though representation has improved compared to decades ago, the imbalance in a classroom or lab can still be intimidating. According to Kumari, though it hasn't been easy being a female in her discipline, this shouldn't dissuade others from pursuing materials science and engineering.

"Though the world is changing, it's challenging as a female in the materials science and engineering field, but nothing is impossible if you have the will to do it. I would say, 'listen to yourself, you know what you want to do,'" she says.

In much of her career so far, Kumari has not let any hesitation stop her.

She earned her bachelor's degree in chemical engineering and computer science and engineering from the Indian Institute of Technology Gandhinagar (IITGN) in 2017. During her undergraduate years, she did a summer internship at Clemson University. Following graduation, she worked as a project associate for an IT firm, Cognizant. A year later, she went back to IITGN to be a junior research fellow.

As an intern at Clemson assisting in computational modeling of fluids through membranes, Kumari began to realize her particular interests which led to her future decision to pursue her Ph.D. She was involved in developing the framework for the fibrous membranes and determining the permeability of the flow when she became engrossed by the significant change in the flow properties which occurred when changing the microstructure. Kumari recalls this as a precipitating moment leading to her future as an MSE Ph.D. candidate.

"I was more interested in understanding the material's behavior irrespective of their application in different domains," she says about materials science and engineering as opposed to chemical engineering.

Students in MSE often face two paths as they progress throughout their career leading up to their undergraduate graduation. Many students will find themselves drawn to either the realm of scholarly research or leaving formal academia behind for industry. According to Kumari, her exposure to research from Clemson to her fellowship at IITGN reinforced her affinity for the fundamental science of investigation, innovation, and experimentation in a university setting.

In particular, Kumari felt inspired by the collaboration and kinship which can occur in group research. As a female— a minority in MSE— her sense of purpose in groups that are often all male drove her past any intimidation or challenge.

"I liked the scientific discussions with my group members. It is the journey that one goes through and skills one obtains during their Ph.D. that was exciting for me. Even though I knew that it can become stressful sometimes, coming out of that and starting fresh again is something we need in all aspects of life, not just a Ph.D. So, basically, the entire journey of 4-5 years full of challenges and learning intrigued me to pursue a Ph.D.," Kumari says.

With her decision to pursue her Ph.D., Kumari then had to figure out where exactly she would want to be for the next few years. She came to know of UConn MSE from a past colleague she met as an undergraduate who had gone on to the department at UConn.

"From her, I heard that the MSE department is quite good here, and she connected me to a few students in MSE from whom I got to know more and was impressed. Therefore, I chose UConn for my higher studies," Kumari says.

Kumari initially joined the UConn MSE Department with the thought of staying in her comfort zone doing computational work in polymers. However, this intention did not work out as planned, she says. Ultimately, she came to know about other groups doing similar work, though different from her prior work. One of the faculty members who was scouting for students was Associate Professor Volkan Ortalan. After talking with him about her interests, Kumari found upon closer introduction that his research would complement her past experience well while also pushing her.

"The only thing was I didn't have any experimental experience at all. I was very confused at that time, but I took it as a challenge to learn, and to my surprise, I started liking it," she says.

MSE graduate student Suman Kumari

As of 2021, Kumari makes up the majority female student group led by Ortalan. Within the group, Kumari says she has been investigating the structure-prop-

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erty relationship of polymeric systems using in-situ TEM (Transmission Electron Microscopy) and understanding the fundamental science of such systems by capturing their dynamics on extreme spatial and temporal scales with Ultrafast TEM.

"It's a bottom-up approach to understand the system from atomic to macroscopic scale. These in-situ techniques could fill up the gap in the fundamental knowledge to help with the processing and manufacturing of materials for a given application. It could be helpful in various disciplines apart from material science," she says.

According to her, she is most interested in the forces of space and time.

"Capturing the ultrafast dynamics on the extreme scale is fascinating to me. It can give a lot more information about how things are changing over such small space and time scales, consequently affecting the behavior at a macroscopic level," she says.

According to Kumari, she and the rest of the group are given a lot of independence by Ortalan to perform their research. This is something, she says, that makes him a great leader.

"He is great as an advisor and provides his full support for our holistic development. He encourages us to take responsibility for our own progress and let us find our own way," she says.

Additionally, Kumari's appreciation for collaboration in research is something Ortalan also values. According to her, the group has open discussions during the meetings and works in smaller groups with one another.

"Learning from each other is something I like about the group," she says.

This is something she has found with UConn MSE as a whole that differentiates it from other universities.

Kumari says that unlike other schools she spent time at, UConn MSE has "hands-on experience with advanced instruments, collaboration with other universities and research groups, and working with diverse groups of people."

"Overall, it's a great experience so far at UConn. The students, faculty, facilities, opportunities, and everything," she says.

Though she has not yet decided exactly where or what she will find herself doing following graduation, she has an idea she won't venture far from academics and inspiring rising women in STEM.

Alexis Ernst is a Woman of Innovation

from the Institute of Materials Science

Dr. Alexis Ernst

For 17 years, the Connecticut Technology Council has recognized and honored women making their mark in science, technology, engineering and mathematics (STEM) with the Women of Innovation Award.

The prestigious awards recognize women innovators, role models and leaders in the STEM disciplines. They were selected from a field of 36 finalists—the scientists, researchers, academics, manufacturers, student leaders, entrepreneurs, and technicians who are catalysts for scientific advancement throughout Connecticut.

Alexis Ernst (Ph.D. '21) has been recognized in the category "Collegian Innovation and Leadership." The award in this category is given to an undergraduate or graduate student who has demonstrated exceptional academic achievement in the technology, science, or engineering areas of study or who has displayed inventiveness or creativity in said fields.

Alexis focused on electron microscopy under the advisement of IMS faculty and former associate director, Dr. Mark Aindow. She is now an SEM Associate Scientist at Johnson Matthey.

Polymer Program Student Receives Henkel Internship

from the Institute of Materials Science

Abhirup Dutta

Polymer Ph.D. student, Abhirup Dutta, received an internship with Henkel Corporation during the summer of 2021. He worked in product development R&D with their adhesives team performing synthesis, formulation, and application testing of novel isocyanate free polyurethane based reactive hot-melt adhesives for engineered wood applications.

Abhirup states the overall experience was a great exposure to research and development of industrial significant materials like adhesives and coatings. It provided the opportunity to apply fundamentals of polymer chemistry to materials development while meeting product and cost requirements. This experience helped him better prepare for a materials/polymer scientist role in industry.

Henkel, an international chemical corporation, has offered internships and employment of many UConn alumni in past years. While they have a production plant and offices in Connecticut, Abhirup was in the Bridgewater, NJ facility.

Abhirup found the internship on the Handshake job portal, managed by UConn's Center for Career Development.

MSE Undergrad Is Paving the Way for Underrepresented Women in the Field of Engineering

from the Materials Science & Engineering Department

MSE undergraduate student Brittany Nelson

In the field of Materials Science and Engineering, black women are highly underrepresented. When she graduates this Spring, University of Connecticut MSE undergraduate Brittany Nelson will stand for the less than 4% of black, Hispanic, and Native American women who are awarded a bachelor's degree in engineering in the United States. She will also be the first generation of her family to earn a college degree.

As a young black woman in a field dominated by men, Nelson has found inspiration to work harder. "I see this as an opportunity for change. I would not be an MSE student without the support of those who invested in me academically, financially, emotionally, etc. I feel that it is my job to return the favor by setting an example and being a resource to those who are interested in pursuing MSE," Nelson said.

The MSE senior has strived to do that since discovering her affinity for engineering in middle school. "In the 7th and 8th grade, I attended UConn's Pre-Engineering Program (PEP) and gained an interest in engineering," she said. According to Nelson, it wasn't until high school that she learned about MSE by attending UConn's Explore Engineering (E2) Program. At the time, she was considering Chemical Engineering (CHEG) and Mechanical Engineering (ME). "MSE was not only fun, but it was a perfect combination of the two fields," she stated.

Her positive experience with the UConn MSE department impacted her decision to study there. "I was specifically impressed by how informed and passionate the MSE faculty and students were about their work. In addition, I gravitated towards the wide range of lab equipment, the friendly atmosphere, and the numerous options of areas to focus on within the MSE program," Nelson said.

Since deciding to join the UConn MSE program, Nelson has been mentored by Dr. Lesley Frame and she recently joined the Frame Research Group. Nelson enjoys the sense of community the group has. "All of the group members willingly provide support and advice to each other in any way possible."

Whether it was her mentorship with Dr. Frame, sense of community, passion, ambition, or a combination of all of the above that motivated her, Nelson was able to pursue research as a Ronald E. McNair Scholar during the Summer of 2020. The McNair program prides itself in promoting talented UConn undergraduate students for doctoral studies in (STEM) disciplines, specifically for those from underrepresented populations in our fields, from under-resourced communities, or who are first-generation graduates in their families.

Nelson has also been honored as a Gates Millennium Scholar, Louis Stokes Alliance for Minority Participation (LSAMP) Scholar, Ronald E. McNair Fellow, and UConn Day of Pride Scholar.

The research that Nelson is currently conducting within the Frame Research group focuses on the effects of tempering processes on the mechanical properties of alloy steel. The results of this research will inform fundamental understanding of phase transformations and changes in strength due to tempering process parameters and will also have direct impacts on heat treatment in a wide range of industry applications. "Brittany has really taken charge of this project. Even though we were operating remotely for much of last summer, Brittany was able to pick up the project, learn the fundamentals of steel tempering processes, and analyze a very large amount of data to discover new trends and materials behaviors. She is currently working on preparing a manuscript on this project for submission to a peer-reviewed journal. I have been so pleased to have Brittany as a member of our team!" says Dr. Frame.

Though this project and her undergraduate career will end in May, Nelson's career in MSE is really just beginning. She hopes to continue doing research and is

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strongly leaning towards graduate school. "It is a bittersweet feeling. Graduation is a huge accomplishment for me, especially as a first-generation college student with parents not born in the U.S. I am definitely going to miss the great people that I have met within the MSE department and the UConn campus," she says.

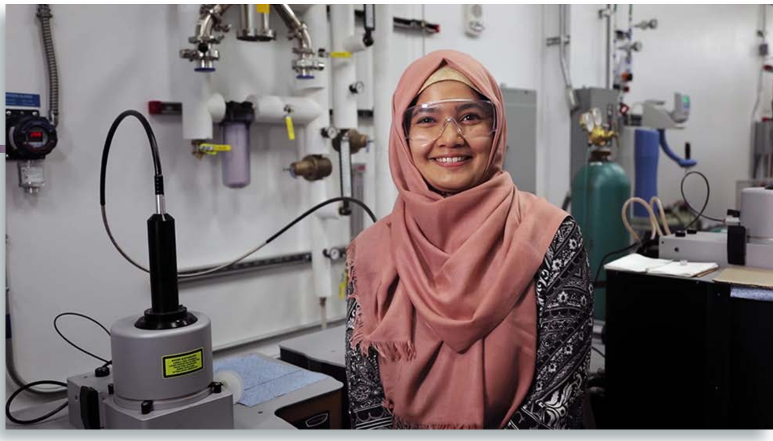
Her future continuing research also holds the potential to continue inspiring young underrepresented girls who are interested in MSE. "To any female students interested in materials science and engineering, I would say go for it! Being an MSE student is extremely rewarding. You will learn so much about yourself and contribute to making a difference in the world of STEM," she stated.

Graduate Student Contributes to Innovation in the Aircraft Industry

from the Materials Science & Engineering Department

Ummay Habiba always had a fascination about experimental and laboratory-based research work. Her attraction to research started during her graduate studies in her home country, Bangladesh, which focused on ferromagnetic materials for cancer treatments and for eco-friendly refrigeration systems. While conducting this research, she realized that the impacts of materials scientists in our society are not confined just to engineering, but actually in every sector of life either directly or indirectly. This influenced Ummay in pursuing a career in materials science and engineering (MSE).

Habiba earned her Bachelor's and Master's degrees in applied physics, electronics and communication engineering at the University of Chittagong, Bangladesh. As her research drew her interests towards materials science and engineering, she decided to continue her education at the UConn MSE department. She had also been attracted by the department's large pool of talented faculty and the state-of-the-art research opportunities. Although Habiba entered the Ph.D. program with a non-materials science background, she felt that the core courses were structured appropriately for students like herself. "The comprehensive nature of these core MSE courses helped me well in settling in to MSE based research," she said.



MSE Graduate student Ummay Habiba at Additive Manufacturing Center (AMC) lab

Habiba's current work is exploring the application of additive manufacturing in the aircraft industry. Working under the supervision of Professor Rainer Hebert, she especially focuses on the surface and thermal properties of powder using the ESI Additive Manufacturing system. This is a prototyping software which simulates a product's behavior during testing, manufacturing and real-life use. Powder spreading in particular is a crucial part of the additive manufacturing process, which if implemented well can diminish the weight and cost of various aerospace components and hence can strongly impact the industry.

Habiba shares that, "I have an 8-month-old boy. There is a myth for women that they have to choose between Ph.D. degree and a family. Many people think that if they want a family, they do not have what it takes to be a successful researcher. This simply is not the case. There are many women and men who are both devoted parents and partners, and also highly successful researchers."

Habiba's career goal is to do something significant and revolutionary for the aircraft industry through her current research. In addition to the inspiration which comes from her research topic, and the broader support from UConn's MSE department, she appreciates the expert guidance from her advisor Professor Herbert. "I am very fortunate to get the opportunity to work with a very supportive and professional supervisor, who has provided us a very positive work environment with strong connections to industry," she said. "I absolutely love what I do, and I am lucky to be able to work on what I love."

Outreach: Partnership for a Stronger Community

Comings and Goings: Staff News

Connecticut Invention Convention Award Winner Tackling Environmental Issues with the Ferro-Sponge

from the Institute of Materials Science

Congratulations to Snigtha Mohanraj for becoming the first ever winner of the Excellence in Materials Science award created by the Institute of Materials Science in partnership with the Connecticut Invention Convention (CIC) for her project titled "Ferro-Sponge".

Snigtha Mohanraj *during her Connecticut Invention Convention presentation.*

The Connecticut Invention Convention has been supporting STEM initiatives for students in grades K-12 for over 37 years. The State Finals were hosted virtually this year due to the COVID-19 pandemic, but included the top 561 inventors out of the 6,500 that participated in Invention Convention programming.

Students who elect to participate submit their video presentation, pictures of the prototype, and their invention log to the online application portal to be reviewed by a panel of trained judges. The top inventors at the state level receive an invitation to the U.S. National Invention Convention competition. Congratulations to Snigtha for being one of the few selected to participate at the U.S. National Competition!

Snigtha was an eighth grade, thirteen-year-old student upon her win in spring of 2021. She has had a passion for science and engineering since she was young and thought the Connecticut Invention Convention competition would be a great way for her to display her research. When speaking about her experience with the program, Snigtha states, "It has taught me how to manage my research and design a prototype to solve a real-world problem. I believe that I have grown a lot as an inventor and student from participating in the Connecticut Invention Convention."

Her interest in the environmental side of science lead her to create the Ferro-Sponge. The Ferro-Sponge removes microplastics and oil from contaminated water. According to Snigtha, the reusable item is made of "a polyurethane sponge thoroughly coated in an iron oxide sludge mixture containing bentonite." Her description of the way it works is that, "The iron oxide is able to attract microplastics and oil, and the bentonite is able to enhance the oil removal."

After learning about the microplastics problem in our environment, Snigtha first researched different solutions that could assist with the issue before landing on iron oxide. Her first barrier to overcome was finding the right consistency of sludge mixture to apply to the sponge to avoid excess leakage. The second being how to thoroughly dry the sponge to ensure full soakage of the sludge mixture, in which an oven ended up being the best method.

Snigtha hopes her passion for environmental issues will play a role in her future endeavors. She explains, "These issues in our world are the most pressing of all problems, yet there's a lack of solutions to them nor are many people even trying to learn about them. Despite them being issues that could deteriorate our world, not enough action is being taken to stop them."

She hopes to continue on to higher education following her graduation from high school. Currently a freshman at an engineering and science specific high school, Snigtha is interested in pursuing a career involving her love of environmental sciences, engineering, law, and potentially economics. She hopes studying these areas will further her pursuit of tackling environmental issues plaguing our world today.

Outreach News

(click images to read these stories)

Lesley Frame Exposes High School Students to UConn Chemistry Through Virtual Event

Mentorship Program Connects UConn Startups with Industry, Business, Investment Experts

IMS Industrial Affiliates Program Continues Its Support of Industry Partners

from the Institute of Materials Science

As operations returned to a "new normal" the IMS Industrial Affiliates Program has continued to provide vital materials analysis and characterization services for our members and non-member industry partners.

Our monthly webinars over the 2020-2021 academic year were very popular, attracting an average of 50 people to each 2-hour webinar.

During 2021-2022 we are planning webinars to run bi-monthly. We kicked off the semester in October with Prof. Lesley Frame discussing Metallurgical Analyses. Look for announcements for our other webinars over the next few months.

Several new and diverse companies have joined IAP including a producer of bio-based lubricants, a producer of cleaning equipment for medical devices, and a third company that recycles fluoropolymers.

IAP has continued to engage faculty in a robust way over the past year, and we believe the experience has been mutually beneficial for our industry partners, our faculty researchers, and IMS. Some examples include catalyst and surface chemistry work by the Suib group; polymer processing and failure analysis by Luyi Sun's lab; metallographic analysis and corrosion by Lesley Frame; polymer crystallinity and morphology by Mu-Ping Nieh's lab; nano-indentation by Seok-Woo Lee's group; and AFM by the Huey group.

New equipment has become available, adding to our ability to assist our partners with their characterization needs. We now have access to the following equipment:

Atomic Absorption: IMS received a *PerkinElmer Atomic Absorption Spectrometer AAnalyst 200* (pictured) that will allow students and industry projects involving metal concentrations in solution to be run in-house. The AAnalyst 200 has many features that allow for optimization of instrument sensitivity, leading to improved detection limits.

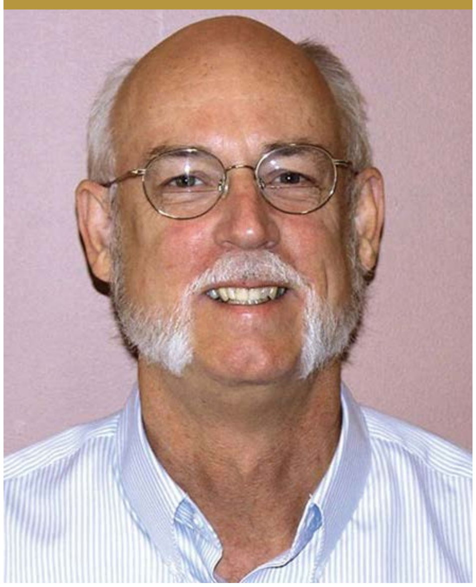
Gas Chromatography Mass Spectrometry (GCMS): IMS purchased a new *Agilent 8890 GC & 5975 MS (pictured left)* that will shorten the timelines for the growing number of industry projects, while serving students and researchers at UConn. The new system also has several built-in self-diagnostic tools to aid in rapid troubleshooting of the instrument, and it comes with a liquid autosampler. Analytes for GCMS must have molecular weight <1000 Dalton, high vapor pressure, low polarity, and (usually) must be non-aqueous.

Liquid Chromatography Mass Spectrometry (LCMS): The addition of *Shimadzu MS-2020 EV (pictured left)* to the IMS Core Labs will increase the range of samples, allowing analysis of medium to high polarity aqueous systems and those prone to thermal degradation. The system has a dual ion source, permitting both ionization modes: electrospray for high-polarity compounds, and atmospheric pressure chemical for lower-polarity compounds. This mass spectrometer has an approximate range of 0-2000 m/z. It also allows a single sample to be run with both positive and negative ion mode, with fast scanning of 15000 u/sec.

Staff News: Hellos and Goodbyes

CAMMA Laboratory Manager Roger Ristau Retires

from the Institute of Materials Science



Dr. Roger Ristau

Roger Ristau, manager of the UConn Thermo Fisher Scientific Center for Advanced Microscopy and Materials Analysis (CAMMA) laboratory has retired after 15 years of service.

A native of Connecticut, Roger received his M.S. and Ph.D. from Lehigh University. Prior to joining the staff of UConn he worked as a research development scientist at Seagate in Fremont, CA, provided microscopy services and support to a wide spectrum of industries at Evans Analytical Group in Sunnyvale, CA, and operated the transmission electron microscope (TEM) at Sandia National Laboratory in Livermore, CA.

Roger joined IMS in 2004 to manage operations in the Institute's Electron Microscopy Laboratory. In addition to ensuring operation of the lab's numerous microscopes, he standardized user training and trained hundreds of new microscope users. He served as an expert resource for the use of the lab's instrumentation in IMS research efforts. He also supported industry outreach and materials problem solving for the IMS Industrial Affiliates Program. He was selected to serve as the managrer for the CAMMA laboratory from its inception in 2018.

JoAnne Ronzello Retires After More Than 35 Years of Service

from the Institute of Materials Science

Ms. JoAnne Ronzello

JoAnne Ronzello, research assistant at the Institute of Materials Science/Electrical Insulation Research Center retired after 35 yars of service. JoAnne specialized in the area of dielectrics including, high voltage testing, failure analysis, dielectric spectroscopy, and novel experimental development. She holds undergraduate degrees in Chemistry and Electrical Engineering and was co--author of numerous peer-reviewed research publications.

MSE Welcomes Administrative Assistant Sarah Moore

from the Materials Science and Engineering Department

Mrs. Sarah Moore

The Department of Materials Science and Engineering welcomed new staff member Sarah Moore, as the administrative program support professional for MSE.

Sarah brings an extensive background in administrative support and customer support services.

She is a wife and mother to a teenage son and daughter. When not at work, she enjoys spending time with family and friends or at the pool or beach, walking her dogs, and camping.

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For over fifty years, the UConn Institute of Materials Science (IMS) has invested in scientific development within the state, across the nation, and around the globe. Our students, faculty, staff, and alumni continue to make countless contributions made possible by the educational, outreach, and research efforts of IMS. We are home to more than 150 graduate students performing research in our materials science, materials science and engineering, and polymer science programs.

Please consider donating to the institute as we make strides toward a richer future. Your donation to the fund(s) of your choice will directly contribute to our efforts to keep our research infrastructure and graduate education strong.

The Owen F. Devereux MSE Undergraduate Excellence Scholarship (31384)
Funds will be used to provide undergraduate merit based scholarships in honor of Professor Owen F. Devereux to students in the Materials Science and Engineering Program.

IMS Equipment and Maintenance (21753)
This account provides cutting-edge equipment and maintains IMS facilities. IMS houses a wide range of advanced research instruments and facilities.

IMS Polymer Mixture Thermodynamics (20334)
This account supports graduate students and faculty studying polymer mixtures.

An Unrestricted IMS General Fund Account (20312)
This account supports all IMS activities, from maintenance of supplies to industrial collaborations.

Julian F. Johnson Alumni Fellowships Fund (22177)
This account provides fellowships to graduate students in the IMS polymer program. The polymer program is the only center in Connecticut dedicated to research and education in polymer science and engineering and is nationally and internationally recognized for its excellence.

Materials Science and Engineering (MSE) General Fund Account (22165)
This account supports the materials science and engineering program offered by the Department of Materials Science and Engineering. MSE focuses on the production, processing, characterization, selection, design, and modeling of materials.

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