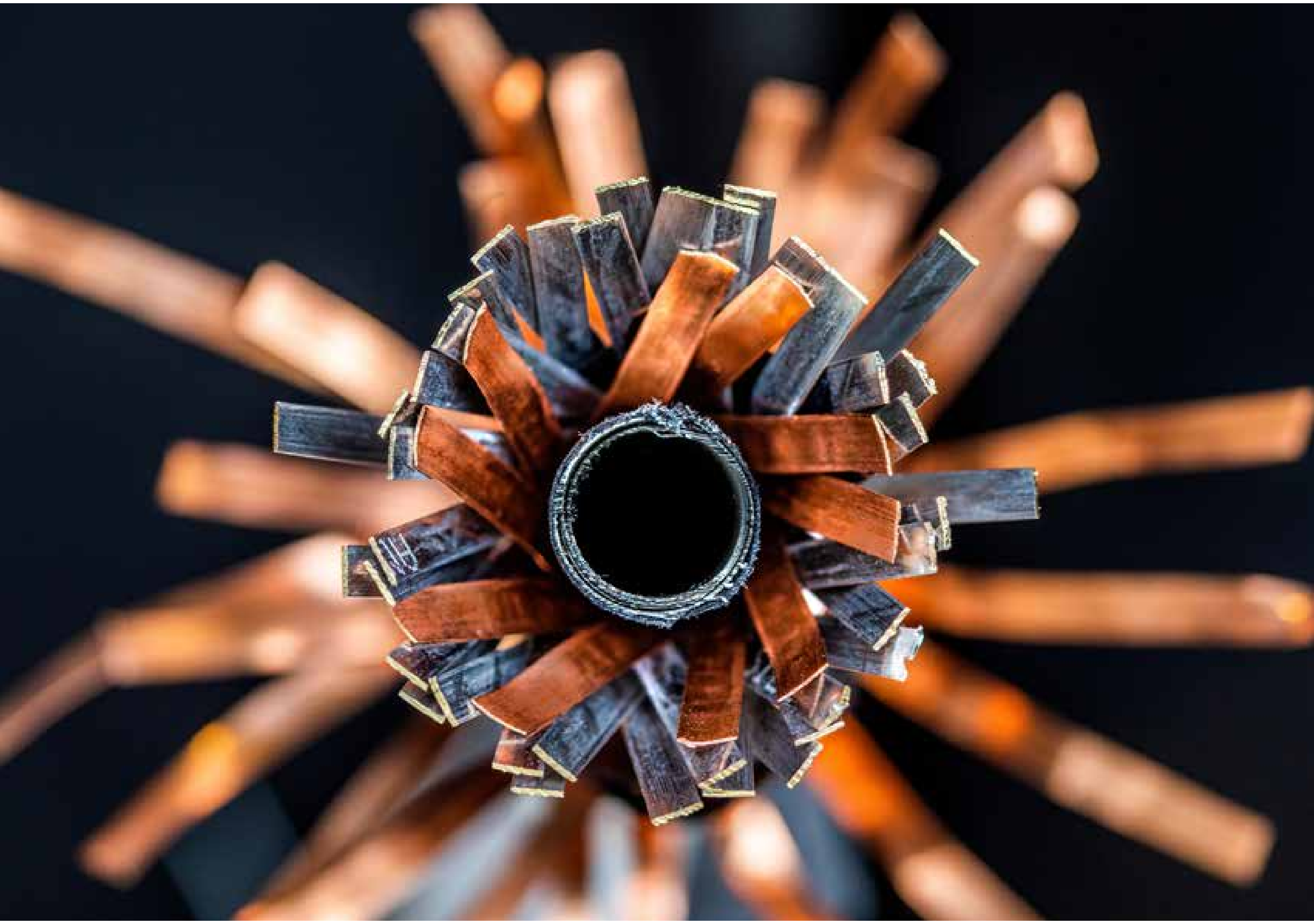
FAMU-FSU
College of Engineering



ANNUAL 2021 – 2022 ENGINEERING RESEARCH REPORT

Associate Professor Shonda Bernadin

Abiola Temidayo Oloye, left, a doctoral candidate with Fumitake Kametani, associate professor of mechanical engineering.

CONTENTS

Diversity is in our DNA

Unique collaboration of a top HBCU and an R-1 university

The FAMU-FSU College of Engineering is the joint engineering institution for Florida A&M and Florida State universities, the only such shared college in the nation. We are located less than three miles from each campus. After satisfying prerequisites at their home university, students learn and research together at the central engineering campus with its eight adjacent, associated research centers and a national laboratory.

This unique collaboration between the nation's top Historically Black University and a Top-20, Tier-1 research institution make the FAMU-FSU College of Engineering a place to hone cutting-edge engineering skills. Our researchers and graduate students benefit from the rich intellectual heritage of both universities. They also enjoy access to both nationally recognized institutions' assets and capabilities to enrich their work.

The college's racial, ethnic and gender diversity exemplifies the future engineering and high-tech workforce to a degree not found at most other engineering schools. Employers value our graduates for not only their engineering skill set, but also the soft skills that make them better employees to work in culturally diverse, modern teams.

Leveraging tradition and research to build a sustainable and better world

WELCOME TO OUR ANNUAL RESEARCH REPORT. We are delighted that despite COVID we have substantially increased our external funding and our graduate student enrollment. Since 2016 our external expenditures have grown by almost a half, and our graduate student enrollment by one third. Thanks for this dramatic growth goes to all our faculty and staff, but especially to Senior Associate Dean for Research and Graduate Studies, Prof. Farrukh Alvi, and his staff who have facilitated the faculty's growing success.

We are fortunate to be in a period of continuing growth, which can be attributed to the unique partnership that is at the core of our college, between Florida A&M University (the #1 public HBCU according to US News), and Florida State University (#19 amongst all public universities in the nation according to US News). The college is ranked in the top 100 for graduate engineering schools, and has moved up 25 points in four years.

J. Murray Gibson
Dean, FAMU-FSU Engineering

We have identified strategic areas where we are strengthening our **unique capabilities:** hypersonics, power systems, cryogenics and magnetism, resilience and disaster recovery, high-performance materials manufacturing and sustainable polymers.

The collaboration intrinsic to our college is an "unfair advantage" since all our faculty have full rights at both universities (with the exception of tenure, which is granted at only one institution) and can leverage the research strength of FSU with the social mobility of FAMU graduates (#13 in the nation by this very important metric). As a result, we are the only top-ranked college in the nation whose student body has a racial and ethnic diversity resembling that of the United States, and we are the #4 producer of engineering doctorates to African-Americans amongst all engineering schools. Since we have doubled our Ph.D. enrollment at FAMU in the last few years, we are aiming to be #1 in this last metric within this decade.

Like all top schools of engineering, while we cover all the major engineering disciplines in research and education, we have identified strategic areas where we are strengthening our unique capabilities. These include hypersonics, power systems, cryogenics and magnetism, resilience and disaster recovery, high-performance materials manufacturing and sustainable polymers. You will find examples of research highlights from these in the pages of this report.

One thing that particularly excites me as dean is the increasing degree of research collaboration with the sciences, and especially with the social sciences and humanities. Only by understanding the societal dimensions of challenges can engineers build a sustainable and better world.

FAMU-FSU College of Engineering

**Numbers are approximate as of 9/21/21; FY 2021: July 1, 2020 – June 30, 2021

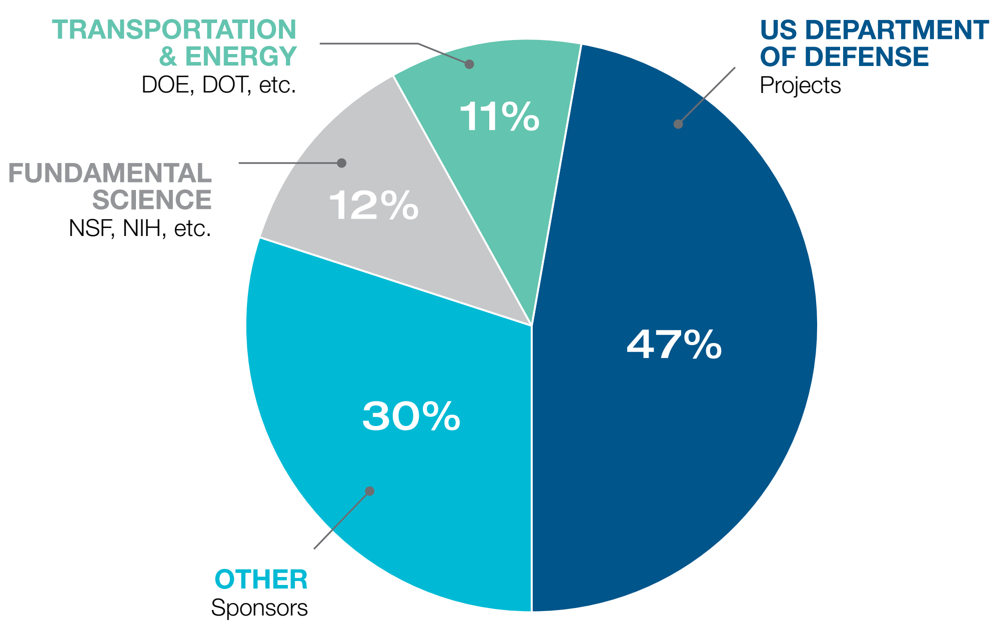
Generated **2/3** of all patent applications filed by Florida State University in FY2021

50% increase in GRADUATE enrollment since 2019

Some of Our Most Generous Corporate Sponsors 2017–2021

Aerosonic
Baidu USA
Bruker Biospin AG
CERN
Cummins Inc.
Curtiss-Wright Electro-Mechanical Corp.
Cytec Engineered Materials
Danfoss Turbocor Compressors
DOW
Duke Energy
Environmental Research and Education
EPRI
ExxonMobil Chemical Company
Ford Motor Company
Geosyntec Consultants
General Atomics Electromagnetics
Infineum USA
Korea Basic Science Institute
L3Harris Technologies
L-3 Maritime System
LG Chem
Lockheed Martin Corporation
Major Tool and Machine
Mitsubishi Heavy Industries
Nikon Instruments
Northrop Grumman Systems Corporation
OMICS
Reliance Industries Limited, India
Rolls-Royce
SentiMetal Journey
SGRI North America
Texas Instruments
Total Raffinage Chimie

FY 2021 Sponsored Research Expenditures
$31.4M**



Junior faculty awards
19 TOTAL
9 ACTIVE
- 8 NSF CAREER
- 1 DARPA YIP*

*Young Investigator Program

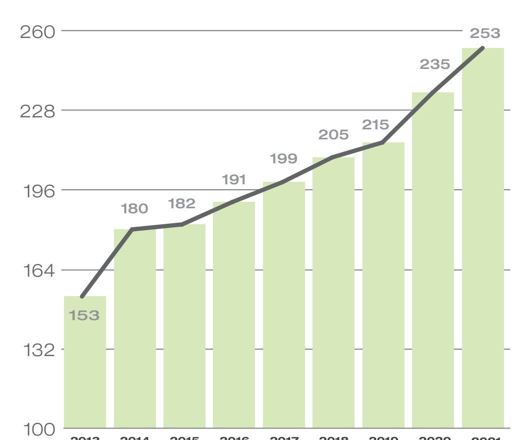
RESEARCH TOTALS '20–'21

153	RESEARCH AWARDS *(received)*
$29.9M	TOTAL AWARDS VALUE
228	PROPOSALS SUBMITTED
67	RESEARCH LABS & CENTERS
31	PATENTS ISSUED

22 FACULTY FELLOWS

- American Association for the Advancement of Science
- American Institute of Chemical Engineers
- American Physical Society
- American Society of Civil Engineers
- American Society of Mechanical Engineers
- Institute of Electrical & Electronics Engineers
- Institute of Physics (UK)
- Materials Research Society
- National Academy of Engineering
- National Academy of Inventors
- Royal Academy of Engineering (UK)
- Royal Microscopical Society (UK)

PhD Enrollment



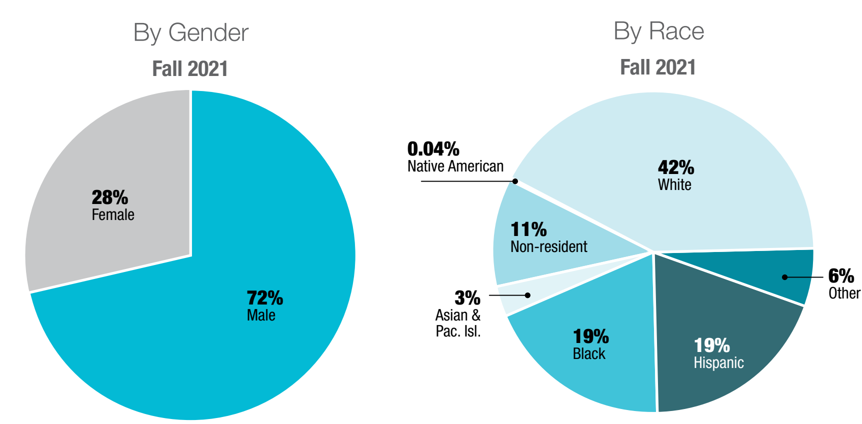
STUDENT POPULATION

2,831 students
2,377 undergraduate
454 graduate

TOTAL ENGINEERING DEGREES AWARDED 2020–21

BS **376** GRADUATE **110**

GRADUATE & UNDERGRADUATE STUDENT POPULATION



Graduate Student Fellowship Awards 2020–2021

DoD Science Mathematics & Research for Transformation Scholarship

NSF Graduate Research Fellowship Program

McKnight Doctoral Fellowship

NIH Predoctoral Fellowship

Department of Energy Office of Science Graduate Student Research Award

FSU Legacy Fellowship

GEM Intel Fellow

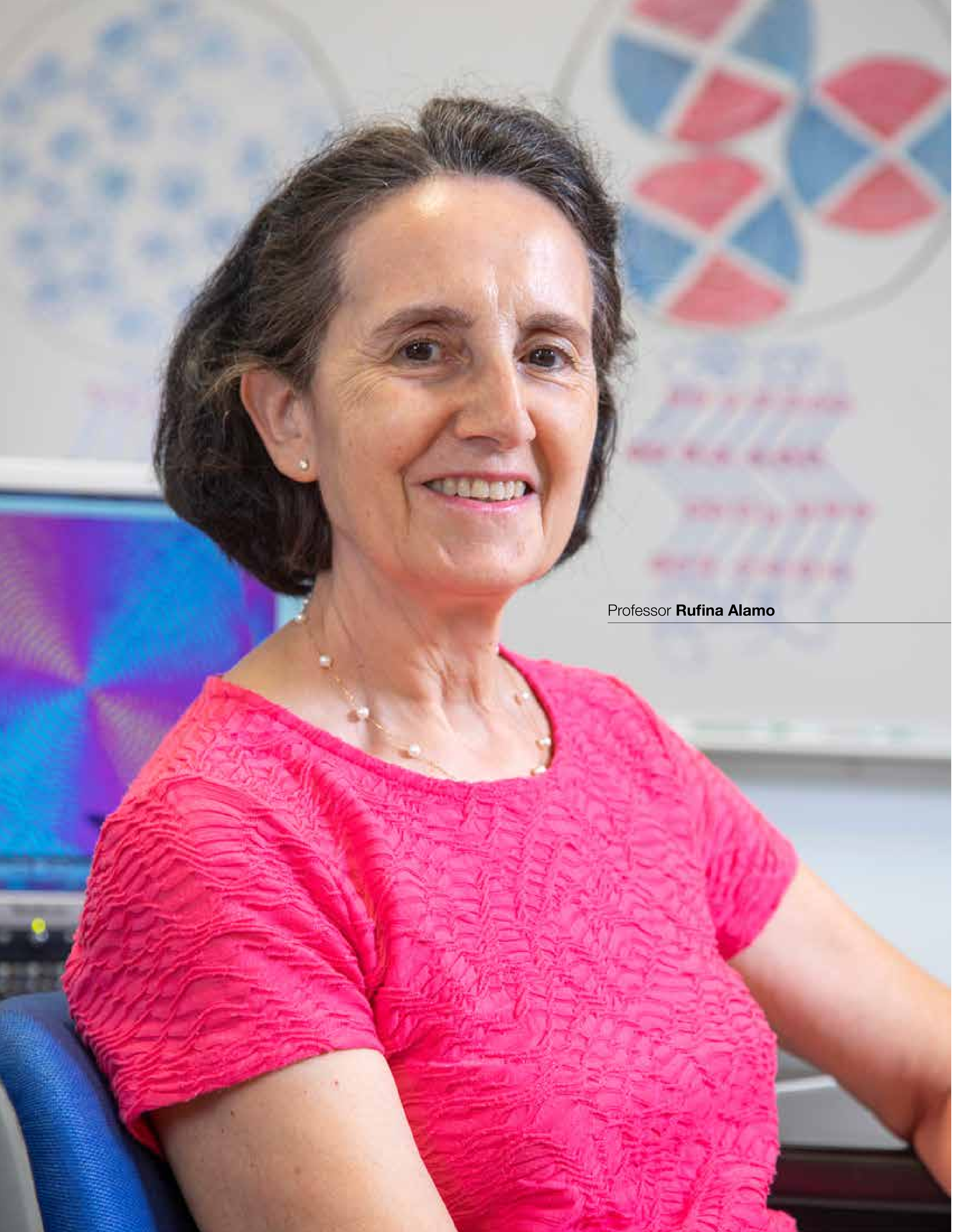
FAMU (HBCU) doctorate enrollment **up 81% since 2016**

ASEE DIVERSITY RECOGNITION PROGRAM BRONZE ASEE

2019 Exemplar

#4 producer of African-American PhDs in engineering nationwide

#1 in percentage of African-American engineering faculty at an R-1 university



Professor **Rufina Alamo**

New polymer research may revolutionize how plastics are processed

CHEMICAL

IN A SERIES OF NEW ARTICLES, RESEARCHERS described new discoveries on the effects of temperature on sustainable polymers. Their findings may help the industry to produce plastics that are more sustainable and better for the environment.

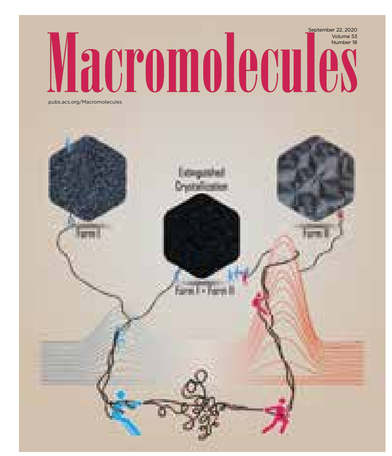
"Plastics made from petroleum, a non-renewable resource, remain too long in our land and water when discarded," Rufina Alamo, chemical engineering professor, says. "We are researching how sustainable polymers are heated and cooled so we may produce more 'environmentally friendly' plastics."

Alamo and doctoral candidate Xiaoshi Zhang, now a postdoctoral research fellow at Penn State, recently published the work in a series of papers that focus on the crystallization of "green" polymers. The latest paper appears as the cover article in issue 18 (2020) of Macromolecules, a leading journal for polymer science.

"There is a worldwide motivation to transform how the largest volume of plastics are made," Alamo says. "Polymer chemists and physicists are working hard to produce substitute materials to end problematic plastic waste."

According to Alamo, replacing inexpensive polymers made from petroleum with economically viable, sustainable polymers is only the first step in the process. Determining the correct temperature for processing is key to producing better materials.

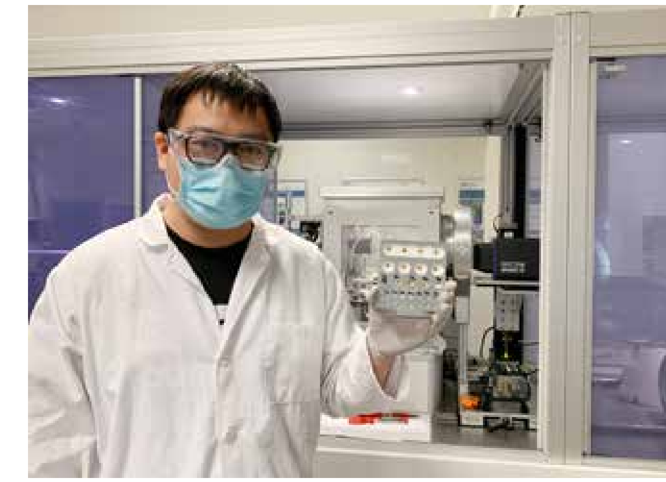
"How the polymer is melted and cooled to make the desired shape is important," Alamo explains. "We are trying to understand the intricacies of crystallization to further understand the transformation process."



The team is studying a type of polymer called "long-spaced polyacetals," which are used in plastics. Synthesized in a laboratory at the University of Konstanz in Germany, the long-spaced polyacetals Alamo's team use come from sustainable biomass. They contain a polyethylene backbone decorated with the acetal groups at a precise equal distance. The structure combines the toughness of polyethylene with the hydrolytic degradability of the acetal group. This type of polymer is strong, but breaks apart more easily with water than traditional polymers.

"What we discovered is these types of polymers crystalize in an unusual way when cooled after melting," Alamo said.

During the cooling process, spaghetti-type molecules in melted plastics disentangle to form crystals and are responsible for the toughness of final material. Alamo's group showed that polymer crystallization is controlled by molecular events that take place at the crystal growth front.



Study co-author **Xiaoshi Zhang** was a doctoral candidate when he performed this polymer research with Dr. Alamo. Now he's a postdoctoral research fellow at Penn State.

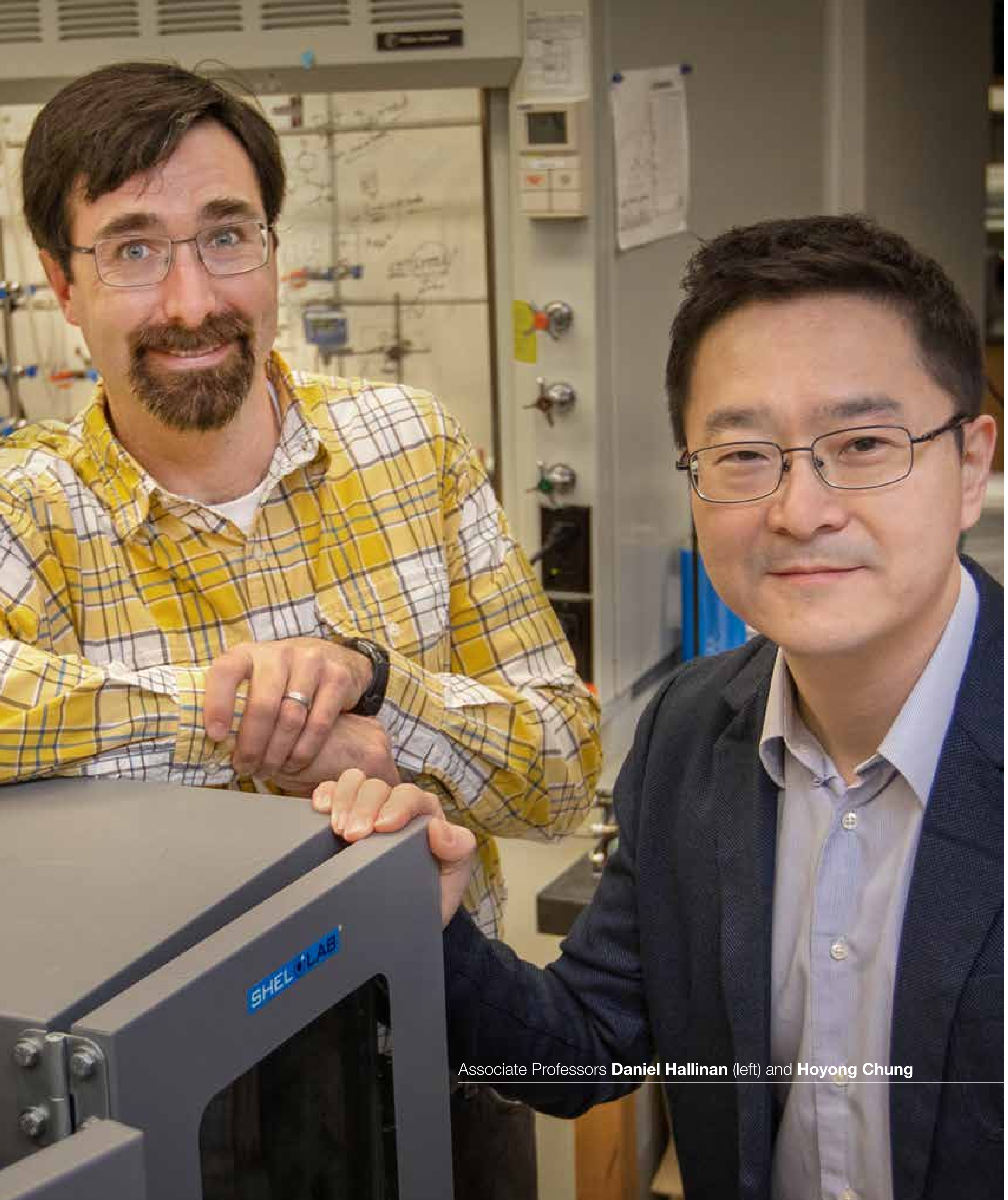
The researchers found that when cooled rapidly, these polyacetals become tough and crystalline and the molecules self-assemble in a type of crystal termed "Form I." When cooled slowly, the material is also very crystalline, but the crystals formed are quite different and dubbed "Form II." When cooled at intermediate temperatures, the material does not solidify at all. This phenomenon has never been observed in any other crystalline polymers, according to the researchers.

"For crystals to be formed, an energy barrier first needs to be surmounted," Alamo said. "At low temperatures, crystals are easily formed. At high temperatures, crystals are more stable and at intermediate temperatures, the crystals compete to form and the material can't solidify."

"This is a significant discovery because it is an important key to understanding how the plastics we use become solids," Alamo said. "We want to provide the industry with the best transformation processes possible. We want sustainable plastics that don't warp or have difficulty solidifying."

The research may provide new ways of manufacturing plastics that will be more economical to produce and sustainable.

Alamo's research is supported by a grant from the National Science Foundation. Stephanie Marxsen, Patrick Ortmann, Stefan Mecking and Xiaobing Zuo contributed to the study. Undergraduate students Sidney Cameron and Michael Parkhurst collected experimental data for the project.



Associate Professors **Daniel Hallinan** (left) and **Hoyong Chung**

Researchers develop battery component that uses compound from plants

CHEMICAL

A TEAM OF ENGINEERING RESEARCHERS RECENTLY developed a way to use a material found in plants to help create safer batteries.

Using the organic polymer lignin — a compound in the cell walls of plants that makes them rigid — the team was able to create battery electrolytes. Their research was published as the cover article in the journal Macromolecular Rapid Communications.

"The main battle in battery science is in new materials," said Hoyong Chung, an associate professor of chemical and biomedical engineering and the study's corresponding author. "Depending on what kind of material we use, we can improve the capacity of the battery and the safety of the battery substantially."

To create their new type of solid electrolyte, the team combined lignin with the synthetic polymer polyethylene glycol.

Electrolytes are a battery part that separate the negative and positive terminals of a battery. They conduct ions, which match the flow of electrons moving from a negative to positive terminal and through whatever the battery is meant to power.

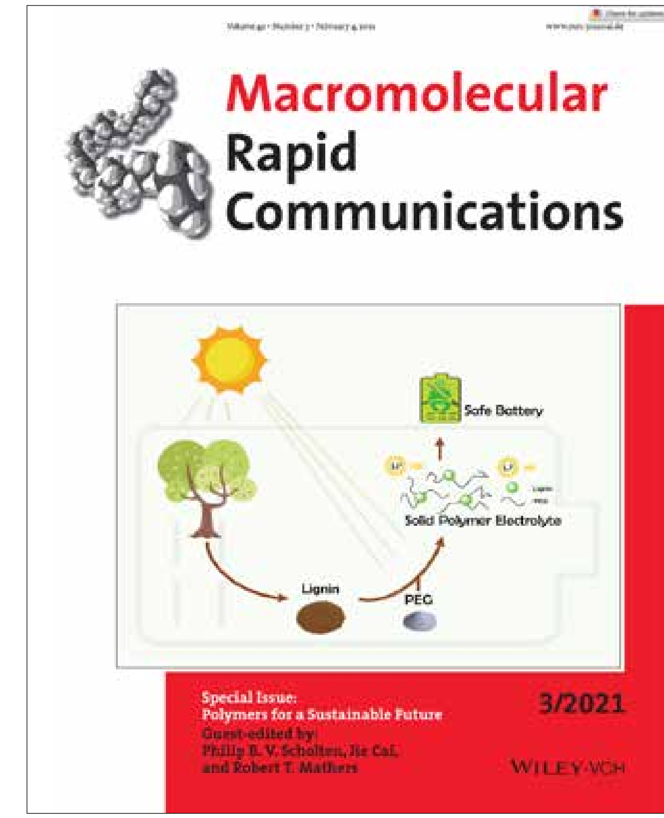
Electrolytes can be either liquid or solid, and each type has its strengths and weaknesses. Liquid electrolytes are good conductors of ions, but solid electrolytes are typically safer, stronger and can be used at higher temperatures than liquid versions.

Polyethylene glycol is a popular candidate for solid electrolytes because of its electrochemical stability, but it doesn't conduct well at room temperature, which limits the abilities of batteries using that material to power something or to rapidly charge.

That's where lignin comes in.

Lignin's chemical structure contains high concentrations of derivatives from the molecule benzene, which makes it a strong material. By using **lignin** as an electrolyte component, the battery keeps the **strength** and **safety** that comes with a typical solid electrolyte but gains the ability to **function** well at room temperature.

Lignin's chemical structure contains high concentrations of derivatives from a compound called benzene, which makes it a strong material. By using lignin as an electrolyte component, the battery keeps the strength and safety that comes with a typical solid electrolyte but gains the ability to function well at room temperature.



Along with increasing the range of temperatures at which a solid electrolyte battery is feasible, using lignin is a way to make batteries more sustainable.

Lignin is cheap and abundant. About 50 million tons are produced each year globally, and most of that is a waste product from the paper industry. Unlike other biomass materials, it's not a human food, so it couldn't be otherwise used to feed people.

"This is a way to improve battery performance and to do so in a sustainable way," Chung said. "Batteries will be even more important in the future, so improving their technology is crucial."

Daniel Hallinan Jr., associate professor and co-author; former graduate student Hailing Liu; and former graduate assistant Logan Mulderrig contributed to this work.

Assistant Professor **Jamel Ali** with students he mentors at the college.

BIOMEDICAL

Chemical engineers receive over $1 million in NSF grants for multi-institutional bacteria research

AN ENGINEERING RESEARCHER, COLLABORATING with a colleague from Howard University, is investigating bacteria-related dynamics in one of two new projects supported by the National Science Foundation (NSF).

The NSF has awarded over $1 million for two research grants for bacteria related investigations that have the potential to impact societal health by supporting new diagnosis and treatment methods for diseases. One award is through Florida A&M University (FAMU) and the other through Howard University, both historically Black colleges and universities (HBCUs) in a multi-institutional partnership with the FAMU-FSU College of Engineering and the National High Magnetic Field Laboratory.

Jamel Ali, a Howard alumnus and assistant professor in chemical and biomedical engineering, is working with Patrick Ymele-Leki, interim-chair and associate professor in chemical engineering at Howard University. The research project aims to determine the role fluid flow has on the development and evolution of bacterial communities.

"Antimicrobial-resistant (AMR) strains of bacteria are increasing and if we want to develop new antibiotics and diagnostic tools to effectively identify and control their spread, we need to better understand what physical forces drive their drug resistance," Ali said.

In the first investigation, Ali and Ymele-Leki will look at how various forms of fluid flow impact the process by which bacteria attach to each other to form complex communities. Findings could lead to new methods to control biofilm formation.

Biofilms are aggregates of bacteria that can attach themselves to surfaces. Examples include the dental plaque that forms on teeth or the slimy substance that builds up in the lungs of cystic fibrosis patients. In the medical field, biofilms play an important role in the development of antibiotic-resistant microorganisms that can cause severe infection.

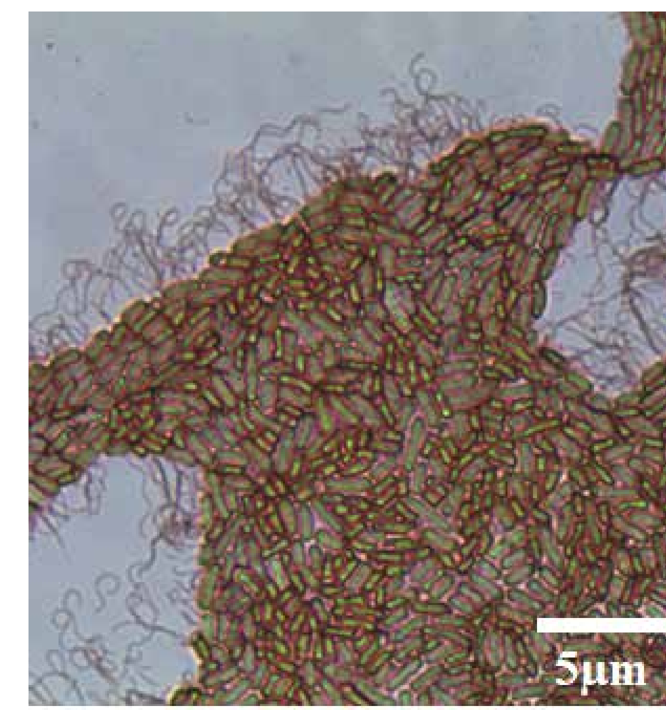
Biofilms typically form in wet environments; however, little is known about how initial single and multi-cell interactions and fluid flow influences their growth and structure. The researchers hope the outcome of their work will provide a better understanding of how they develop and will lead to new diagnosis and treatment methods for problems caused by biofilms.

In the second NSF-funded project, Ali will develop novel biological sensors using bacteria's flagella, which are long, hairy external structures that help the organisms move. He hopes to create nanoscale sensors capable of detecting very small changes in biological environments. By identifying the changes in local cellular regions within human cells, Ali hopes treatment options will be better identified.

"In both projects, for the first time we will be using a set of specialized tools at both institutions that allow us, in real-time, to look not only at bacteria but also at their subcellular components and how they interact with their surroundings," Ali said.

"Antimicrobial-resistant (AMR) strains of bacteria are increasing and if we want to **develop** new antibiotics and diagnostic tools to effectively identify and control their spread, we need to better understand what **physical forces** drive their drug resistance."

— ASSISTANT PROFESSOR JAMEL ALI



Brightfield image of stained biofilm with visible flagella (Scale bar is 5 µm). (Courtesy Ali)

Assistant Professor **Christian Hubicki** talks robotics with local high school students

Professor will teach robots the concept of risk with Toyota Grant

FOR ENGINEERING ASSISTANT PROFESSOR CHRISTIAN HUBICKI, robots aren't just a tool for the future. They're a way to understand everything around us.

Hubicki, a faculty member in mechanical engineering, will continue that quest thanks to a $750,000 Young Faculty Researcher grant from the Toyota Research Institute (TRI). The grant is part of a larger initiative from TRI that will distribute $75 million to 16 institutions around the country.

"I'm really excited about this because if we crack this nut — and we have, I think, a very promising approach — then that means robots will be able to reason in a way that is really impressive in real-life situations, as opposed to being very rigid in their thinking, or some might say, robotic," Hubicki said. "If we succeed in this, the way that a robot might think is a lot more adaptive and fluid than you might have otherwise thought a robot was."

Hubicki's project is focused on teaching robots the concept of risk.

"I really think that risk is a fundamental unifying concept for anything we want to do in our lives," he said.

A visit to a farm inspired him to explore how robots could learn the idea. At the farm, chickens were running around, pecking at their food when Hubicki came along. He tried to pet some of the chickens. They suddenly had a choice to make. They wanted the food. They also wanted to avoid this strange new creature in their space.

"They had to somehow balance the risk of not eating with the risk of this scary-looking human being too close to them," he said. "They had to move dynamically and rapidly assess the situation, see what a risk is and try to navigate that in a way where they still did what they needed to do."

People do the same thing every day, he said. Consider something as simple as a trip to the mailbox, where one might have to contend with unstable terrain, reckless bike riders and weather.

For a robot, risk is anything that compromises its ability to complete the task it has been programmed to do. That could be slipping on the ground or being knocked over by a pedestrian. It could be something like losing power from a battery or overheating by putting too much electricity through its motor. The challenge for engineers is to create the algorithms that allow a robot to constantly evaluate risk in a changing environment.

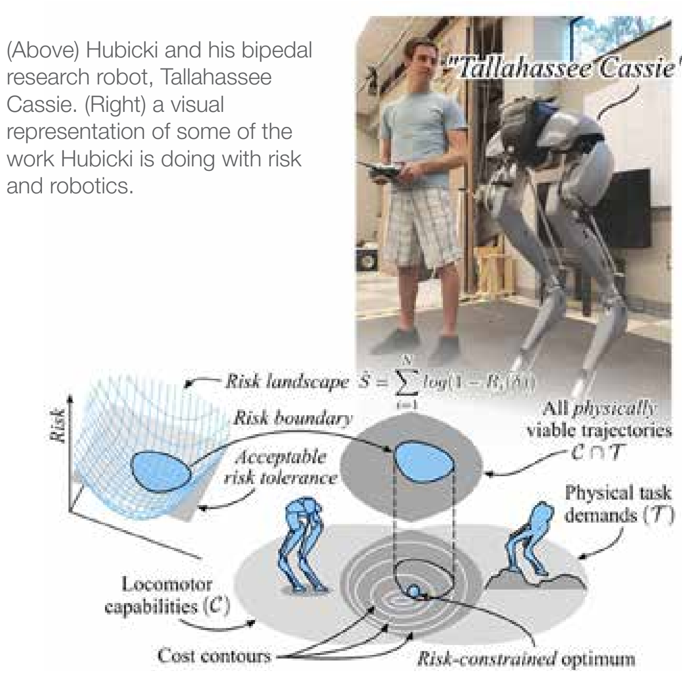
"How do we take all these very different sources of failures and put them into one equation for the robot to understand?" Hubicki said. "That's what this project is all about."

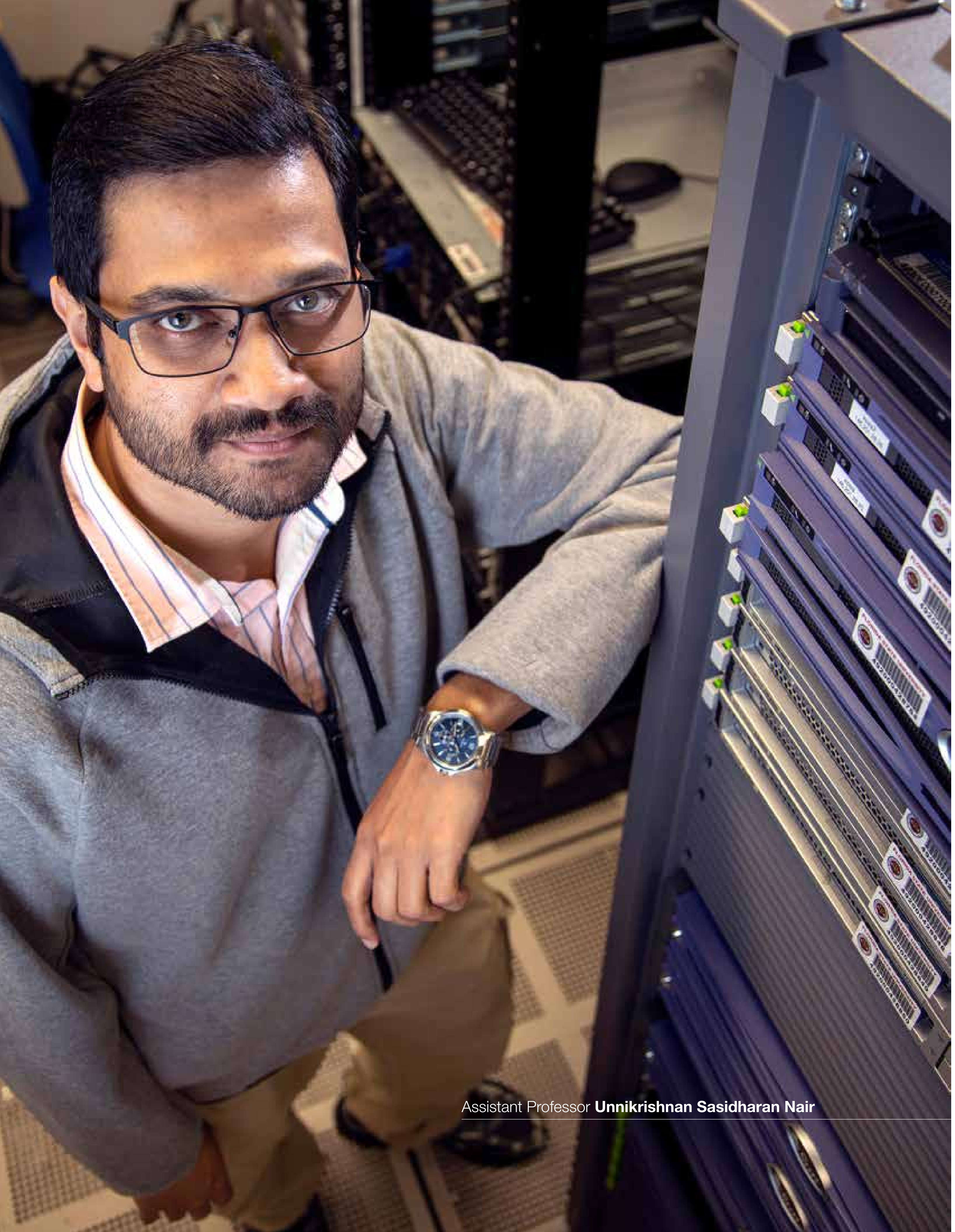
Understanding risk is an important part of giving robots the ability to be more flexible in how they complete the tasks humans ask them to do within the parameters we give them.

The Young Faculty Researcher grant Hubicki received from TRI is specifically designed to support promising tenure stream faculty members, enabling them to explore broadly, inquire deeply and address higher-risk, higher-payoff ideas. In YFR projects, TRI invests in the researcher and provides them the freedom and flexibility to pivot from one direction to another.

"Our first five-year program pushed the boundaries of exploratory research across multiple fields, generating 69 patent applications and nearly 650 papers," said Eric Krotkov, TRI chief science officer, who leads the university research program. "Our next five years are about pushing even further and doing so with a broader, more diverse set of stakeholders. To get to the best ideas, collaboration is critical. Our aim is to build a pipeline of new ideas from different perspectives and underrepresented voices that share our vision of using AI for human amplification and societal good."

(Above) Hubicki and his bipedal research robot, Tallahassee Cassie. (Right) a visual representation of some of the work Hubicki is doing with risk and robotics.





Assistant Professor **Unnikrishnan Sasidharan Nair**

Combining theoretical, experimental and computational aerodynamics into one dynamic locale

AEROSPACE

IN A REGION OF THE UNITED STATES THAT IS HOME to 20 major military installations and a defense business presence worth $95 billion annually, the FAMU-FSU College of Engineering is uniquely situated for high-impact aerospace research and testing.

Florida hosts two (of only four) deep-water naval ports with adjacent airfields, the Joint Gulf Range Complex in the Gulf of Mexico, the military's only east coast space launch facility and several critical Department of Defense (DoD) research, development, training and evaluation (RDT&E) centers. Of those, the majority are located in the northwest region of the state, within a short distance of the college.

This backdrop provides a rich atmosphere for commercial aerospace and defense-related engineering research to thrive. In addition to close contacts with key defense stakeholders in the research frame, the college also enjoys collaborative research efforts with defense-industry public and private businesses including Boeing, Lockheed Martin, BAE Systems and Raytheon.

For a college and mechanical engineering department with its sights set on becoming a nationally-recognized hub for aerospace research, there is likely no better place than Tallahassee and Leon County's Innovation Park, adjacent to the campus.

FAMU-FSU Engineering is already surging ahead in the field, with the Florida Center for Advanced Aero-Propulsion (FCAAP), a state-recognized and supported Center of Excellence whose research has had a major impact on the space and aerospace industry in Florida and beyond. With its trio of high-tech (and high-speed) wind tunnels, high-temperature jet and short take-off/vertical landing aircraft (STOVL) facilities, FCAAP is the site for mission-critical engineering test model research by mechanical engineering faculty such as Louis Cattafesta and Rajan Kumar.

A relatively new area for the college is computational fluid dynamics (CFD), brought to the department by junior faculty members emerging in their field as highly creative and prolific researchers. Assistant Professor of Mechanical Engineering Unnikrishnan Sasidharan Nair joined the faculty alongside his colleagues Neda Yaghoobian and Kourosh Shoele, both also assistant professors in mechanical engineering focused on advanced, multi-physics CFD.

From Algorithm to the Field

Historically, the faculty at FCAAP and other college-associated centers have focused on materials science and experimental aerodynamics, leveraging our advanced wind tunnels and other test facilities.

These recently-hired mechanical engineering researchers are interested in advanced computational fluid sciences, which is an area that includes simulations, mathematical models and other research methods fine-tuned to the study of fluid-thermal systems, including aerodynamics.

Using algorithms and computer models to solve equations that predict fluid flow, for example, researchers develop simulations which offer low-cost pre-test environments for defense-related concepts. Once a design is established, computational research can develop algorithms and apply advanced mathematics to evaluate critical performance parameters before a model is built out and ready for the wind tunnel.

> The college is already **surging ahead** in the field, with the Florida Center for Advanced Aero-Propulsion (FCAAP) a state-recognized and supported Center of Excellence whose research has had a **major impact** on the **space** and **aerospace** industry in Florida and beyond.

"In one study, we are simulating air flow in the context of high-speed aircraft," Sasidharan Nair explains. "This can help define the size of the wings and other parts of an aircraft (before they enter the costly design and test phase)."

In a series of recent grants totaling $1.4 million, Sasidharan Nair is pushing forward on computational aero-sciences as a new research thrust at the college, complementing his colleagues' work in similar engineering areas.

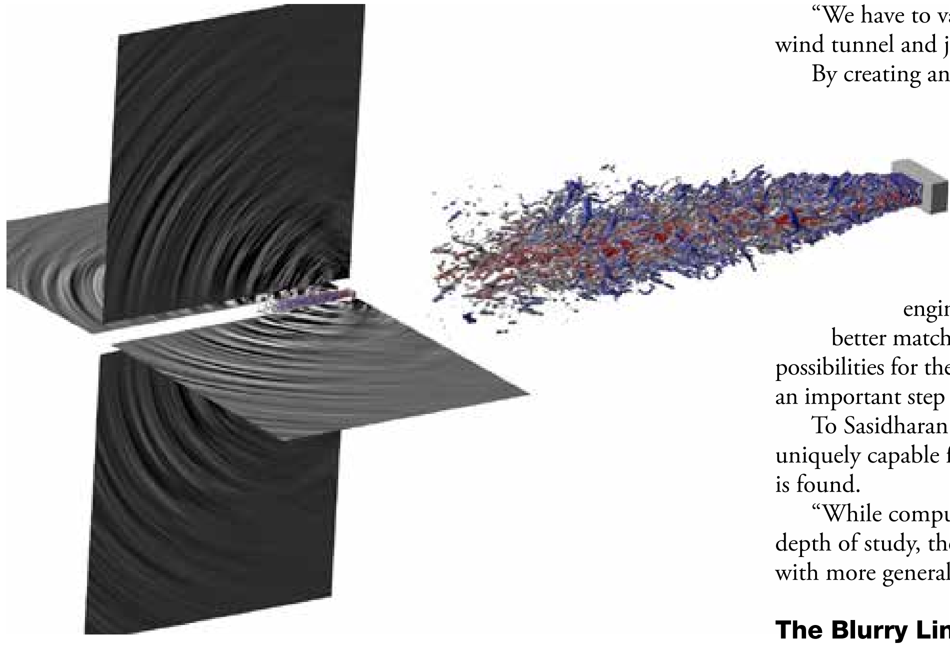
As a mechanical and aerospace engineer in the aerodynamics field, Sasidharan Nair is specifically interested in the design of aircraft components that move through the air at very high speeds. How does air behave as a compressible-fluid as it flows over the aircraft? What principles of fluid dynamics apply and how can they be harnessed to mitigate environmental, health and physical impacts of these machines on crews and communities?

Mitigating the Boom

Aero-acoustics refers to the study of sound and associated fluid dynamics, and is a key discipline utilized to evaluate the noise emitted by military aircraft as they soar through the air. In one study for the U.S. Navy, Sasidharan Nair and his team are determining how the acoustical properties of those aircraft behave differently at supersonic speeds and in different atmospheric conditions likely encountered at high altitudes.

While common to communities in Northwest Florida, the traditional "sonic boom" emitted from military jets as they break the sound barrier at supersonic speeds can negatively affect humans and wildlife.

According to JSTOR Daily, sonic booms aren't just loud; they can also cause physical damage, breaking glass, cracking plaster and shaking objects off shelves. A boom from a single fighter aircraft in 1966 dislodged tons of rock, crushing archaeological sites in the famous Canyon de Chelly National Monument. In addition,



Right: Simulation of the turbulent plume ejected by a supersonic jet.
Left: A zoomed-out image of the jet highlighting its acoustic emissions.
(Courtesy Sasidharan Nair)

the U.S. military acknowledges that the shock waves cause ear and hollow cavity damage to human bodies.

Because of its deleterious effects, the U.S. military is interested in ways to mitigate the boom itself—perhaps by designing aircraft that create smaller "booms" during supersonic travel. A key milestone in advancing civil aviation in the near future will be the reintroduction of supersonic flight—similar to the Concorde, but in a more environment friendly and sustainable manner. For supersonic commercial aircraft to be practical they must be able to fly at supersonic speeds overland, something the Concorde could not due to its very loud sonic boom. Hence the challenge is in how to design efficient commercial supersonic aircraft where the aerodynamic and propulsive design is boom-constrained.

To better control the sound emissions from aircraft, Sasidharan Nair is looking at the noise-sources involved in the traditional sonic boom, as well as the "shock-dominated jets" that often accompany them as the high-temperature, high-velocity exhaust from jet engines create differences in pressure that are mismatched with the surrounding atmosphere. These characteristic "shock cells" in these jets create sound signatures in addition to the sonic boom. Their extremely high temperatures and pressures make it very difficult to predict their behavior and their acoustic impact on ground crew. For U.S. Navy aircraft carriers where humans and jet engines are always in close proximity, understanding and mitigating these impacts is a priority.

To attack this problem, Sasidharan Nair has developed algorithmic tools to exactly predict how much sound is generated from this complex flow system of military plane exhaust. His model includes some of the most advanced algorithms available and is part of the reason he was chosen for the study.

Sasidharan Nair's work on simulating the complex dynamics of shock cells and characterizing the acoustics of military tactical aircraft, particularly Naval aircrafts, dovetails nicely with the state-of-the-art experimental high-speed jet aero-acoustics research performed steps away at FCAAP.

"We have to validate our algorithms and calculations against wind tunnel and jet-rig test data," he says.

By creating and testing a model component in the Mach-5 polysonic wind tunnel, the team is able to validate or fine-tune their algorithms for the military.

Creating techniques to control sound emissions is ripe with possibilities, including using actuators in the system. Active control, as it's known, excites the engine exhaust to achieve a lower acoustic impact and better match the atmospheric conditions. There are multiple possibilities for the future of acoustic mitigation, and these studies are an important step in that direction.

To Sasidharan Nair's mind, having FCAAP and highly and uniquely capable facilities he needs so close is where the real nexus is found.

"While computational aerodynamics and acoustics provides the depth of study, the jet noise anechoic chamber provides actual data with more generalizable details," he says.

The Blurry Line of Hypersonics

While the term "hypersonic" is a bit hard to define—there's no sharp boundary between super- and hypersonic regimes—for aerospace research it's generally accepted as any craft traveling 5 times the speed of sound (Mach 5) or faster. Currently the realm of unmanned concept vehicles including rockets and missiles, sustained hypersonic flight has great potential and many challenges. At speeds this fast, materials burn up and the air begins to act more like a reacting plasma than an unreactive gas. Despite challenges, the U.S. military and commercial aviation industries have their sights set on even faster speeds—above Mach 6.

In a 4-year collaboration with The Ohio State University, Sasidharan Nair and his team are working to computationally mitigate the distortion of boundary layer profiles (of velocity), a major challenge in designing hypersonic aircraft. This boundary layer is the region on an aircraft wing where air "sticks" as it flows over the surface, causing internal friction in the air to heat the surface. Much like the turbulent flow of water from a faucet that causes it to spray out from its downward stream, irregularities in the surface of aircraft systems can affect the boundary layer, causing it to transition from a laminar to a turbulent state. For example, when the faucet water is a smooth column flowing outward, it is considered laminar. However, once the water "catches" on a scratch inside the faucet fixture, it results in a turbulent zone that produces a scattered "spray" at the end of the flow.

In aircraft systems, the heat and drag loads are manageable and limited when the flow is laminar. However, these exceed safe thresholds when the flow transitions and becomes turbulent, resulting in surface damage. To realize safe, manned, hypersonic aircraft, this laminar to turbulent transition must be managed. With his collaborators, Sasidharan Nair aims to help identify materials or mechanisms to mitigate surface damage due to transition at hypersonic speeds.

Sasidharan Nair's computational models seek to help understand — and describe — the mechanics of the transition. Then, they can better define the optimal shape, design and materials for aircraft components where these flows are encountered.

"We want to avoid the dangerous transition to turbulence or at least move it further down the vehicle," he explains.

Tweaking Geometry for Better Design

In another computational-to-test collaboration, Sasidharan Nair and Rajan Kumar, associate professor in mechanical engineering

The anechoic test chamber at the Florida Center for Advanced Aero-Propulsion.

and FCAAP director, are studying the optimal design for a supersonic jet engine inlet. The co-PIs believe the research could help end disastrous engine failure events.

In traditional subsonic aircraft, turbines compress the air prior to combustion inside the engine. In supersonic aircraft, however, the inside surface of the air intake conduit "bends" the high-speed air to create shocks that compress the air flow in a highly efficient process that super-concentrates air-density to a level required by the engine. While this is one of the innovations of jet design, the sometimes-violent breakdown of this compressed air stream into the engine results in a deadly "unstart," or engine failure event.

"If we can tweak the geometry of the inlet's internal design," Sasidharan Nair says, "we can produce a more robust inlet shock train that will mitigate these back-pressure variations, making them less sensitive to disturbances."

Back to Basics

In addition to these military applications, Sasidharan Nair's computational approaches and FCAAP's aerodynamics research facilities are being used for work on fundamental fluid dynamics. In a research and development project, Sasidharan Nair is looking at fundamental questions involving hydrodynamic stability and the aerothermal chemistry of fluid dynamics. He's asking what causes instability in fluid flows, as well as what makes fluid systems challenging to predict; and what are the aerodynamic, chemical and thermodynamic properties of high-speed flows?

"I had the opportunity to leverage my startup funds when I joined the college in 2019," Sasidharan Nair says. "Now we are working on grants that will affect and inform various parts of aircraft design for the future, like inlets, exhausts and wings."

With the funds, he created the algorithmic prototype tools that were the basis for these military and R&D grants. It was, he believes, his contribution to the burgeoning computational aerodynamics and aerospace research center that will soon be a reality.

> "We are not as big as some others but we are very **efficient** for our size. This work is a big step toward our goal to become the **leading center** that addresses high-speed aerodynamics for commercial and defense applications."
>
> — FARRUKH ALVI, SENIOR ASSOCIATE DEAN

Farrukh Alvi, senior associate dean for research and graduate studies and mechanical engineering professor, agrees.

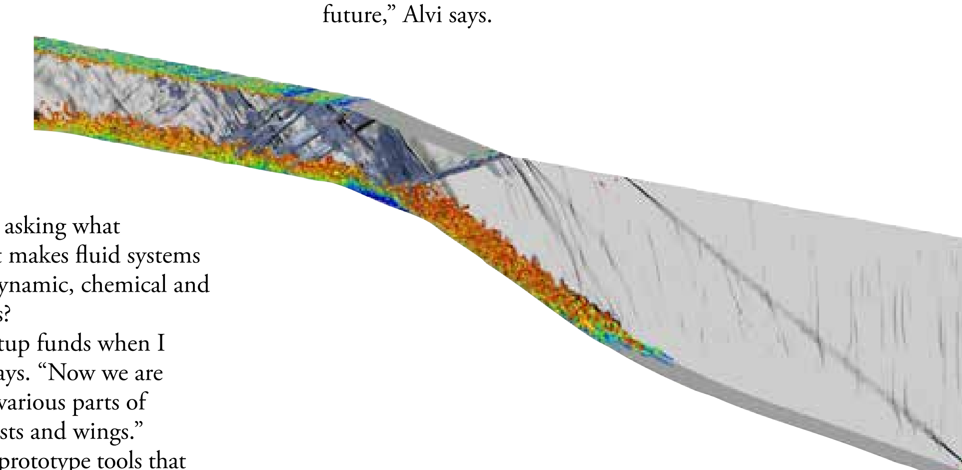
"Unni's work complements and leverages our current work in high-speed aerodynamics and jet aero-acoustics, and our strong computational skills in the field," he says. The computational and experimental team in mechanical engineering now routinely tackles multi-scale, multi-physics projects.

The dream is still to become a computational center of excellence, but that's for others to bestow. FAMU-FSU Engineering is already in the top 10 nationally for high-speed experiential aerospace research with its FCAAP facilities, and Sasidharan Nair's work is a great complement and extension to that.

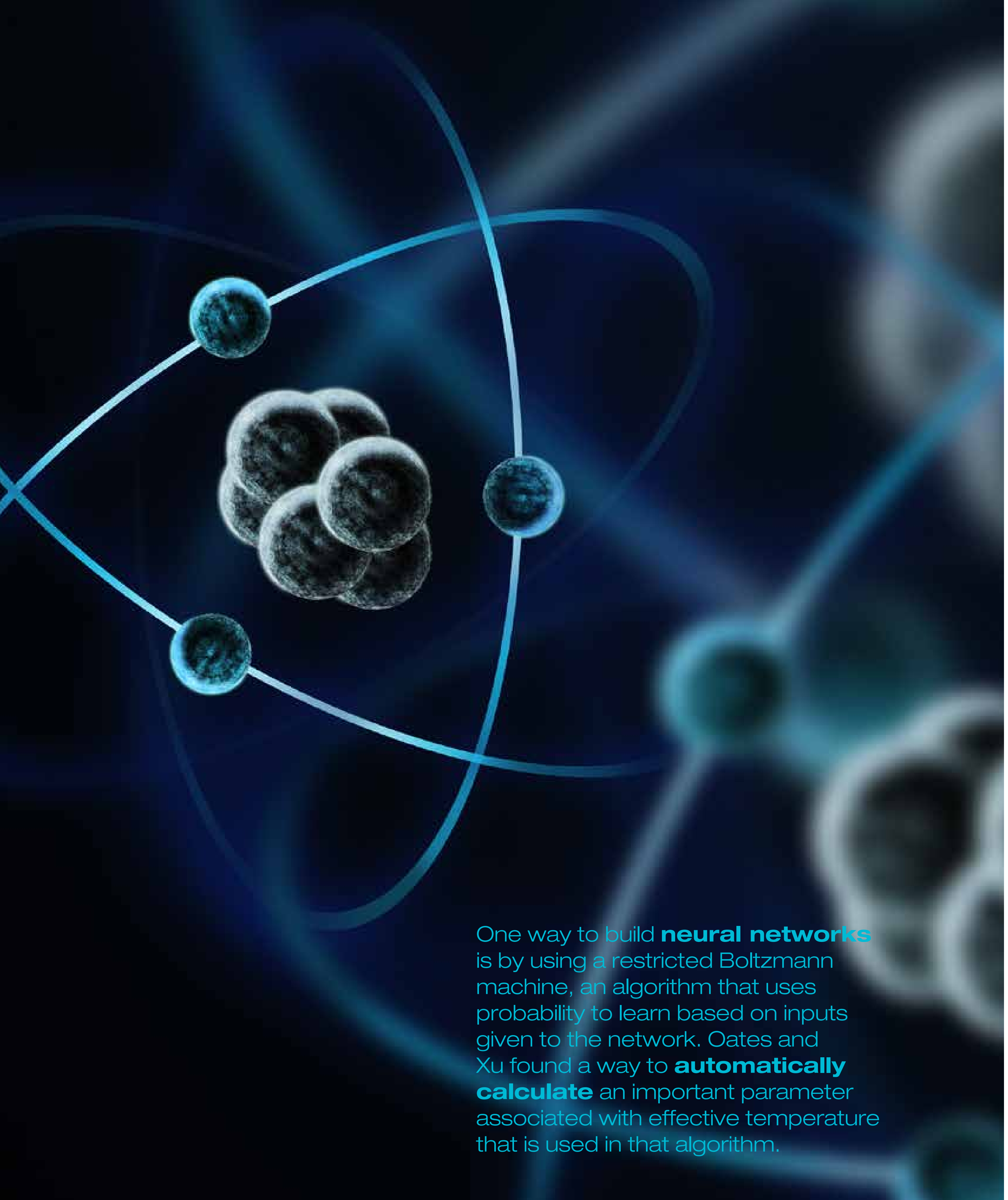
"We are not as big as some others but we are very efficient for our size," Alvi contends. "This work is a big step toward our goal to become the leading center that addresses high-speed aerodynamics for commercial and defense applications."

With the rich groundwork laid by Kumar, Cattafesta, Shoele, Yaghoobian and a host of others in the mechanical engineering department, the opportunities seem endless for collaboration and innovation in the aerospace sector.

"Our work college-wide in these areas, combined with our advanced materials capability, make us holistically suited for tackling more realistic and complex problems, now and in the future," Alvi says.



Simulation of the air flow inside an inlet of a supersonic aircraft. (Courtesy Sasidharan Nair)



QUANTUM

Researchers enhance quantum machine learning algorithms

WILLIAM OATES, THE CUMMINS INC. PROFESSOR AND CHAIR of the department of mechanical engineering, and postdoctoral researcher Guanglei Xu found a way to automatically infer parameters used in an important quantum Boltzmann machine algorithm for machine learning applications.

Their findings were published in Scientific Reports, a multidisciplinary journal from the publishers of Nature.

The work could help build artificial neural networks to be used for training computers to solve complicated, interconnected problems like image recognition, drug discovery and the creation of new materials.

"There's a belief that quantum computing, as it comes online and grows in computational power, can provide you with some new tools, but figuring out how to program it and how to apply it in certain applications is a big question," Oates said.

Quantum bits, unlike binary bits in a standard computer, can exist in more than one state at a time, a concept known as superposition. Measuring the state of a quantum bit — or qubit — causes it to lose that special state, so quantum computers work by calculating the probability of a qubit's state before it is observed.

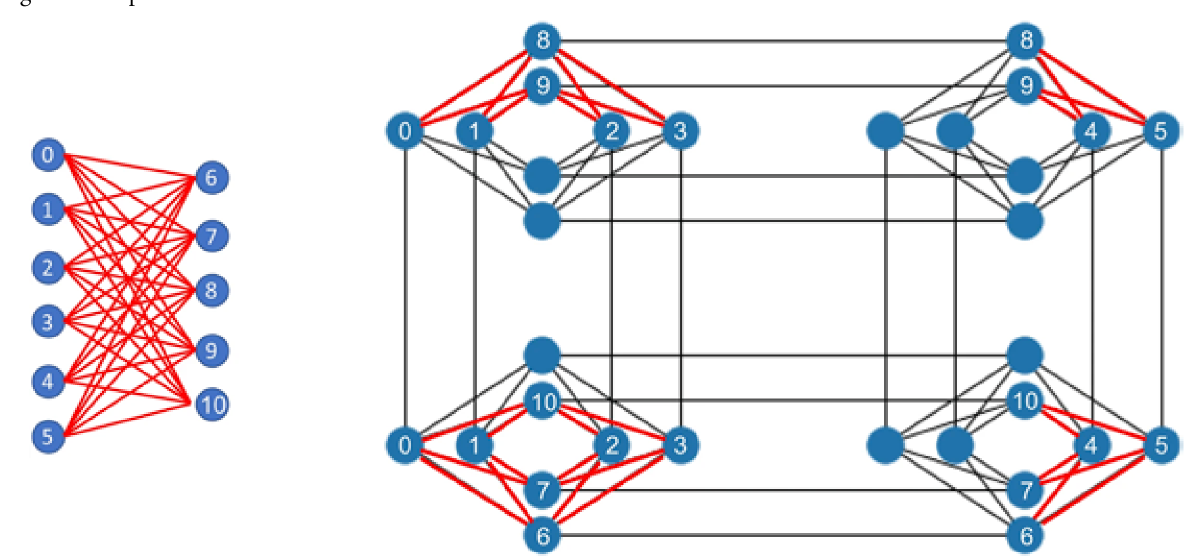
Specialized quantum computers known as quantum annealers are one tool for doing this type of computing. They work by representing each state of a qubit as an energy level. The lowest energy state among its qubits gives the solution to a problem. The result is a machine that could handle complicated, interconnected systems that would take a regular computer a very long time to calculate — like building a neural network.

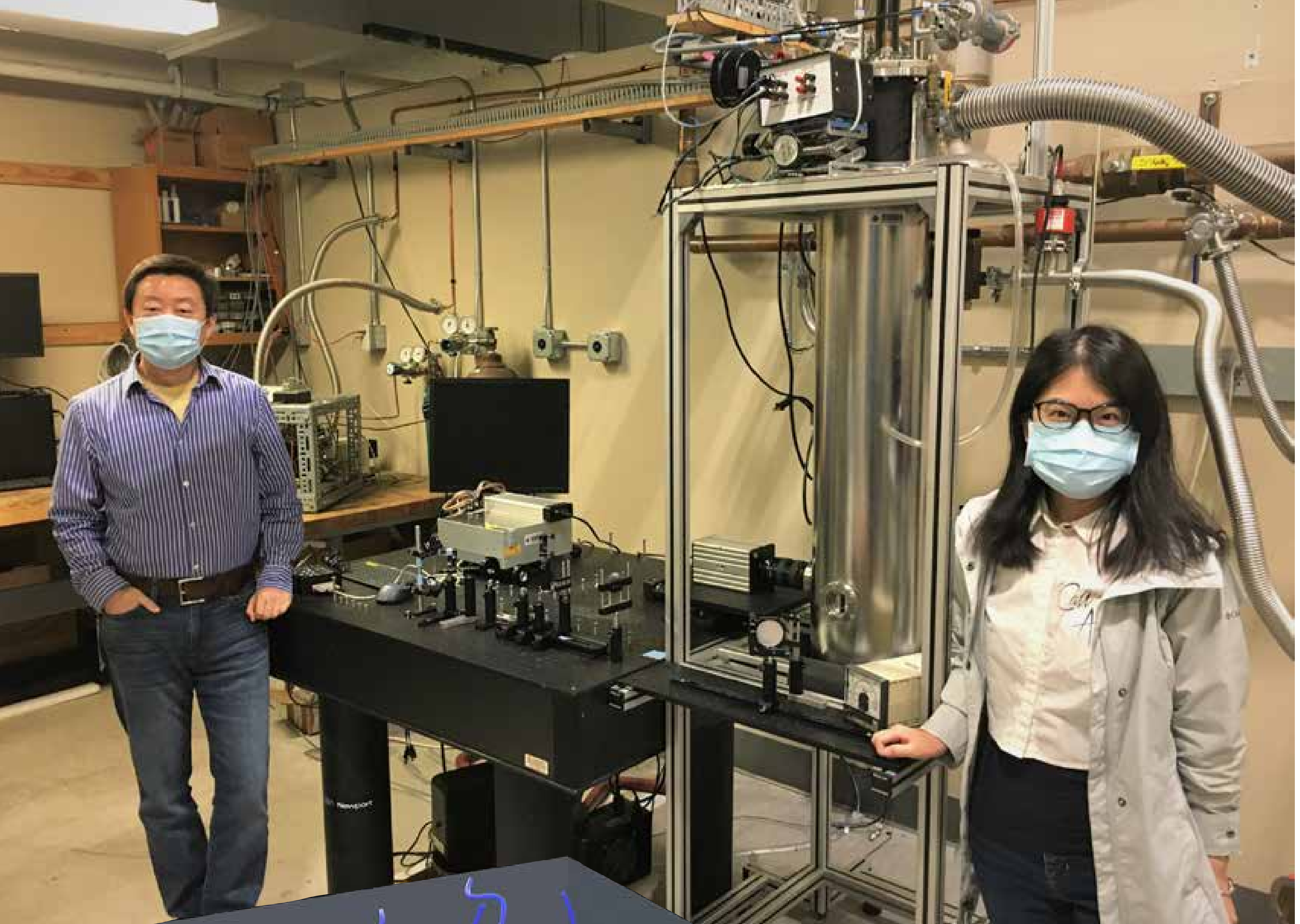
One way to build neural networks is by using a restricted Boltzmann machine, an algorithm that uses probability to learn based on inputs given to the network. Oates and Xu found a way to automatically calculate an important parameter associated with effective temperature that is used in that algorithm. Restricted Boltzmann machines typically guess at that parameter instead, which requires testing to confirm and can change whenever the computer is asked to investigate a new problem.

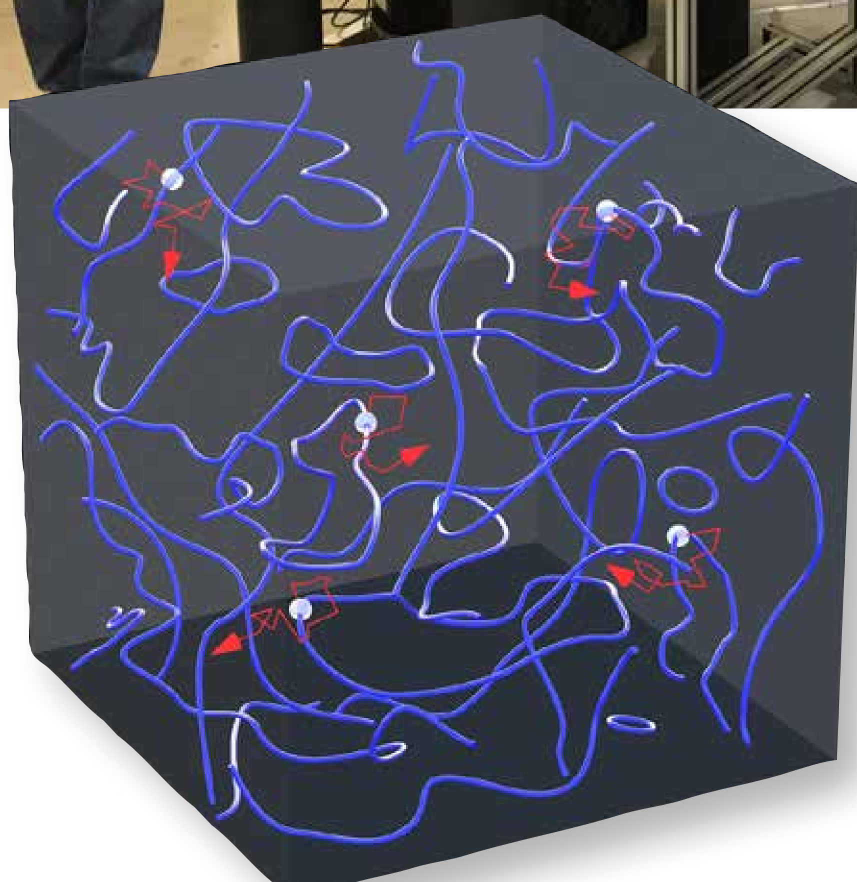
William Oates, Cummins, Inc. Professor and chair of mechanical engineering.

"That parameter in the model replicates what the quantum annealer is doing," Oates said. "If you can accurately estimate it, you can train your neural network more effectively and use it for predicting things."

▶ Illustration of a Restricted Boltzmann Machine (RBM) bipartite graph of size 6×5 (left), and embedded Chimera graph7 on D-Wave hardware (right). (Courtesy Oates)







Associate professor in mechanical engineering **Wei Guo** (above, left) and post-doctoral researcher **Yuan Tang** (above, right) were able to visualize the vortex tubes in a quantum fluid (left), which could help researchers better understand turbulence in quantum fields and beyond. Their work was published in Proceedings of the National Academy of Sciences.

QUANTUM

Engineering researchers visualize the motion of vortices in superfluid turbulence

NOBEL LAUREATE IN PHYSICS RICHARD FEYNMAN once described turbulence as "the most important unsolved problem of classical physics."

Understanding turbulence in classical fluids like water and air is difficult partly because of the challenge in identifying the vortices swirling within those fluids. Locating vortex tubes and tracking their motion could greatly simplify the modeling of turbulence.

But that challenge is easier in quantum fluids, which exist at low enough temperatures that quantum mechanics—which deals with physics on the scale of atoms or subatomic particles—govern their behavior.

In a new study published in Proceedings of the National Academy of Sciences, engineering researchers managed to visualize the vortex tubes in a quantum fluid, findings that could help researchers better understand turbulence in quantum fluids and beyond.

"Our study is important not only because it broadens our understanding of turbulence in general, but also because it could benefit the studies of various physical systems that also involve vortex tubes, such as superconductors and even neutron stars," said Wei Guo, an associate professor of mechanical engineering and the study's principal investigator.

The research team studied superfluid helium-4, a quantum fluid that exists at extremely low temperatures and can flow forever down a narrow space without apparent friction.

Guo's team examined tracer particles trapped in the vortices and observed for the first time that as vortex tubes appeared, they moved in a random pattern and, on average, rapidly moved away from their starting point. The displacement of these trapped tracers appeared to increase with time much faster than that in regular molecular diffusion — a process known as superdiffusion.

Analyzing what happened led them to uncover how the vortex velocities changed over time, which is important information for statistical modeling of quantum-fluid turbulence.

"Superdiffusion has been observed in many systems such as the cellular transport in biological systems and the search patterns of human hunter-gatherers," Guo said. "An established explanation of superdiffusion for things moving randomly is that they occasionally have exceptionally long displacements, which are known as Lévy flights."

But after analyzing their data, Guo's team concluded that the superdiffusion of the tracers in their experiment was not actually caused by Lévy flights. Something else was happening.

"We finally figured out that the superdiffusion we observed was caused by the relationship between the vortex velocities at different times," said Yuan Tang, a postdoctoral researcher at the National High Magnetic Field Laboratory and a paper author. "The motion of every vortex segment initially appeared to be random, but actually, the velocity of a segment at one time was positively correlated to its velocity at the next time instance. This observation has allowed us to uncover some hidden generic statistical properties of a chaotic random vortex tangle, which could be useful in multiple branches of physics."

Unlike in classical fluids, vortex tubes in superfluid helium-4 are stable and well-defined objects.

"They are essentially tiny tornadoes swirling in a chaotic storm but with extremely thin hollow cores," Tang said. "You can't see them with the naked eye, not even with the strongest microscope."

"To solve this, we conducted our experiments in the cryogenics lab, where we added tracer particles in helium to visualize them," added Shiran Bao, a postdoctoral researcher at the National High Magnetic Field Laboratory and a paper author.

The researchers injected a mixture of deuterium gas and helium gas into the cold superfluid helium. Upon injection, the deuterium gas solidified and formed tiny ice particles, which the researchers used as the tracers in the fluid.

"Just like tornadoes in air can suck in nearby leaves, our tracers can also get trapped on the vortex tubes in helium when they are close to the tubes," Guo said.

This visualization technique is not new and has been used by scientists in research labs worldwide, but the breakthrough these researchers made was to develop a new algorithm that allowed them to distinguish the tracers trapped on vortices from those that were not trapped.

"The **motion** of every vortex segment initially appeared to be **random,** but actually, the velocity of a segment at one time was positively correlated to its velocity at the next time instance. This observation has allowed us to uncover some hidden generic **statistical properties** of a chaotic random vortex tangle, which could be **useful** in multiple branches of physics." —ASSOCIATE PROFESSOR WEI GUO

Students in the cryogenics superconducting lab at CAPS

POWER SYSTEMS

The Center for Advanced Power Systems part of $1.6 million grant from ARPA-E for transformational energy technology

THE CENTER FOR ADVANCED POWER SYSTEMS (CAPS) is part of a $1.6 million grant from the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E). The project is a partnership with lead organization Advanced Conductor Technologies (ACT), as a small business in the superconductor sector. Researchers from CAPS and ACT aim to design power-dense superconducting cables for electric aircraft.

"This funding really speaks to the successful, long-term partnership of CAPS and ACT," said Sastry Pamidi, chair of the electrical and computer engineering department and associate director of CAPS. "ACT has been a partner with us in more than 10 different projects, totaling over $1 million in research funds for the center's work."

In past projects, CAPS researchers have worked with ACT on their superconducting Conductor on Round Core (CORC®) cables for U.S. Navy electric ship technologies. The practical applications of ARPA-E's funded research focus on superconducting power cables for use in future twin-aisle electric aircraft with distributed electric propulsion.

"Electric aircraft require high power in smaller, lighter packages," Pamidi explained. "That means we need to make the power cables with a high power density. ACT's superconducting CORC® cables are perfect for that. Using our experience working on the technology for ships we will now be able to work on cables for electric aircraft."

The project team includes Pamidi and members of his research staff, Danko van der Laan, president and CEO of Advanced Conductor Technologies and other ACT personnel, and Doan Nguyen, Ph.D., Director of the National High Magnetic Field Laboratory's Pulsed Field Facility at Los Alamos National Laboratory.

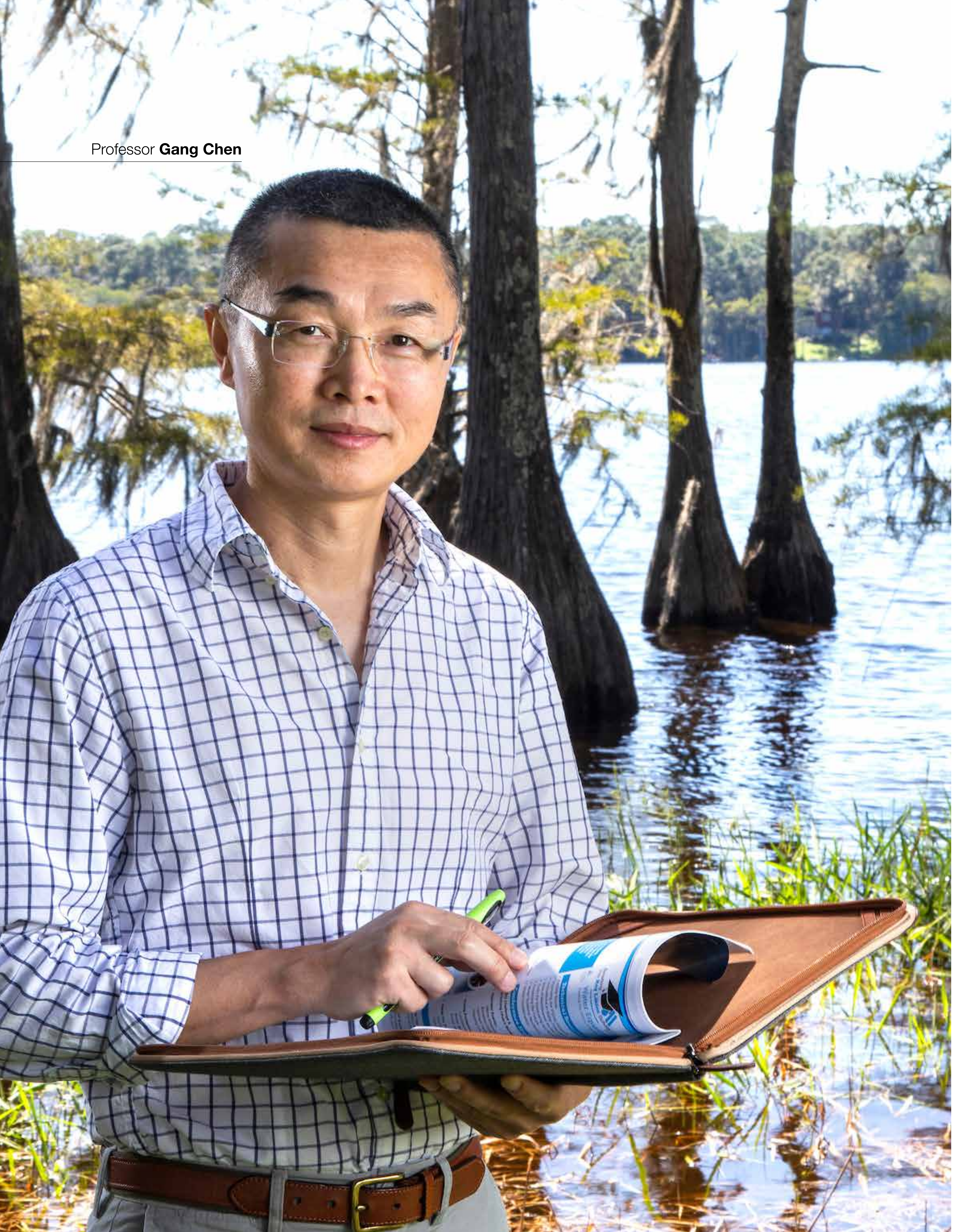
ACT received this competitive award from ARPA-E's (Topics Informing New Program Area's) Connecting Aviation By Lighter Electric Systems (CABLES) Topic, for the development of technologies for medium-voltage (>10 kV) power distribution cables with fault current limiting abilities and cable connectors for fully electric aviation applications.

"Our goal is to develop superconducting cables that will ultimately be able to deliver power of up to 50 MW to the electric motors of future aircraft, which is the power required during take-off of large twin-aisle passenger aircraft with 200-300 passengers. The cable technology would ultimately be applied to aircraft that would burn liquid hydrogen, which would also provide the cooling to the superconducting cables, enabling fully carbon-free commercial flights," according to ACT's van der Laan.

"Our **goal** is to develop superconducting **cables** that will ultimately be able to deliver power of up to 50 MW to the **electric** motors of future **aircraft,** which is the power required during take-off of large twin-aisle passenger aircraft with 200–300 passengers. "

— DANKO VAN DER LAAN, PRESIDENT AND CEO OF ACT

Professor **Sastry Pamidi** and **Danko van der Laan** of Advanced Conductor Technologies (ACT).



Professor **Gang Chen**

ENVIRONMENT

New climate model helps researchers better predict water needs

NEW RESEARCH COMBINES CLIMATE AND LAND USE projections to predict water availability.

"Current climate models are a reliable tool to predict future water availability," said Gang Chen, a professor of civil and environmental engineering. "What we are lacking is enough data to make those models as effective as they can be."

Chen is leading a team of experts to produce new data techniques to improve hydrological modeling that is essential for water resource management planning. Their work was published in WATER.

The study looked at the hydrological processes in Alabama's Upper Choctawhatchee River Watershed, which eventually flows into Florida and empties into the Choctawhatchee Bay. Using modeling software known as the Soil and Water Assessment Tool, the researchers integrated land use projections with future climate data to study the combined effects on the hydrological response of the watershed.

"Using water balance simulations, we discovered that surface runoff and evapotranspiration are dominant pathways for water loss in the Southeast," Chen said.

Yashar Makhtoumi, a doctoral candidate in the department of civil and environmental engineering, is working with Chen on new data downscaling techniques. The innovative process provides more data and improves modeling outcomes.

"Few research projects have been done to investigate the combined effects of land use change and climate change using projections," Makhtoumi said.

"Current climate **models** are a reliable tool to predict future water availability. What we are lacking is enough **data** to make those models as **effective** as they can be."

— PROFESSOR GANG CHEN

The results of the study showed the impacts on water resource variables were seasonal. Surface runoff caused the most significant changes in various simulations, and evapotranspiration was also an issue, though to a lesser degree. The models indicate that by midcentury, more frequent extremes in water balance are projected to be an issue.

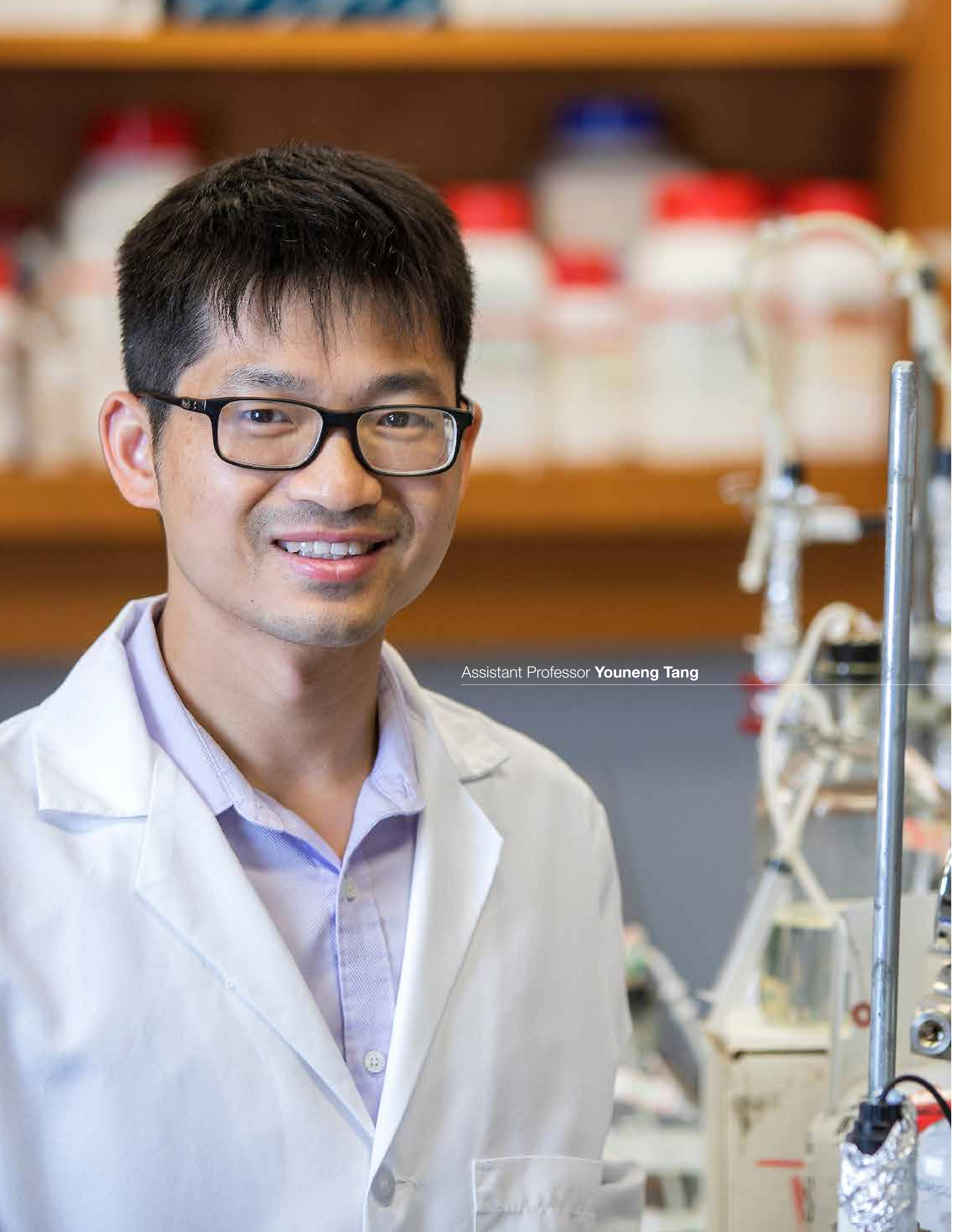
Although the research focuses on a single watershed, the researchers believe their work could be applicable on a wider scale. That's important for a state like Florida, where population growth, development and climate change are forcing residents and planners to realize the limitations of the state's water supply.

Doctoral candidate in civil and environmental engineering **Yashar Makhtoumi** is working with Professor Chen to increase data and improve outcomes for the new water modeling technique.

"Our model demonstrated that it could capture hydrologic parameters accurately and could be used for future studies of water quality," Chen said. "It can provide the necessary data to determine sustainable conservation practices needed now and in the future to help manage and protect our water resources."

Researchers from Florida A&M University and California State Polytechnic University Pomona contributed to this work.

The research was supported by a $1.2 million grant from the National Institute of Food and Agriculture of USDA.



Assistant Professor **Youneng Tang**

$1.4M NIH grant helps researchers clean carcinogens from groundwater

ENVIRONMENT

AN ENGINEERING RESEARCHER IS LEADING A STUDY into how bacteria can be used to remove carcinogens from groundwater thanks to a $1.4 million grant from the National Institute of Environmental Health Sciences.

Researchers from the FAMU-FSU College of Engineering will collaborate with Texas Tech University to investigate a bioremediation method that could remove health hazards like chlorinated volatile organic compounds (CVOCs) and 1,4-dioxane more rapidly than current technology. The process could be an effective tool for cleaning so-called Superfund sites, places that are contaminated from hazardous waste and deemed a priority for cleanup by the U.S. Environmental Protection Agency.

"The bioremediation techniques we are using have the potential to take carcinogens from polluted locations that normally require a long-term response," said Youneng Tang, an assistant professor in the department of civil and environmental engineering.

The research uses bacteria that grow on what are called macrocyclic molecules, which have a unique geometry and internal chemistry that allows them to individually bind with molecules like CVOCs and 1,4-Dioxane.

That's especially important for remediating groundwater containing those compounds, because they need different conditions to biodegrade. CVOCs require anaerobic conditions (free from oxygen) to biodegrade, but 1,4-Dioxane metabolizes under aerobic circumstances (needing oxygen).

"The process of remediation requires two steps," Tang said. "First, we promote growth of dechlorinating biofilm on one type of material to anaerobically biodegrade the CVOC, then we use another macrocyclic material to produce a highly efficient culture to aerobically metabolize 1,4-Dioxane."

> "We hope our research will give us a better understanding of the mechanisms of how novel sorbents **enhance** bioremediation. Our long-term goal is to make biological processes more **effective** and **sustainable** in the near future."
>
> — ASSISTANT PROFESSOR YOUNENG TANG

In an off-site treatment for the contaminants, the researchers pack a reactor with absorbing materials. Then they pump contaminated groundwater through the reactor to allow the bacteria to develop and degrade the contaminant.

For on-site treatment, they reduce an absorbent material to microscopic size and inject it directly into the ground. The material then absorbs contaminants and bacteria that can degrade the pollutants.

"We hope our research will give us a better understanding of the mechanisms of how novel sorbents enhance bioremediation," Tang said. "Our long-term goal is to make biological processes more effective and sustainable in the near future."

The researchers plan to perform two long-term studies at a Superfund site and are partnering with Geosyntec Consultants of Huntington Beach, California, to test the feasibility of the proposed remediation.

Yuexiao Shen, assistant professor of civil engineering at Texas Tech University, is leading the effort at TTU.

Colonies (cultures of bacteria) from Tang's research on an agar plate. The colonies originated from a local wastewater treatment plant and are able to degrade 1,4-Dioxane (a contaminant in this project) to low levels. His research includes isolating the colonies as pure cultures for future studies.

Multidisciplinary NSF CIVIC grant to study community resilience to disaster

RESILIENCE

EREN OZGUVEN, PROFESSOR IN CIVIL AND ENVIRONMENTAL engineering, is co-PI for a cross-campus team of researchers in a new National Science Foundation Civic Innovation Challenge (NSF CIVIC) project titled "Rural Resiliency Hubs: A Planning Approach to Addressing the Resiliency Divide." The project, co-led by Florida State University College of Communication and Information (CCI) Associate Dean for Research and School of Information Professor Marcia A. Mardis, began in January 2021.

In addition to Mardis and Ozguven, the team includes faculty from Florida State University's College of Social Work, Department of Geography and College of Medicine.

"To bring researchers together from so many different units across campus gives us the benefit of a wide range of expertise and perspectives to support our nearby rural neighbors," Mardis said.

According to Ozguven, the goal is to "study and develop emergency plans that fit distinct needs of rural communities, guided by a central hypothesis: Understanding interdependencies among the community actors, population needs, environment, information, and infrastructure that foster emergency operations efficacy in rural communities can lead to the successful strategies and policies for optimizing multi-faceted disaster response."

The NSF CIVIC challenge is a research and action-based competition that strives to make a stronger research-to-innovation pipeline. It is awarded to researchers who encourage collaboration with civic community partners such as non-profit representatives, community organizers and community service providers. This challenge switches the community-university dynamic by asking communities to identify issues that require innovative thinking and then partner with researchers who can create solutions.

Building on Mardis and Jones' current Institute of Museum and Library Services project about the central role of public libraries in rural Florida's disaster response and related FSU projects funded by the NSF's Coasts and People (CoPe) program and the College of Medicine's Clinical and Translational Science Award (CTSA) partnership, this multidisciplinary research team will investigate how rural communities respond to natural disasters. These previous studies have focused on how communities utilize public libraries and community assets to distribute aid to citizens, working from the premise that rural communities do not have quick access to public infrastructure or detailed plans for disaster response and, as a result, are suffering a "resiliency divide" from their urban counterparts.

"This project is short but impactful," Mardis said. "Not only will this work help us define community-based disaster ecosystems, but it will also further position public libraries as resiliency hubs that are an intentional part of action plans and models for other communities."

The goal is to study and develop emergency plans that fit distinct needs of rural communities, guided by a central hypothesis: Understanding **interdependencies** in communities and the factors that foster emergency operations efficacy in rural communities can lead to the successful strategies and policies for optimizing **multi-faceted** disaster response.

Professor in civil and environmental engineering **Eren Ozguven** collaborated in a NSF study to define and bolster community-based disaster ecosystems, including libraries.

Commercial products that delay or eliminate reflective cracking are on the market, but inconsistency in their **performance** is a big issue. There is a need for **better testing methods** in the lab for interlayer manufacturers and local transportation agencies.

INFRASTRUCTURE

Civil engineering professor developing new testing apparatus for improved road repair materials

ONE OUT OF EVERY FIVE MILES OF HIGHWAY PAVEMENT is in poor condition and needs significant road repair, according to the American Society of Civil Engineers. Driving on poor roads costs U.S. motorists $120.5 billion in extra vehicle repair and operating costs, according to the group, and cracks in road pavement is a factor.

Qian Zhang, an assistant professor in civil and environmental engineering, wants to improve those numbers and is developing a new system to test material that supports how roads perform.

Zhang is working on a lab-scale testing apparatus and method that evaluates products used to reinforce pavement during rehabilitation. The products specifically treat reflective cracking problems that are a leading cause of pavement failure.

"Many commercial interlayer products and treatments have been developed to treat reflective cracking problems," Zhang says. "These products don't all perform in the same way, and we need consistent ways to evaluate them before they are used in the field."

Reflective cracking is a type of failure in asphalt pavement repairs that occurs with traffic and thermal loading. Repeated stress causes cracks to develop in locations where there are joints in the existing pavement. Paved roads have interlayer products applied to improve performance that can also extend the life of the pavement.

"Local transportation agencies need to know what product works best for their particular road conditions," Zhang says. "Manufacturers also need to better understand how their product performs."

Conditions like road use, subgrade condition and many other factors can affect how well the interlayer products work. Commercial products that delay or eliminate reflective cracking are on the market, but inconsistency in their performance is a big issue. There is a need for better testing methods in the lab for interlayer manufacturers and local transportation agencies.

Assistant professor in civil and environmental engineering **Qian Zhang** won Florida State University's Grant Assistance Program (GAP) Commercialization Investment Program funding for her road reinforcement testing product to help bring it to market.

"The **GAP award** helps researchers further develop a **promising** research invention—in my case, a testing system—and turn it into a **commercial** product." — ASSISTANT PROFESSOR QIAN ZHANG

"We are working to address these challenges and develop a reliable testing set up and protocol that considers all major loading effects and support conditions related to reflective cracking," Zhang explains.

Her research is funded in part by the Grant Assistance Program (GAP) Commercialization Investment Program at Florida State University. Zhang recently earned a GAP award that supports researchers who bring their academic work to the marketplace.

"The GAP award help researchers to further develop a promising research invention — in my case, a testing system — and turn it into a commercial product," Zhang says. She is working with a graduate student and leading synthetic pavement interlayer company, TenCate Geosynthetics, on the project.

RESILIENCE

Engineering researcher develops a tool aimed at better stormwater management, planning

FLORIDA IS THE THIRD MOST POPULOUS STATE in the nation and it's still growing. As the population increases, the state must balance a growing population with protecting the natural environment.

The strained link between land development and the state's water resources is the focus of a new study by Assistant Professor Nasrin Alamdari.

Stormwater management systems are vital in reducing runoff and controlling flooding that can harm water quality. However, Alamdari, a civil engineer, says that more stormwater resource tools are needed for managers and other decision-makers to analyze how systems perform.

"We are developing a holistic planning tool for water resource managers and other decision-makers to use when deciding a course of action," Alamdari said. "Our tool predicts the effects of stormwater management and gives hard data to show the cost-effectiveness of various solutions."

Alamdari is developing a new open-source tool to predict the effects of best management practice (BMP) in stormwater management. BMP techniques include structural, vegetative and managerial practices to treat, prevent and reduce water pollution.

In urban areas where the strain from growth is the greatest, impervious surfaces prevent water from naturally soaking into the ground. The water instead picks up debris, trash, and other pollutants and causes flooding. Stormwater management practices include bio-retention basins, wet ponds, vegetated swales and infiltration trenches to handle water flow in the environment.

Alamdari is working with urban planners from cities and counties across Florida. The decision support tool she is working on allows integration of the hydrologic model, EPA Stormwater Management Model (SWMM), to simulate runoff and pollutant loads.

"The final product will be a free, open-source tool that includes hydrologic and water quality treatment in a different range of BMPs, site selection of BMPs, and automatic cost optimization based on runoff and nutrient reduction goals," Alamdari said.

The open-source tool will apply to urban communities throughout Florida, and the modeling framework is transferable to urban centers across the United States.

"We plan to increase public awareness through community participation and outreach," Alamdari said. "We hope to educate the general public as well as engineers, scientists, and stormwater managers in strategies available in their communities."

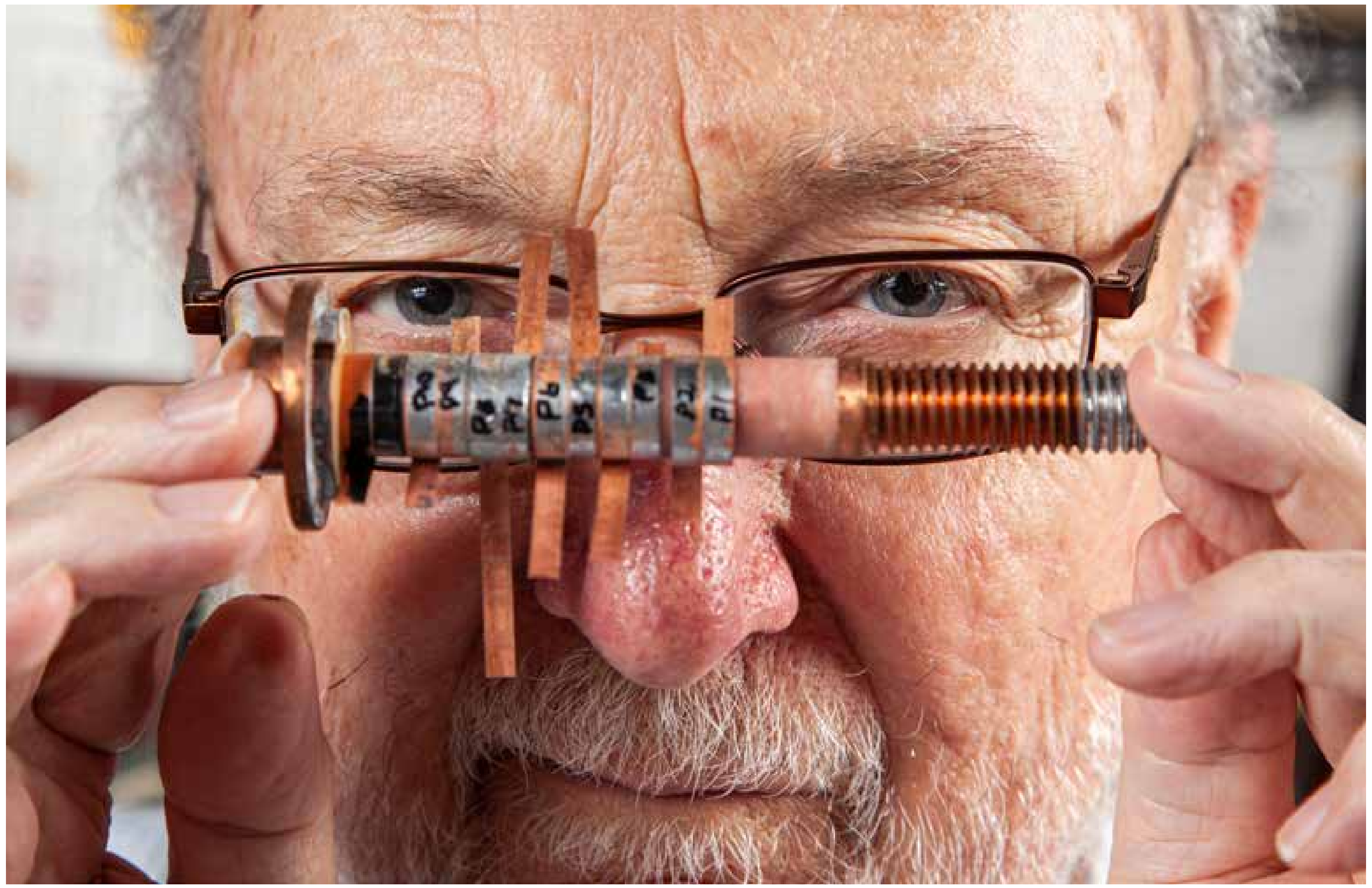
Her research is funded by a grant from the Florida Department of Environmental Protection.

> "We are developing a **holistic** planning tool for water resource managers and other decision-makers to use when **deciding** a course of action. Our tool predicts the effects of stormwater management and gives **hard data** to show the cost-effectiveness of various solutions."
>
> — ASSISTANT PROFESSOR NASRIN ALAMDARI

Assistant Professor in civil and environmental engineering **Nasrin Alamdari** recently built a tool that helps predict the effects of stormwater management and provides cost-effectiveness data for various solutions.

FACULTY

Superconductivity expert elected Fellow of Royal Academy of Engineering



Materials scientist
Engineering professor
Chief materials scientist
Fellow, Royal Academy

DAVID LARBALESTIER, THE CHIEF MATERIALS SCIENTIST at the National High Magnetic Field Laboratory and a Krafft Professor in the department of mechanical engineering at the FAMU-FSU College of Engineering, has been elected a Fellow of the Royal Academy of Engineering.

Larbalestier was cited for his "seminal work in high current, high field superconducting materials for over 50 years." A native of the United Kingdom, he joins 49 of his compatriots in this year's group of Fellows, along with three International Fellows. The Royal Academy is the U.K.'s national academy for engineering and technology, dedicated to advancing and promoting excellence in engineering for the benefit of society.

Larbalestier has accrued numerous honors over his career, most of which has been spent stateside. But this one, he said, feels different.

"There's no question that there's something special about being honored by the academy of the land of your birth," Larbalestier said.

Throughout his career, Larbalestier has pushed the envelope on superconductor technologies. Superconductors are materials that conduct electricity with perfect efficiency. Unlike copper, in which energy is lost through the friction of the moving electrons, superconductors allow electrons to flow unimpeded, under the right (and typically extremely cold) conditions.

Over the decades, he has played a leading role in developing early superconductors like niobium tin and niobium titanium, helped to transfer that technology to medical and scientific use in MRI machines, nuclear magnetic resonance instruments and particle accelerators, and has constantly improved the performance of those materials.

In the 1980s, the first high-temperature superconductors (HTS) were discovered, compounds that perform at higher, more practical temperatures but presented their own challenges in terms of wire production. In fact, no magnets of any utility were made with HTS wire for two decades. However, the National MagLab believed in their potential and in 2006 invited the Applied Superconductivity Center (ASC), then based at the University of Wisconsin-Madison and directed by Larbalestier, to join the lab and FSU.

Since then, he has led partnerships that have driven HTS materials to magnetic fields twice as high as any possible with niobium tin. This work culminated in the 32-tesla magnet, the world's strongest superconducting magnet. Designed and built at the National MagLab and slated to open for experiments later this year, it features the HTS conductor YBCO (yttrium barium copper oxide).

Another world-record magnet that Larbalestier shepherded into being is the world's strongest continuous field magnet. In 2017, this test magnet generated a field of 45.5 teslas using the superconductor known as REBCO (rare earth barium copper oxide) and a novel "no insulation" design. The article reporting the achievement, one of 12 papers Larbalestier has published in the prestigious journal Nature, was among the most highly cited science articles of 2019. In all, Larbalestier's 490 publications have received more than 17,000 citations.

"From superconducting materials to magnet technologies to international partnerships, David has been the engine behind many prestigious firsts at the MagLab," said Greg Boebinger, director of the National MagLab. "He fully deserves to be the first faculty member elected to the Royal Academy."

The new honor pairs nicely with Larbalestier's 2003 election as a Fellow of the National Academy of Engineering in the U.S., noted J. Murray Gibson, dean of the FAMU-FSU College of Engineering.

"David Larbalestier is a world-leading materials engineer who we are fortunate to have as a member of our mechanical engineering faculty," Gibson said. "David's work to develop real applications for superconducting wires has changed the world."

After earning his doctorate in materials engineering at Imperial College London, Larbalestier launched his career at the Superconducting Magnet Research Group at Rutherford Laboratory in the U.K., where he developed multifilamentary niobium tin conductors and magnets. In 1976, he moved to the U.S. to become a faculty member at UW-Madison, where he taught in the department of materials science and engineering and the Department of Physics and joined the ASC, rising to director in 1990. He continued as director through 2018.

Since his early days in superconductivity, when he began collaborations with the magnet manufacturer Oxford Instruments that have flourished ever since, industry partnerships have been a hallmark of Larbalestier's career. The MagLab has always supported that synergy as ASC research has helped advance more powerful, more efficient magnets from hospital MRIs to the Large Hadron Collider to the National MagLab's own research magnets.

"It's the ability of the MagLab to do both science and great technology that I'm very pleased to see celebrated in the Royal Academy's citation," said Larbalestier, who has also actively promoted collaborations with other national laboratories and university groups.

Professor and Chief Materials Scientist **David Larbalestier.**

Over the decades, Larbalestier has played a **leading role** in developing early **superconductors** like niobium tin and niobium titanium, helped to transfer that technology to medical and scientific use in MRI machines, nuclear magnetic resonance instruments and particle accelerators, and has constantly **improved** the **performance** of those materials.

Many other honors have preceded this most recent distinction. Larbalestier has been awarded prizes from the Institute of Electrical and Electronics Engineers (IEEE) and the Council for Chemical Research; was given a Lifetime Achievement Award by the International Cryogenic Materials Conference; and was the Distinguished Lecturer at an IEEE Council on Superconductivity. He is a Fellow of the American Physical Society, the Institute of Physics (U.K.), the National Academy of Inventors, the IEEE, the Materials Research Society and the American Association for the Advancement of Science.

Among his many other professional duties, Larbalestier has served as a member of the U.S. Department of Energy's High Energy Physics Advisory Panel and the National Materials and Manufacturing Board of the National Research Council.

Professor **Sastry Pamidi**

Professor honored as Fellow of the Cryogenic Society of America

A FAMU-FSU COLLEGE OF ENGINEERING PROFESSOR recognized in cryogenics has been selected as a Fellow from the Cryogenics Society of America.

Sastry Pamidi is the chair and professor of electrical and computer engineering and the associate director for the Center for Advanced Power Systems (CAPS). Pamidi received the award during the virtual joint 23rd Cryogenic Engineering Conference and International Cryogenic Materials Conference, held in July 2021.

“Professor Pamidi is a leader in the field of superconducting cables and cryogenic technology related to superconducting power devices,” said Dean Murray Gibson. “It is a pleasure to see him recognized by his colleagues.”

The Cryogenic Society of America Fellowship is bestowed on persons who have made notable contributions of significant magnitude to the field of cryogenics. The distinction is awarded to one or two persons every other year.

“It is a distinct honor to be elected as a Fellow of the Cryogenic Society of America,” Pamidi said. “I am pleased to join the distinguished group of CSA Fellows. The CSA is the professional organization for cryogenic engineers in all areas of the field, and I am proud that my contributions to the field of cryogenics are acknowledged by my peers.”

Pamidi has been working on the development of superconducting devices and related cryogenic technologies since 2000 and has published more than 190 peer-reviewed papers. He leads a multidisciplinary research group at CAPS and has worked in research laboratories in Asia, Europe and the United States. He collaborates with many research groups worldwide.

> “Professor Pamidi has made **substantial** contributions in the area of **cryogenics** and has advanced our understanding in superconducting technologies that are **far-reaching.**”
>
> — ROGER MCGINNIS, DIRECTOR OF CAPS

“Dr. Pamidi’s research contributions and personal qualities are fitting with the status of a Fellow,” said Lance Cooley, a professor in mechanical engineering and the director of the Applied Superconductivity Center. “His warmth and friendliness have been essential to keep collaborations together and maintain esprit de corps during difficult project stretches.”

Pamidi and his team have been developing high-temperature superconducting devices by integrating cryogenic, superconducting and high voltage engineering technologies.

“Professor Pamidi has made substantial contributions in the area of cryogenics and has advanced our understanding in superconducting technologies that are far-reaching,” Roger McGinnis, director of CAPS, said. “He takes great pride in mentoring our students, and our students greatly appreciate his kindness, mentorship and teaching.”

Chul Kim and Peter Cheetham, faculty researchers at CAPS and members of Pamidi’s team, expressed a sentiment similar to McGinnis’.

“Professor Pamidi being recognized as a CSA fellow demonstrates the significant and long-lasting impact his research has had on the cryogenic community,” Cheetham said. “The recognition gives us the opportunity to show our appreciation and thank him for the work he does at both the FAMU-FSU College of Engineering and the Center for Advanced Power Systems to train and mentor the next generation of engineers.”

“Our team has greatly benefited from Professor Pamidi’s broad knowledge and passionate energy. His enthusiasm in research and teaching has a positive influence on everyone.” Kim said.

“Being honored as Fellow for the CSA is a recognition of not only my contributions but also of my past and current team members and my students who made significant contributions to advancing cryogenic technology for superconducting power devices,” Pamidi said.

Matthew Sze (in red with back to the camera) with Omicron, conducted a site visit to the high voltage lab at CAPS to demonstrate partial discharge measurements for power devices to graduate and undergraduate students enrolled in **Dr. Sastry Pamidi’s** Instrumentation and Measurement class. (Photo: M Wallheiser)

"We want to **leverage** the strengths of partnering institutions with established research connections, recruiting and training academically-talented **minority** students from Kindergarten through college, using a variety of **activities** in outreach, education and research." — ASSOCIATE PROFESSOR SHONDA BERNADIN

College partners with ASTERIX to build pipeline of diversity in STEM workforce

FACULTY AT THE FAMU-FSU COLLEGE OF ENGINEERING are part of a new Florida International University (FIU)-led consortium of universities, private and public partners, who received a $4.9 million Department of Energy grant to help fill the need for more diversity in the STEM workforce.

Sharing a vision, the Advanced Sensor Technologies for Applications in Electrical Engineering - Research and Innovation eXcellence (ASTERIX) group is on a mission to provide opportunities for minority students to excel in careers in science, technology, engineering and math.

Shonda Bernadin, an associate professor in computer and electrical engineering, is the principal investigator for the grant. Through Florida A&M University, about $1.5 million was awarded to the college as part of the overall ASTERIX project.

"The ASTERIX consortium will build a sustainable pipeline of talented diverse engineering students who are highly prepared to enter the STEM workforce, especially in areas of interest to the Department of Energy/National Nuclear Security Administration (DoE/NNSA) Enterprise," Bernadin said.

Shekar Bhansali, a distinguished university professor of electrical and computer engineering at FIU, is the lead investigator for the ASTERIX project. Bhansali also is the director of the Division of Electrical, Communications, and Cyber Systems of the National Science Foundation (NSF).

"The consortium leverages the unique strengths of its participants, Florida colleges and national labs, to address one of the grand challenges in developing low-cost sensing systems: how to seamlessly code slip sensors and electronics with new materials for novel applications," Bhansali said.

The consortium focuses on exploring novel manufacturing techniques to fabricate the next generation of sensors and electronics and provides opportunities for students to work closely with practitioners.

ASTERIX partners include Florida International University, Florida A&M University, Miami-Dade College, Department of Energy National Nuclear Security Administration, Los Alamos National Lab, Kansas City National Security Campus and Y12 National Security Complex.

The FIU-FAMU-MDC alliance will serve one of the largest populations of Hispanic and African-American students in the nation creating innovative academic and career pathways for minorities who want to pursue engineering careers.

"We want to leverage the strengths of partnering institutions with established research connections," Bernadin said. "We hope to recruit and train academically-talented minority students from Kindergarten through college, using a variety of activities in outreach, education and research."

Sastry Pamidi, chair and professor of the electrical and computer engineering department and associate director of the Center for Advanced Power Systems, is working with Bernadin as a co-investigator for the project.

Associate Professor in computer and electrical engineering **Shonda Bernadin** is a principal investigator for the ASTERIX grant, which focuses on building a sustainable pipeline of talented, diverse engineering students for the STEM workforce.

"The project is a great opportunity for our undergraduate and graduate students to get involved in highly collaborative research and provides excellent networking and professional growth opportunities," Pamidi said. "The success in the project will lead to more opportunities for our department and college to establish relationships with government laboratories, Florida International University and Miami Dade College."

The consortium hopes to recruit well-qualified STEM students to satisfy the increasing demand for scientists and engineers in areas of interest to the DoE, specifically, in advanced sensor technologies for applications in electrical engineering. Both undergraduate and graduate students will have access to enriching educational experiences, internship opportunities at ASTERIX and DoE laboratories.

"We hope to strengthen partnerships between the FIU, FAMU, and MDC electrical engineering departments and DoE enterprises," Bernadin said, "and to allow young minority students to be trained as scientists and engineers to meet the research needs of a more diverse and representative industry."

ALUMNI

Alumnus named new engineering dean of the A. James Clark School at the University of Maryland

WHEN SAMUEL GRAHAM WAS AT THE FAMU-FSU College of Engineering in the early '90s, the young mechanical engineering major was a first-generation college student navigating the challenge of how to make it through college and pay for it.

Fast forward to 2021. In the fall term, the Florida State University (FSU) alumnus began as the new engineering dean of the A. James Clark School of Engineering at the University of Maryland.

"It's been quite a journey and I'm really excited about the opportunity to serve as dean," Graham said, "I hope to continue to build on the excellent research program at the college and help grow innovation and entrepreneurship in an inclusive manner. I hope we can become a national leader in diversity and inclusion in engineering."

"Having **access** to both FAMU and FSU and the **support** from faculty and friends is something I won't forget. The **networks** I built from both campuses provided a memorable experience I would not trade for anything." — S. GRAHAM, ALUMNUS

Samuel Graham, dean of the A. James Clark School of Engineering at the University of Maryland and FAMU-FSU College of Engineering alumnus.

Graham graduated in 1998 from FSU with a bachelor's in mechanical engineering via FAMU-FSU Engineering and earned his master's and doctorate from the Georgia Institute of Technology. He began his career as a senior member of technical staff at Sandia National Laboratories before joining the faculty at Georgia Tech.

"My undergraduate experience at the FAMU-FSU College of Engineering prepared me well for the successes that followed," Graham said. "Having access to both FAMU and FSU and the support from faculty and friends is something I won't forget. The networks I built from both campuses provided a memorable experience I would not trade for anything."

Graham has served as a member of the Defense Science Study Group and the Air Force Scientific Advisory Board. He also received the National Science Foundation CAREER Award and serves on the advisory board of the Engineering Science Research Foundation of Sandia National Laboratories and the Emerging Technical Advisory Committee of the U.S. Department of Commerce. He is a fellow of the American Society of Mechanical Engineers and a Senior Member of the Institute of Electrical and Electronics Engineers.

Graham's research encompasses the development of new wide bandgap semiconductor devices, which enable smart power systems in electric vehicles and smart grids. The devices work with radio frequency communication systems such as 5G wireless and advanced radar.

As an educator, Graham wants students to look for opportunities that connect the classroom to their passions. He encourages them to embrace the journey and follow their personal roadmap to success.

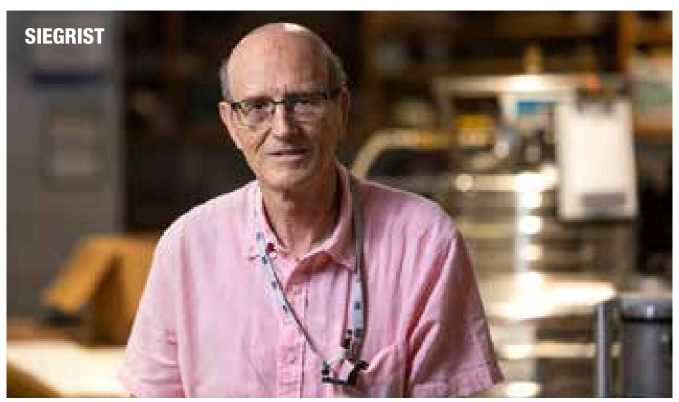
"Learn from others' experiences but understand your path will be different and build strong networks while in school," Graham said. "It is amazing how many times you and your network will continue to interact in the future and help each other over your lifetime."

Alumni faculty at peer institutions

Dr. Hafiz Ahmad	Florida State University
Dr. Aws Al-Taie	University of Technology Iraq
Dr. Bhuiyan Alam	University of Toledo
Dr. Alex Almarza	University of Pittsburgh
Dr. Eric Berson	University of Louisville
Dr. Indranil Bhattacharya	Tennessee Tech University
Dr. Sylvia Bhattacharya	Kennesaw State University
Dr. Wasu Chaitree	University of Silpakorn, Thailand
Dr. Deo Chimba	Tennessee State University
Dr. Isacc Choutaplli	The University of Texas, Rio Grande Valley
Dr. Eric Coyle	Embry-Riddle Aeronautical University
Dr. Ashley Danley-Thomson	Florida Gulf Coast University
Dr. Santosh Dasika	Andrha University, India
Ms. Lisa Davids	Embry-Riddle Aeronautical University
Dr. Tarik Dickens	Florida Agricultural & Mechanical University
Dr. Ryan Doczy	American University Dubai
Dr. Celina Dozier	University of Central Florida
Dr. Gregg Duncan	University of Maryland
Dr. Damion Dunlap	Florida State University
Dr. Mohamed El-Gafy	Michigan State University
Dr. Farzad Ferdowsi	University of Louisiana, Lafayette
Dr. Erik Fernandez	University of Central Florida
Dr. Stacy Pace Finley	University of Southern California
Dr. Craig Galban	University of Michigan
Dr. Amine Ghanem	Roger Williams University
Dr. Jamie Gomez	University of New Mexico
Dr. Samuel Graham	University of Maryland
Dr. Warren Greyson	Johns Hopkins University
Dr. Marwan Al-Haik	Embry-Riddle Aeronautical University
Dr. Jerris Hooker	Florida State University
Dr. Kimberly Hunter	Florida State University
Dr. Muhammad Imran	BUITEMS, Quetta, Pakistan
Dr. Anwarul Islam	Youngstown State University
Dr. Hamed Janani	Ferdowsi University of Mashhad, Iran
Dr. Raphael Kampmann	Florida State University
Dr. Emmanuel Kidando	Mercer University
Dr. Michael Kirkpatrick	Ecole Superieure, Paris
Dr. Doreen Kobelo	Florida Agricultural & Mechanical University
Dr. Phil Kreth	University of Tennessee Space Institute
Dr. Tara Kulkarni	Norwich University
Dr. Valerian Kwigizile	Western Michigan University
Dr. Silas Leavesley	University of South Alabama
Dr. Jamal Lewis	University of California - Davis
Dr. Simeng Li	California Polytechnic State University, Pomona
Dr. Hailing Liu	Liaoning University of Petroleum and Chemical Technology, China
Dr. Ihssan Massad	Yarmouk U. Jordan
Dr. Timur Mauga	United Arab Emirates (UAE) University
Dr. Geophrey Mbatta	Ardhi University (Tanzania)
Dr. Selma Mededovic Thagard	Clarkson University
Dr. Kayleigh Millerick	Texas Tech University
Dr. Jubily Musagasa	University of Dar es Salaam, Tanzania
Dr. Judith Mwakalonge	South Carolina State University
Dr. Aditya Nair	University of Nevada, Reno
Dr. Sirish Namilae	Embry-Riddle Aeronautical University
Dr. Gideon Nnaji	Tallahassee Community College
Dr. Terri Norton	Bucknell University
Dr. Mario Oyanader	California Baptist University
Dr. Gökhan ÖZKAN	Clemson University
Dr. Behnaz Papari	Texas A&M - Galveston
Dr. Chanyeop Park	Mississippi State University
Dr. Young Gyu Park	Daejin University, Korea
Dr. Michael Perez	Auburn University
Dr. Makita Phillips	Johns Hopkins University
Dr. Michelle Rambo-Roddenberry	Florida Agricultural and Mechanical University
Dr. Darin Ridgway	Ohio University
Dr. Aaron Robinson	University of Memphis
Dr. William Robinson	Vanderbilt University
Dr. Thobias Sando	University of North Florida
Dr. Sharon Sauer	Rose-Hulman Institute of Technology
Dr. Joseph Seymour	Montana State University
Dr. Salman Siddiqui	Georgia Southern University
Dr. Melissa Smith	Clemson University
Dr. Yiyang Sun	Syracuse University
Dr. John Solomon	Tuskegee University
Dr. Cherie Stabler	University of Florida
Dr. Tejal Udhan-Mulay	Florida Agricultural & Mechanical University
Dr. Omar Thomas	University of West Indies at Mona, Jamaica
Dr. Gary Triplett	Virginia Commonwealth University
Dr. Tuyen Vu	Clarkson University
Dr. Ken Walsh	Ohio University
Dr. Robert Wandell	Florida State University
Dr. Mark Weatherspoon	Florida Agricultural and Mechanical University
Dr. Claudia Wilson	New Mexico Tech
Dr. Sudong Xu	Southeast University, Nanjing, China
Dr. Chi-An Yeh	North Carolina State University
Dr. Donghui Zhu	Stony Brook University-SUNY

CONDUCTIVE PERFORMANCE OF 3D PRINTED COMPOSITES

Researchers discovered they can influence and increase the electrical performance of composites infused with graphene nano-platelets in an NSF study that could change the way materials are designed and manufactured. Their research is highlighted in the journal Additive Manufacturing, a peer-reviewed publication that reviews innovative research papers in additive manufacturing. **Subramanian Ramakrishnan** is a professor in chemical and biomedical engineering and is the lead investigator for the study. He is collaborating with researchers from industrial and manufacturing engineering and the Air Force Research Laboratory to conduct the work. Funding from the project is supported in part by a $5 million grant from the NSF. “Our aim is to 3D-print lightweight conductive composites and to study the effect of printing conditions on particle orientation and final composite performance,” Ramakrishnan said. “The combination of epoxy resins and graphene nano-platelets is of interest in several applications for the Air Force, such as thermal interface materials, heat sinks, and electromagnetic shielding materials.”


SIEGRIST

EXTERNAL MAGNETIC FIELD MAKES STRONGER ALLOYS

New research shows critical changes to the microstructure of iron-based alloys, materials that are important for manufacturing permanent magnets for use in electrical appliances and cars. In a new study, researchers from the FAMU-FSU College of Engineering, National High Magnetic Field Laboratory and the School of Materials Science and Engineering at Northeastern University in China, are collaborating to understand the effect of the magnetic field on the microstructure of magnetic materials. Their findings may improve the ways these materials are processed and ultimately perform. Scientists are interested in the microstructure of these materials because it can be shaped for tuning magnetization. By influencing and controlling the microstructure, scientists can control both the magnetic and mechanical properties of the substance. “We have found that an external magnetic field can drive changes to the microstructure of the specific alloys of iron (Fe), chromium (Cr) and cobalt (Co) used for magnet-based materials,” **Theo Siegrist,** a professor of chemical and biomedical engineering and National MagLab researcher, said. “The application effects the hardness of the alloys when heat is applied.”

NEW MODEL OF FLOW PROPERTIES FOR CLASS OF POLYMERS

Researchers developed a theoretical model that explains the flow of polymer materials. They found that the energy required to start flowing is the sum of the energy required to break the bonds of two separate parts of the polymer, which is useful for manufacturers or recyclers who are designing ways to use vitrimers. Their work was published in Macromolecules. “If you’re able to predict the flow properties, that helps guide the design of the processing units to process these,” said **Ralm Ricarte,** an assistant professor of chemical and biomedical engineering and paper co-author. “You can understand at what temperature it will start flowing and how viscous it will be. If you want to create a special application, you could determine what sort of chemistry you would need to build what you want with the very specific properties you might want.”


ARNETT

MAKING CERAMIC NANOMATERIAL PRODUCTION SAFER AND EXPANDING USE

In a new study, scientists will collaborate with researchers from Clark Atlanta University on a multi-disciplinary NSF study on MXenes, the novel class of 2D nanomaterials. **Natalie Arnett,** an associate professor in chemical and biomedical engineering, leads the team of scientists developing novel MXene materials for batteries, radiation shielding and supercapacitors. They also aim to improve the performance of existing MXene applications. “We want to develop MXenes by characterizing their electronic and magnetic properties,” Arnett said. “These materials hold great promise for several applications.” First discovered in 2011, MXenes are created from 3-dimensional crystals called MAXs, often consisting of titanium or chromium, aluminum, and carbon or nitrogen, arranged in microscopic layers.

NEW MICROWAVE TECHNIQUE MAKES FERTILIZER BETTER AND MORE ENVIRONMENTALLY FRIENDLY

Researchers have discovered a new technique that uses microwave technology to synthesize fertilizer for agriculture production. The process makes the fertilizer more efficient and better for the environment. Their work was recently published in Polymer Testing, an open-access scientific journal. **Gang Chen,** a civil and environmental professor, and his team are using the new technology to improve the performance of biochar-hydrogel composites. Biochar is a cost-effective product used for soil fertility. When combined with the hydrogel, the product absorbs water and fertilizes the soil. By adding the microwave processing technique, the researchers were able to improve the effectiveness of the composite by 20 percent. “The microwave-mediated polymerization technique we are using heats the material and optimizes its structure,” Chen said. “The process is cost-effective, better for the environment, and greatly improves the performance of the material.” Superabsorbent hydrogels are widely used in agricultural production to improve the efficiency of conventional fertilizers. They enhance water and fertilizer retention in soil. Although useful in the industry, they are made from organic solvents that can be harmful to the environment. Wide applications of these types of hydrogels can be costly as well, and the researchers hope the new cost-effective technology will encourage industry to use the more environmentally friendly product.

NEDA YAGHOOBIAN RECEIVES NSF CAREER AWARD FOR FIRE SCIENCE RESEARCH

Neda Yaghoobian, mechanical engineering researcher and assistant professor recently earned an NSF Faculty Early Career Development Award to advance the prediction and mitigation of fire spread into wildfire-prone areas. Her findings may elevate the importance of fire science in the national landscape. Yaghoobian is the principal and sole investigator in a new study to explore the effect of the flight behavior and transport of fragments of burning materials, called “firebrands” or flying embers, by turbulent winds. Yaghoobian’s five-year $500,000 grant began in the spring of 2021. “By understanding what a flying ember experiences in its flight path through turbulent winds we can predict where it will land and whether the ember can create a spot fire,” Yaghoobian said. Yaghoobian’s research uses computer modeling techniques to replicate the physics of firebrand transport in her models. The method allows her to examine the flight dynamics of the fiery ember particles in the turbulent wind flows to predict where they might land, and whether they can initiate new spot fires.

KAMPMANN HONORED AS DISTINGUISHED TEACHER

Raphael Kampmann, a civil engineering teaching faculty member, is the recipient of Florida State University’s 2021 Distinguished Teacher Award. “I am very happy that I have been recognized for the effort and dedication that I put into my work with students. It is fantastic to see students reach a learning goal through their own path, and I believe that those moments are equally inspiring to the students and to the instructor.” Kampmann became a full-time faculty member in the college in 2015. He has received several awards for his teaching, including FSU’s Undergraduate Teaching Award, the National Outstanding Faculty Advisor Award from the American Society of Civil Engineers and the Distinguished Engineering Educator Award from The Engineers’ Council. He received the Distinguished Teacher Award during the university’s annual Faculty Awards ceremony, which was held virtually April 22.

BERNADIN RECEIVES RESEARCH EXCELLENCE AWARD

Shonda Bernadin, associate professor of electrical engineering, received the Florida A&M University 2021 Research Excellence Award. The award honors outstanding faculty members for their commitment to research excellence. “I am pleased that Dr. Bernadin is being honored with the Research Excellence Award,” Sastry Pamidi, chair of the Department of Electrical and Computer Engineering, said. “She makes valuable contributions to FAMU and to the college—not only in research, but also in the areas of outreach, recruitment and retention.” Bernadin is active in engineering education research, K-12 outreach activities, and retention efforts within her department. Recent grants from the U.S. Department of Defense Army Outreach Program, the Intel Corporation, and the National Center for Women & Technology support her mission of building a strong pipeline of diverse engineering professionals to the workforce.

LI RECEIVES DEVELOPING SCHOLAR AWARD

Yan Li, associate professor of chemical and biomedical engineering and a Faculty Affiliate of the Institute for Successful Longevity, was honored with a Developing Scholar Award at Florida State University’s 2021 Faculty Awards ceremony. The Developing Scholar Award identifies, recognizes and honors future research leaders currently at the rank of Associate Professor. Dr. Li’s award provides $10,000 to be used in the coming year to promote her research. The award is sponsored by the Council on Research and Creativity in FSU’s Office of Research Development.

PROFESSORS RECEIVE JUNIOR & SENIOR FACULTY TEACHING INNOVATION AWARD

Two faculty in civil and environmental engineering, **Yassir AbdelRazig** (professor) and **Maxim Dulebenets,** (assistant professor) received the 2021 Florida Agricultural and Mechanical University (FAMU) Senior and Junior (respectively) Faculty Teaching Innovation Award (TIA). The award recognizes outstanding faculty members who explore and implement nontraditional teaching strategies, approaches, techniques or tools to produce measurable gains for student outcomes. It exemplifies the efforts of the teacher to explore new ways of teaching, impacting the students to think critically. “The civil department has been blessed with many outstanding teachers: this is our third university-level teaching award in recent years,” Lisa Spainhour, professor and chair of the college’s civil and environmental engineering department, said.


JUNG & SEYEDI

NEW TRANSIT IDEA STUDY HELPS RESEARCHERS IMPROVE THE SAFETY OF DRIVERLESS PUBLIC TRANSPORTATION

Researchers are trying to answer whether the nation is ready for driverless vehicles with a new $100,000 multi-disciplinary study funded by the Federal Transit Administration (FTA). The 21-month Transit IDEA project is part of the Transit Cooperative Research Program, designed to foster innovative concepts. **Sungmoon Jung,** a professor in civil and environmental engineering, is the principal investigator for the study that uses computer-based simulations to investigate crash risks. He is working with **MohammadReza Seyedi, Ph.D.,** a post-doctoral researcher, in the study that will help the industry make the autonomous bus safer. “For this project, experts in autonomous bus operation and researchers in computational mechanics are collaborating to make the autonomous bus safer for road users.”

CENTER FOR ADVANCED POWER SYSTEMS TO PARTNER WITH CITY ON POWER GRID RESEARCH

Researchers will join the City of Tallahassee and other partners on a U.S. Department of Energy project to improve integration of solar panels into electrical grids. The project, which is funded by a $3.8 million grant from DOE as well as $1.8 million from FSU and other research partners, will develop cutting-edge technologies including electronic controls and artificial intelligence to allow power plants to better utilize solar panels with the help of a battery energy storage system (BESS). The technology could potentially lower energy costs by 10 percent or more. "We want to enhance connected operations and the ability of solar plants to determine whether to send their energy to the grid or to store it for later," said **Yuan Li,** an assistant professor. "It means making the power plant more flexible in order to support the power grid, which will make the grid more resilient." Researchers will develop a control system that can give power plants enhanced capabilities, including the ability to quickly and reliably switch between a connection with the electrical grid to a self-contained system. The project will test and demonstrate the technologies on a 100-kilowatt hybrid photovoltaic/BESS power plant connected to the City of Tallahassee Utilities grid. The project involves faculty members **Olugbenga Moses Anubi, Hui Li, Yuan Li** and **Fang Peng.**

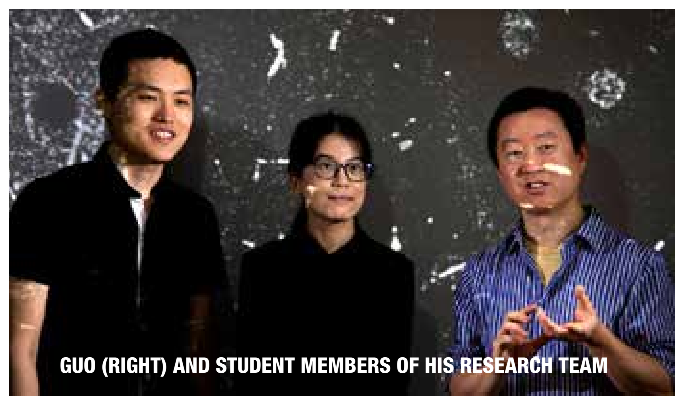
PAMIDI & KIM

COLLABORATING TO DETECT FAULTS IN SUPERCONDUCTING CABLES USING MACHINE LEARNING

In a new study, engineering researchers are developing a novel machine learning tool that may increase the reliability of high-temperature superconductor (HTS) power systems. The method finds early indicators of series faults in HTS cables. Series faults occur when one or more conductors fail, creating an imbalance that can cause problems in the system. Detecting defects early greatly improves the life and safety of the cables and prevents catastrophic and costly damage. **Sastry Pamidi,** chair of the electrical and computer engineering department and the Associate Director of the Center for Advanced Power Systems (CAPS), is a lead researcher on the study that will help improve early fault detection. "We're collaborating with Dr. Lukas Graber's group at Georgia Tech on multiple projects," Pamidi said. "We are developing a machine learning tool to detect the magnetic signature of HTS cables in order to monitor their transmission characteristics." The project team includes Pamidi and members of his research staff, CAPS research faculty members **Peter Cheetham** and **Chul Kim,** along with researchers from the Georgia Institute of Technology, Mississippi State University, and the Korea Electric Power Corporation.

ENGINEERING RESEARCHERS IMPROVE PERFORMANCE OF HIGH-TEMPERATURE SUPERCONDUCTOR WIRES

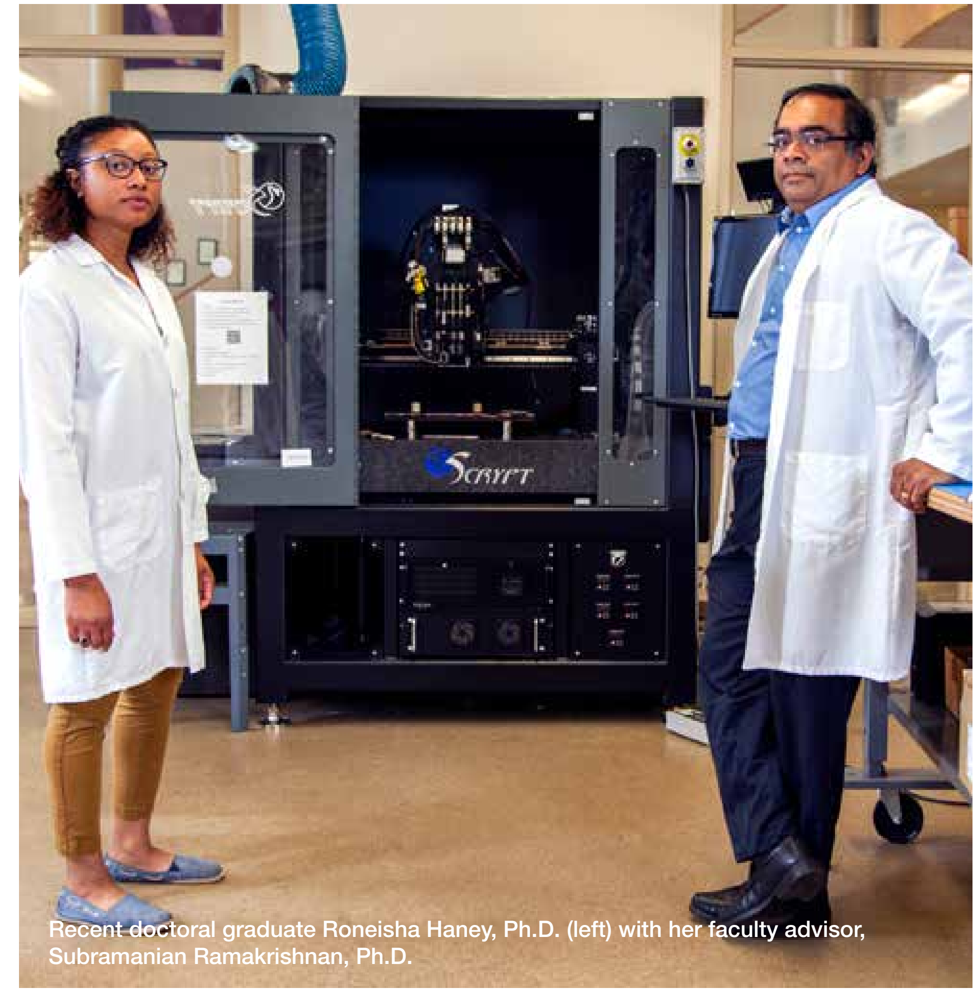
Researchers used high-resolution scanning electron microscopy to understand how processing methods influence grains in bismuth-based superconducting wires (known as Bi-2212). Those grains form the underlying structures of high-temperature superconductors, and scientists viewing the Bi-2212 grains at the atomic scale successfully optimized their alignment in a process that makes the material more efficient in carrying a superconducting current, or supercurrent. Their work was published in the journal Superconductor Science and Technology. They found that the individual grains have a long rectangular shape, with their longer side pointing along the same axis as the wire—a so-called biaxial texture. They are arranged in a circular pattern following the path of the wire, so that orientation is only apparent at very small scale. Those two properties together give the Bi-2212 grains a quasi-biaxial texture, which turned out to be an ideal configuration for supercurrent flow. "By understanding how to optimize the structure of these grains, we can fabricate the HTS round wires that carry higher currents in the most efficient way," said **Abiola Temidayo Oloye,** a doctoral candidate and researcher at the National High Magnetic Field Laboratory (MagLab) and the paper's lead author.



GUO (RIGHT) AND STUDENT MEMBERS OF HIS RESEARCH TEAM

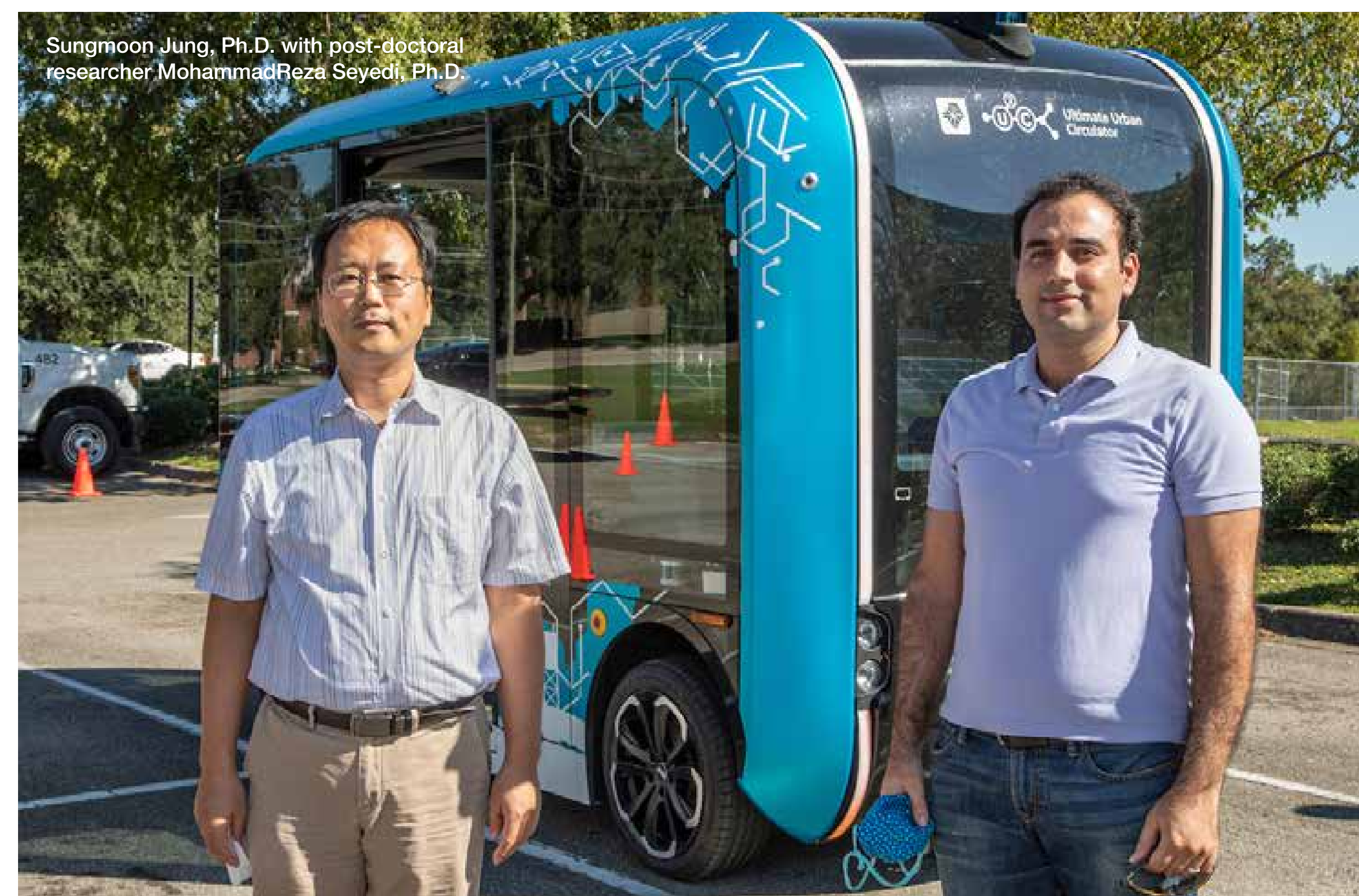
USING 3D IMAGING TECHNOLOGY TO ADVANCE QUANTUM FLUID RESEARCH

Wei Guo, an associate professor of mechanical engineering, is the principal investigator for a new grant funded by the NSF to investigate the dynamics of superfluids. The research will advance our understanding of quantum turbulence using three-dimensional flow visualization technologies. Previous research from Takeshi Egami of Oak Ridge National Laboratory showed that when helium gas is cooled to extreme temperatures, it becomes a liquid and behaves oddly—it can flow without friction as a superfluid. Absence of friction means no loss of kinetic energy in the fluid. Guo and his team of graduate students and post-doctoral researchers will use multidimensional flow visualization to further study the superfluid and its unique properties. "We will cool helium to its superfluid state," Guo said. "Then we will develop and use advanced 3D flow visualization systems to study phenomenon related to turbulence in this quantum fluid."



Recent doctoral graduate Roneisha Haney, Ph.D. (left) with her faculty advisor, Subramanian Ramakrishnan, Ph.D.

Raphael Kampmann, Ph.D.



Sungmoon Jung, Ph.D. with post-doctoral researcher MohammadReza Seyedi, Ph.D.

FAMU-FSU Engineering
2525 Pottsdamer Street
Tallahassee FL 32310
www.eng.famu.fsu.edu

One **college,**
two **universities,**
unlimited **opportunity.**

The FAMU-FSU College of Engineering is the joint engineering institution for Florida A&M and Florida State universities, the only such shared college in the nation. We are located less than three miles from each campus. After satisfying prerequisites at their home university, students learn together at the central engineering campus with its adjacent, nationally-renowned associated research centers and a national laboratory.