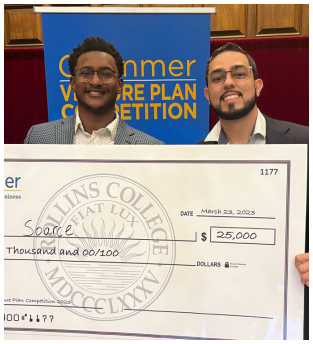
CONTINUUM

UCF Department of Materials Science and Engineering
Orlando, Florida | Volume 2 | 2022-2023

Contents

Page 12



Page 17

UCF | Materials Science and Engineering
UNIVERSITY OF CENTRAL FLORIDA

Continuum is an annual publication that highlights the achievements of the students, faculty, staff and alumni from the University of Central Florida's Department of Materials Science and Engineering.

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Letter From the Chair

Welcome to the fall 2023 semester!

I extend my heartfelt wishes for the well-being of you and your loved ones. Together we celebrate a significant milestone at the UCF Department of Materials Science and Engineering.

This semester, we welcome five new faculty members to the department, bringing our total of tenured and tenure-track faculty members to 23. I want to extend my sincere gratitude to the current UCF initiatives on artificial intelligence, machine learning and infectious disease, which has made these outstanding hires possible. Their cutting-edge research will propel our interdisciplinary research initiatives to new heights.

Our *Continuum* magazine represents captivating highlights from our department over this past year. I also heartily congratulate faculty members Akihiro Kushima and Tengfei Jiang on their well-deserved promotions to associate professor with tenure. This achievement is a testament to their remarkable contribution to the National Science Foundation CAREER program.

Over this past year, research articles from our faculty and students were accepted to high impact journals, and they received several federal and industry grants from FEMA, the Department of Energy, the Department of Defense and the National Science Foundation, to name a few. Their research quest spans a wide spectrum, from aiding frontline heroes to advancing energy production, pioneering novel battery materials, driving drug discovery for pandemic preparedness, exploring quantum materials, delving into nano- and microscale research and fostering technology transfer.

Our materials science and engineering undergraduate program continues its impressive growth, and I am thrilled to announce that it was recently awarded ABET accreditation, reflecting the exceptional quality of education our students receive. Furthermore, I am delighted to share that all our graduates find gainful employment with many wonderful organizations in the industry.

We are delighted that our faculty, students and staff were honored at UCF and won national and international awards. Additionally, we take immense pride in celebrating the distinguished alumni of our department who have recently received accolades from the UCF College of Engineering and Computer Science for their professional accomplishments.

Through this magazine, I extend a warm invitation to our wonderful alumni and friends, urging you to share your stories and accomplishments with us. Your generous support is pivotal in the continued growth of our department. As we embark on this new academic year, I extend my best wishes for a productive year ahead. I trust you will find inspiration and delight in the pages of this edition of *Continuum*. Stay safe and well.

Go Knights!

Sincerely,

Sudipta Seal
Chair, Department of Materials Science and Engineering
UCF College of Engineering and Computer Science

To find out how you can support the MSE department, visit bit.ly/givetomse.

Strength in Numbers

Five new faculty members have joined the UCF Department of Materials Science and Engineering for the 2023-24 academic year. The faculty bring with them a wide range of experience and expertise in biosensors and biowearables, semiconductor materials, electron microscopy, machine learning and much more. With the addition of these five faculty, the number of core faculty increases to 23. The MSE department also houses several faculty with joint appointments from across the university and beyond. Meet the newest faces in the MSE department:

Paria Gharavi
Assistant Professor

Gharavi joins UCF as an assistant professor from the University of Pennsylvania, where she worked as a postdoctoral scholar. She earned her doctoral degree in materials science and engineering in 2019 from the University of New South Wales in Australia and her master's degree in materials science and engineering from Sharif Technology University in Tehran. Gharavi specializes in electron microscopy techniques and multifunctional materials. Her work with leading electron microscopy centers around the world have resulted in several prestigious awards, including first place in the National Nanotechnology Coordinated Infrastructure microscopy image contest.

Liping Yu
Associate Professor

Yu comes from the University of Maine, where he taught as an assistant professor of physics. His research focuses on semiconductor physics and first principles design of new and improved materials for next-generation electronics and sustainable energy. For his work, he received a National Science Foundation CAREER Award earlier this year. Prior to his time at the University of Maine, Yu worked at the U.S. Department of Energy Frontier Research Center, the University of Colorado Boulder and Temple University. He earned his doctoral degree in physics from North Carolina State University.

Leland Nordin
Assistant Professor

Nordin comes to UCF from the Geballe Lab for Advanced Materials at Stanford, where he worked as a postdoctoral scholar. He holds a joint appointment between the Department of Materials Science and Engineering and the UCF College of Optics and Photonics (CREOL). His research focuses on the design, growth, fabrication and characterization of semiconductor materials and devices, specifically nanostructuring techniques to enhance light-matter interactions and significantly improve device performance. He earned his doctoral degree and master's degree in electrical and computer engineering from The University of Texas at Austin and his bachelor's degree in physics from Grinnell College.

Ehsan Shirzaei Sani
Assistant Professor

Sani joins MSE as an assistant professor under the Infectious Disease and Travel Health Initiative. He comes to UCF from the California Institute of Technology, where he served as a postdoctoral scholar. He earned his doctoral degree in engineering from the University of California, Los Angeles, in 2020 and his master's degree in engineering from Sharif Technology University in Tehran. His research focuses on advanced multifunctional and multimodal biomaterials for human and machine interfaces and regenerative medicine. He also explores wearable and implantable technologies for theragnostic applications. He has authored more than 40 research articles and holds five U.S. patent applications.

Shruti Vyas
Assistant Professor

Vyas joins the MSE department as an assistant professor after completing postdoctoral work in computer vision at UCF. Her research focused on effective representation through deep learning, and her long-term goal is to utilize her expertise in machine learning and bring the benefits of artificial intelligence to experimental research. She earned her doctoral degree in chemical engineering the National University of Singapore in 2016 and her other research foci include bioleaching and chemical leaching, material characterization and ultrasound applications.

To learn more about our faculty, visit **mse.ucf.edu.**

Helping the Helpers

UCF Researcher Receives $1.5M Award to Develop Health Monitoring Tool for Firefighters

Each time a firefighter puts their life on the line to save a member of the community, they may also put their health in jeopardy. Continuous exposure to extreme heat increases the core body temperature and causes a condition known as heat stress, which has been linked to serious medical conditions.

To help firefighters track their physiological response to heat stress, materials science and engineering Assistant Professor Kaitlyn Crawford will develop a wearable, wireless health monitor through a $1.5 million grant from the U.S. Department of Homeland Security. The award is part of the Federal Emergency Management Agency's Fire Prevention and Safety grant program.

"I am elated and honored to be selected to lead a large project that has the potential to make a significant positive impact on the fire service community," says Crawford, the principal investigator of the project. "I look forward to collaborating with the multidisciplinary team — including MSE Assistant Professor Kausik Mukhopadhyay, who is the co-principal investigator, and the subrecipients at the Illinois Fire Service Institute and Northwestern — and for the opportunity to interact directly with fire service members."

For the next three years, Crawford and her team will develop the physiological status monitor (PSM), which will be ultra-thin, flexible and comfortable for firefighters to wear. The device would be placed directly on the skin to accurately monitor a firefighter's vital signs and assess their physiological response to heat stress.

Crawford says the PSM will be used to identify correlations among heat stress and skin thermal activity near the skin surface for the first time using the proposed integrated methods. Current methods for evaluating heat stress require the aid of trained personnel to administer and only account for single exposure events. The PSM would resolve those issues, and the data collected could provide insight into the link between heat stress and the serious medical issues that plague firefighters.

"It is commonly understood that acute heat stress contributes to cardiovascular strain, may impact cognitive function, and likely increase skin permeability to carcinogens and other combustion products," Crawford says. "However, it is unknown how continuous, reoccurring exposure to heat stress may be a predisposing risk factor for occupational accidents, cardiac events and cancers over a firefighter's career."

The research team expects to deliver the PSM to market within the

Kaitlyn Crawford and Kausik Mukhopadhyay (below).

next five to seven years. Crawford says the health monitor could also be used by law enforcement, agricultural workers, astronauts, military personnel and even citizens in warm climates or those exposed to extreme weather conditions.

Mukhopadhyay says the monitor could be especially helpful to people in Florida, since the state has warmer weather compared to many other parts of the country.

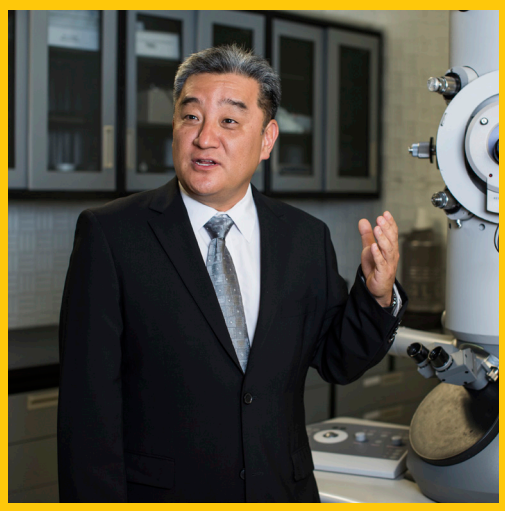
"Ideally, Floridians could wear the tool in future to monitor their heat stress exposure during daily outdoor activities — especially in the summer months," he says.

Crawford joined UCF in 2017 as an assistant professor of materials science and engineering and a member of the Biionix faculty cluster. She also has courtesy appointments in the Department of Chemistry and the NanoScience Technology Center. Crawford's research focuses on identifying new materials for sensing applications that are environmentally sustainable. She completed her doctorate in chemistry from the University of Maryland, College Park in 2015 and received a master's in chemistry from North Carolina State University in 2011. She has received more than 10 awards related to research and teaching.

Mukhopadhyay is an assistant professor of materials science and engineering, and he directs the Hybrid Materials and Surfaces Laboratory, where his team utilizes fundamentals of materials, chemistry, physics, medicine and engineering to develop solutions for a multitude of exciting research problems related to surfaces, coatings, electrochemistry, corrosion, catalysis and wound healing solutions for acute trauma. Mukhopadhyay has a bachelor's degree and a master's degree in chemistry from Calcutta University, and he received his doctorate in chemistry from the Council of Scientific and Industrial Research–National Chemical Laboratory.

Written by Marisa Ramiccio

To learn more about our faculty's research, visit mse.ucf.edu.



Sohn Named President of Korean American Science Organization

Materials science and engineering Professor Yongho Sohn has been elected president of the Korean American Scientists and Engineers Association. He succeeds former KSEA president Young Kee-Kim to become the 52nd leader of the organization.

Sohn officially assumed the role in July 2023. As president, he oversees a variety of activities, including the U.S.-Korea Conference on Science, Technology and Entrepreneurship and the National Math and Science Competition for K-12 students. He'll also administer conferences for emerging scientists and youth, career development workshops and professional development forums.

Sohn joined UCF in 2001 as an assistant professor and is now a Pegasus Professor and a Lockheed Martin Professor of Engineering. He is also a fellow of ASM International and an inductee of UCF's Scroll and Quill Society. Over the years, he has earned a number of grants and awards including the 2020 Engineer of the Year Award from KSEA.

KSEA was established in 1971 as a nonprofit professional organization to represent all Korean American scientists and engineers who work and study in the U.S. The goal of the organization is to support these scientists, to foster international cooperation and to promote the application of science and technology for the general welfare of society.

National Recognition

UCF Ranks as a Top 25 U.S. Public University for Patents Granted

The University of Central Florida has moved into the ranks of the top 25 public universities in the nation for patents granted, according to the latest report from the National Academy of Inventors (NAI).

UCF secured 63 patents in 2022, ranking it No. 52 in the world and No. 23 among public universities in the nation, as shown in the annual Top 100 Worldwide Universities Granted U.S. Utility Patent rankings report released this week.

This places the university ahead of leading public and private institutions such as Yale University (61 patents), Carnegie Mellon University (59 patents), the University of North Carolina at Chapel Hill (49 patents) and Florida State University (33 patents).

This is the 10th year that UCF has ranked in the top 100 universities in the world for patents, and the new ranking represents an eight-spot jump from last year's worldwide ranking.

"I continue to be impressed by the sustained technology development of our UCF researchers — placing UCF among the top 25 public universities in the U.S. for patents granted and surpassing many other prestigious institutions," says Winston Schoenfeld, UCF's interim vice president for research and innovation. "UCF's consistent top rankings over the last decade demonstrate our strong dedication as a research institution to innovation and translation for societal benefit."

Svetlana Shtrom, director of UCF's Office of Technology Transfer, says UCF is very strategic in selecting inventions for patent protection to ensure fiscal responsibility and to maximize the potential of receiving impactful patents.

"Not every invention results in a patent," Shtrom says. "For an invention to be patentable, it must be deemed by the United States Patent and Trademark Office to be novel, nonobvious and useful. UCF's success in receiving patents reflects the depth of the university's research and the commitment of its researchers to seek solutions to pressing problems, identify the most efficient and effective methods, and reach beyond the well-established standards to create impactful innovations."

Here are a few of the UCF inventions that led to patents in 2022:

Interdigitated Electrodes For In vitro Analysis of Cells

Lead researcher: Associate Professor Swaminathan Rajaraman, NanoScience Technology Center

This invention is a new tool that enables electrical and optical analysis of single cells and cell networks. It combines the simplicity of an interdigitated electrode (IDE) with the sophistication of plasmonics for in vitro biosensing applications. The invention may be used in applications such as in vitro drug development, single-cell analysis, toxicity testing and organ-on-a-chip models.

UCF is actively seeking licensing partners for this technology.

Cerium Oxide Nanoparticle Compositions and Methods

Lead researcher: Sudipta Seal, Pegasus Professor and chair of the Department of Materials Science and Engineering

This invention is a wet chemical synthesis process for fabricating cerium nanoparticles (CNPs) used in biomedical applications. With the UCF technology, companies can create CNPs that have the same material but comprise different properties. In one example application, the CNPs can be used to develop therapeutics to treat radiation exposure.

UCF is actively seeking licensing partners for this technology.

Written by Robert Wells

To read the full article, visit bit.ly/msepatents.

Academic Excellence

UCF Ranks Among Top Universities for Materials Science and Engineering Education

UCF, a top-tier public research university renowned for driving innovation and delivering broad-based prosperity, continues to distinguish itself in the latest *U.S. News & World Report* Best Graduate Schools rankings. In these influential 2023-24 rankings, nine College of Engineering and Computer Science graduate programs rank in the top 75 in the nation in their respective fields. Among them is the materials science and engineering program, which ranked No. 51 in the U.S. and No. 32 among public universities.

A total of 21 UCF graduate programs rank in the top 100 of their fields, with four programs in the top 25 and nearly a dozen showing marked advancement.

"These rankings highlight UCF's longstanding commitment to student success and academic excellence," says President Alexander N. Cartwright. "Our outstanding graduate programs provide students with opportunities to earn high-quality advanced degrees in vital and impactful fields of study that improve the quality of life for our region and have a positive impact on society."

UCF's master's and doctoral programs are critical in addressing workforce shortages and fostering job growth in high-demand fields such as education, business and healthcare.

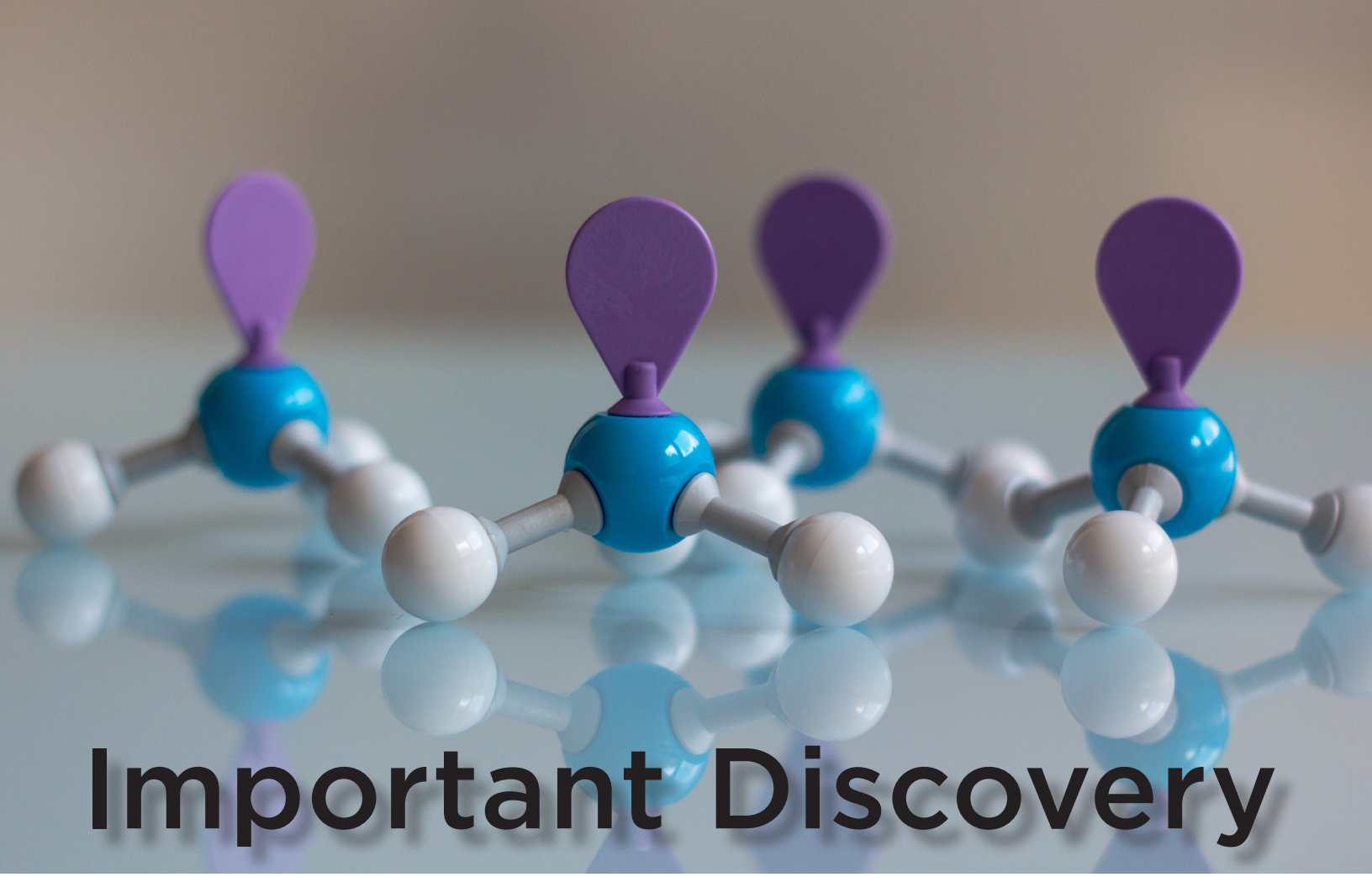
"Our latest rankings underscore UCF's unwavering focus on advancing the quality of our academic programs as we prepare students to excel in the global marketplace," says Michael D. Johnson, UCF's provost and executive vice president for Academic Affairs. "I am grateful for our faculty's focus on excellence and commitment to continuously elevating our scholarship, research, and societal impact."

UCF is a public research university invested in unleashing the potential within every individual, enriching the human experience through inclusion, discovery, and innovation, and propelling broad-based prosperity for the many communities it serves.

Ultimately, these rankings represent the drive, effort and dedication of our students, faculty, staff, and leaders to positively change the world.

Written by Rachel Williams '15 '20MA

To see all of UCF's rankings, visit bit.ly/UCFrankings.



Important Discovery

UCF Researchers Uncover Key Mechanisms for Sustainable Ammonia Production

A University of Central Florida research team with collaborators at Virginia Tech have published critical findings about the electrochemical synthesis of ammonia, advancing sustainable fertilizer research and thus aiding global food safety efforts.

Ammonia, a compound of nitrogen and hydrogen, is an essential ingredient in many fertilizers for food production. However, its primary method of production, the Haber-Bosch method, is energy and fuel-intensive, consuming 3% to 5% of the world's natural gas output and accounting for more than 1% of global carbon emissions.

Using the metal ruthenium as a catalyst, researchers identified the most efficient way to produce ammonia through a more sustainable production method — electrochemically. This production method can be more sustainable when electricity from renewable sources, such as solar or wind, is used to power the electrochemical synthesis, the researchers say.

The findings were published recently in *ACS Energy Letters*.

While there are many research efforts on electrochemical ammonia production, the underlying mechanisms have yet to be better understood, the researchers say.

However, this new research helps provide a clearer picture of the reaction mechanism, says study co-author Xiaofeng Feng, a professor in UCF's Department of Physics.

"The results of this in-depth work can provide important guidance to researchers on how to design more efficient catalysts towards sustainable ammonia production," Feng says.

How They Did the Work

Ruthenium's optimal binding strength with reaction intermediates makes it one of the most active catalysts for the nitrogen reduction reaction, which produces ammonia by combining nitrogen with hydrogen from water molecules.

Using atomic layer deposition, the researchers were able to have very precise control of the synthesized nanomaterials at the atomic scale, allowing the testing of ruthenium nanoparticles ranging from two to eight nanometers.

Researchers discovered that while layering ruthenium atoms into a catalytic structure, a special arrangement of ruthenium surface atoms — named the D5 step site — was the most active site for the electrochemical nitrogen reduction reaction.

Unlike other sites, the D5 step site possesses the "perfect balance," favoring the formation of the N2H intermediate and not getting poisoned, or rendered unable to allow new molecules to adsorb and react, by the NH2 intermediate, the researchers say.

Ruthenium nanoparticles of around four nanometers in size were

thus found to have the best catalytic performance for the nitrogen reduction reaction. Activity peaked at four nanometers and then dropped by five-fold as the particle size was doubled, demonstrating the critical effect of ruthenium particle size on the catalysis.

The researchers' previous work to improve the efficiency of the electrochemical production of ammonia helped the current study by providing the mechanistic understanding and research methodology.

Collaborative Research

The new research is a collaboration between three research teams.

Feng and his students characterized the ruthenium samples and investigated them as catalysts for the electrochemical production of ammonia. Study co-author Parag Banerjee, a professor in UCF's Department of Materials Science and Engineering, and his students focused on the precise synthesis of ruthenium metal nanoparticles in Banerjee's lab.

Additionally, Virginia Tech professor Hongliang Xin and his student performed computational studies to model and identify the atomic structure that is responsible for the highest catalytic performance.

The researchers plan to collaborate further to develop more complex, efficient materials using atomic layer deposition for sustainable ammonia production, Feng says.

They also will implement the catalyst materials in advanced electrolyzer devices to improve the yield rate and efficiency of electrically powered ammonia production.

Researcher Credentials

Feng received his doctorate in materials science and engineering from the University of California, Berkeley in 2013 and joined UCF in 2016 as an assistant professor in the Department of Physics. The research in his lab is supported by an U.S. National Science Foundation CAREER award.

Banerjee received his doctorate in materials science and engineering from the University of Maryland in 2011 and joined UCF in 2018.

The work in Banerjee's lab was partially supported by the U.S. National Science Foundation and EMD Performance Materials.Banerjee and Feng are both members of the Renewable Energy and Chemical Transformations (REACT) Cluster, which facilitated the collaboration and supports more future opportunities.

Written by Katrina Cabansay

To learn more about Banerjee's research, visit bit.ly/ParagLab.

Parag Banerjee (far right) with the research team.

UCF Researchers Are Advancing AI-Assisted Drug Discovery

University of Central Florida researchers are advancing AI-assisted drug screening technology with a new method that not only improves their own model's predictive ability but also that of seven other state-of-the-art models.

This new method can be beneficial in accelerating the development of life-saving medicines that otherwise take billions of dollars and decades of time to produce. The results were published recently in the journal *Briefings in Bioinformatics*.

Their new model, BindingSite-AugmentedDTA, uses their previously reported model, AttentionsiteDTI, as the first step of a two-step prediction approach.

"A unique aspect of our approach is that it can be easily integrated with any deep learning-based prediction model, which allows for improved performance compared to using the prediction models alone," says study co-author Ozlem Garibay, an assistant professor in the Department of Industrial Engineering and Management Systems.

"By integrating our approach with other state-of-the-art deep learning-based drug-target-affinity prediction models, we have shown significant improvement in prediction performance across multiple metrics," Garibay says.

Materials science Professor Sudipta Seal and postdoctoral researcher Craig Neal '14 '16MS '21PhD are collaborators on this project.

Fighting Infections

UCF Researchers Receive Patent for COVID-Killing Nano-Coating

A team of UCF researchers, led by Materials Science and Engineering Professor Sudipta Seal, have been awarded a patent for their nanomaterial-based disinfectant that can kill several viruses, including COVID-19. This is the 85th patent that Seal has been awarded through the UCF Office of Technology Transfer.

The Pegasus Professor and chair of the Department of Materials Science and Engineering says this patent was awarded much faster than most, which demonstrates the importance of the disinfectant.

"We are very excited to get this patent accepted so quickly, and we're glad that the work is of great value for combatting viruses and pathogen-born infections," Seal says. "Thanks to the U.S. Patent and Trademark Office for recognizing this work and to the UCF Office of Technology Transfer for its support."

Co-recipients of the patent include Seal's postdoctoral researcher, Craig Neal '14 '16MS '21PhD, and his former research assistant, Udit Kumar '22PhD.

How the Disinfectant Works

The COVID-killing coating is made with a nanomaterial that activates under white light, such as sunlight or LED light. As long as the nanomaterial is exposed to a continuous light source, it can regenerate its antiviral properties, creating a self-cleaning effect.

The efficacy of the disinfectant was tested and proven through a study that was published in *ACS Applied Materials and Interfaces* this past year. The study found that the coating can not only destroy the COVID-19 virus, but it can also combat the spread of Zika virus, SARS, parainfluenza, rhinovirus and vesicular stomatitis.

The research was funded by the U.S. National Science Foundation's RAPID program and conducted by a multidisciplinary team of researchers, including Griff Parks, a professor in the UCF College of Medicine and the co-principal investigator of the grant.

Next Steps

Now that the disinfectant has been patented, the research team will continue testing the product and UCF will seek a commercial partner to manufacture and sell it to a wide range of customers within the next few years.

"We plan to carry on the work in larger samples and also to test in vivo models and other means of infection control," Seal says. "The process is well defined, and we plan to work with an industry partner to bring it to the mass market."

Seal joined UCF's Department of Materials Science and Engineering and the Advanced Materials Processing Analysis Center, which is part of UCF's College of Engineering and Computer Science, in 1997. He has an appointment at the College of Medicine and is a member of UCF's prosthetics cluster Biionix. He is the former director of UCF's NanoScience Technology Center and Advanced Materials Processing Analysis Center. He received his doctorate in materials engineering with a minor in biochemistry from the University of Wisconsin and was a postdoctoral fellow at the Lawrence Berkeley National Laboratory at the University of California Berkeley.

Written by Marisa Ramiccio

Learn more about Seal's research at mse.ucf.edu/nanobiomaterials.

Alumna-Led Company Earns $1M Grant to Develop Disinfectant

The National Science Foundation has awarded a Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Phase II award worth $1 million to Kismet Technologies to further its research and development of a broad-spectrum disinfectant that can kill COVID-19 among other bacteria and viruses.

The company, led by UCF materials science and engineering alumna Christina Drake '07PhD, is working with a multidisciplinary team of UCF researchers, including Department of Materials Science and Engineering Chair Sudipta Seal, Burnett School of Biomedical Science Director Griff Parks and College of Medicine Professor Melanie Coathup, to create the disinfectant. Kismet Technologies is one of 10 recipients of the STTR award this year.

College of Engineering and Computer Science Dean Michael Georgiopoulos says this award demonstrates the power of collaboration at UCF.

"One of the key goals of CECS is to the be the nation's technology partner leader," Georgiopoulos says. "This collaboration of UCF faculty with Kismet Technologies is a testament of the creativity, innovation and building-together culture of our faculty and alumni. Furthermore, the collaborative work conducted has significant societal impact and contributes to the economic well-being of our region."

Building a Better Battery

New UCF-Developed Battery Could Prevent Electric Vehicle Fires After Hurricane Flooding

A University of Central Florida researcher has developed technology that could prevent electric vehicle fires, like those caused by saltwater flooding from Hurricane Ian.

The technology, an aqueous battery, replaces the volatile and highly flammable organic solvents found in electric vehicle lithium-ion batteries with saltwater to create a battery that is safer, faster charging, just as powerful and won't short circuit during flooding.

The work is detailed in a new study in *Nature Communications*.

"During Hurricane Ian, a lot of electric cars caught fire after they were soaked in floodwater," says Yang Yang, an associate professor in UCF's NanoScience Technology Center who led the research. "That is because the saltwater corrodes the battery and causes a short circuit, which ignites the flammable solvents and other components. Our battery uses saltwater as an electrolyte, eliminating the highly volatile solvents."

Also key to the battery's design is its novel, nano-engineering that allows the battery to overcome limitations of previous aqueous batteries, such as slow charging times and poor stability.

The UCF-designed battery is fast charging, reaching full charge in three minutes, compared to the hours it takes lithium-ion batteries.

Yang is an expert in developing materials for renewable energy devices such as batteries with improved safety.

Saltwater Electrical Vehicle Fires

The issue of electric vehicle fires after saltwater flooding surfaced during Hurricane Sandy in 2012 and Hurricane Isaias in 2020.

As a result, the U.S. Fire Administration and the National Highway Traffic Safety Administration have issued special guidance for responding to electric vehicle fires caused by saltwater flooding.

The fires require copious amounts of water to douse, with the International Association of Fire Chiefs recommending firefighters secure a continuous and sustainable water supply of 3,000 to 8,000 gallons.

At least 12 electric vehicle fires were reported in Collier and Lee counties in Florida after Hurricane Ian, where many cars were submerged at least partially in saltwater, according to the U.S. Fire Administration.

Designing the Battery

Previous aqueous battery designs have suffered from low energy output, instability, the growth of harmful metallic structures called

Yang Yang

dendrites on the negative electrode and corrosion.

By using saltwater as the battery's liquid electrolyte, the UCF researchers were able to use naturally occurring metal ions found in the saltwater, such as sodium, potassium, calcium and magnesium, to create a dual-cation battery that stores more energy. This implementation allowed them to overcome the sluggishness of previous single-cation aqueous battery designs.

To solve problems with instability, dendrite growth and corrosion, the researchers engineered a forest-like 3D zinc-copper anode containing a thin zinc-oxide protective layer on top.

The novel, nano-engineered surface, which looks like a birds-eye-view of a forest, allows the researchers to precisely control electrochemical reactions, thereby increasing the battery's stability and quick charging ability.

Furthermore, the zinc-oxide layer prevented dendritic growth of zinc, which was confirmed using optical microscopy.

"These batteries using the novel materials developed in my lab will remain safe even if they are used improperly or are flooded in saltwater," Yang says. "Our work can help improve electric vehicle technology and continue to advance it as reliable and safe form of travel."

Licensing and Acknowledgements

The patent-pending technology is available for licensing through UCF's Office of Technology Transfer.

The research was supported with funding from the U.S. National Science Foundation and American Chemical Society Petroleum Research Fund.

Yang holds joint appointments in UCF's NanoScience Technology Center and the Department of Materials Science and Engineering, which is part of the university's College of Engineering and Computer Science. He is a member of UCF's Renewable Energy and Chemical Transformation (REACT) Cluster.

He also holds a secondary joint-appointment in UCF's Department of Chemistry and The Stephen W. Hawking Center for Microgravity Research and Education. Before joining UCF in 2015, he was a postdoctoral fellow at Rice University and an Alexander von Humboldt Fellow at the University of Erlangen-Nuremberg in Germany. He received his doctorate in materials science from Tsinghua University in China.

Written by Robert Wells

To read the *Popular Science* article on this research, visit bit.ly/PopSciYang.

UCF Hosts Materials Science Symposium

Materials scientists, researchers and engineers recently convened on the UCF campus for the 2023 Science and Technology Emerging Materials Symposium, better known as STEMS. The event featured speakers from across the U.S. who spoke on topics related to the exotic properties of quantum materials, the characterization of novel materials for energy and the environment, and light interaction with quantum matter.

The symposium was organized by the PREM Center for Ultrafast Dynamics and Catalysis in Emerging Materials, an NSF-sponsored partnership between UCF and the University of Washington that aims to develop the next generation of materials scientists and engineers.

More than 80 guests, including NSF program managers, attended the two-day event, which was hosted at the L3 Harris Engineering Center. The symposium included 18 contributed talks and a poster session. Notable speakers included Joshua Robinson, a professor of materials science at Penn State; Michael Filler, an associate professor of chemical and biomolecular engineering at the Georgia Institute of Technology; and Tracy Lohr, a research scientist at Shell Corporation.

Assistant Professor Parag Banerjee said this year's STEMS symposium was a success, not only for the university, but for its students as well.

"UCF has the benefit of size and incredible diversity in its student population," Banerjee says. "For us to host this event means we are able bring valuable networking opportunities to our students."

A MICRO PERSPECTIVE

New $1.25M Research Project Maps Materials at the Nanoscale

A University of Central Florida researcher will lead a recently announced $1.25 million project to map and manipulate materials at the nanoscale.

The project's funding is through the Gordon and Betty Moore Foundation, a philanthropic foundation established by Intel co-founder Gordon Moore and his wife Betty Moore to support scientific discovery, environmental conservation, patient care improvements and more.

Laurene Tetard, an associate professor and associate chair of UCF's Department of Physics, an affiliated faculty member of the Department of Materials Science and Engineering and a researcher with the NanoScience Technology Center, is the project's investigator. She is one of 16 researchers from across the U.S., including from Harvard University, Princeton University and Cornell University, selected to receive the five-year funding award.

Tetard's research focuses on advancing nanoscale imaging and spectroscopy tools, including atomic force microscopy, to unlock new capabilities of materials at the nanoscale. The work will advance the fundamental understanding of materials behavior at the nanoscale. It can lead to new catalysts and other compounds that could be applicable in a range of areas including quantum science, renewable energy, life sciences and sustainability.

For example, the researchers are working on manipulating the chemical compound hexagonal boron nitride at the nanoscale level to have a defect that allows it to capture carbon from greenhouse gases, such as methane, and release value-added byproducts.

Some of her group's latest work in this area was published recently in the journal *ACS Nano Letters*. In the study, the researchers showed that by creating nanoscale defects in hexagonal boron nitride, they could functionalize the material for potential applications including in sensing, catalysis, optoelectronics, and quantum computing.

The new funding will support Tetard's continued research into new ways to functionalize materials.

"Being selected for this program by the Gordon and Betty Moore Foundation is a great opportunity to deepen our understanding of chemical processes taking place at very small scales in a way that could help us develop better materials for greenhouse gases capture and conversion, sensing and more," Tetard says. "It is exciting to think of the research the team will be able to carry out with this support from the foundation. I am also eager to launch new projects at the departmental and university level, which will help our students connect with researchers in academia, in industry and at national laboratories, especially to strengthen our work on making physics a more diverse and inclusive community."

The foundation will support the researchers' work by providing equipment grants and by hosting convenings to share new ideas and encourage collaborations. The foundation says central to this initiative is supporting the investigators as they strive to make their research groups inclusive and advance equity in their departments.

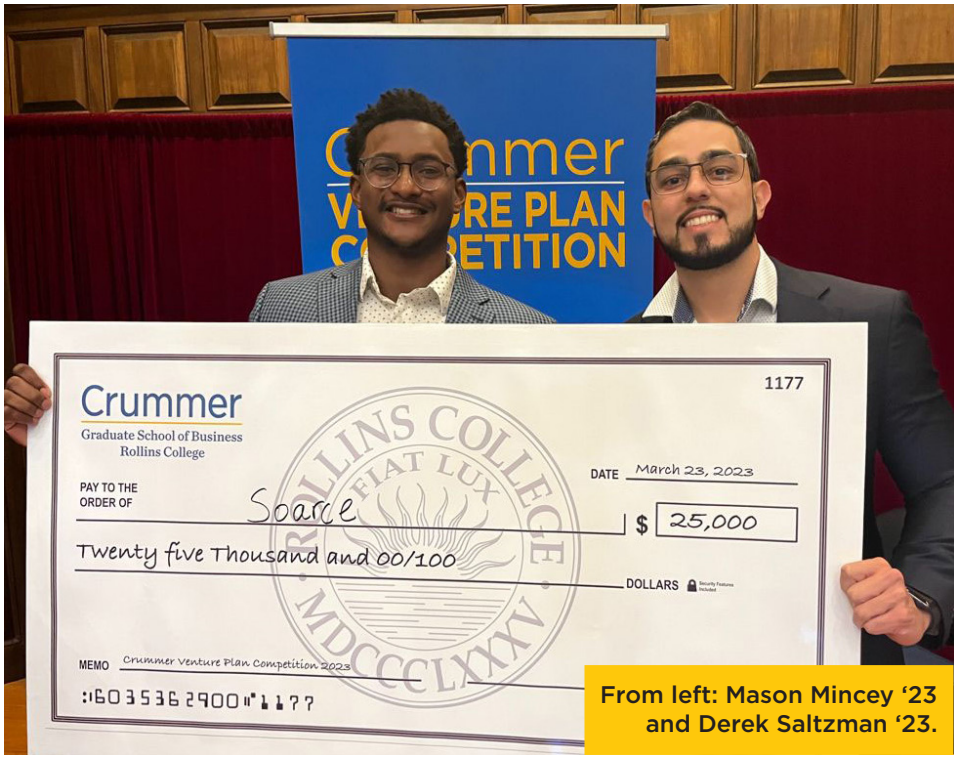
"It's critical to support not just those who have had opportunities and resources to excel, but to support adoption of practices that will expand access to these opportunities in the future," says Catherine Mader, program officer in the Experimental Physics Investigators Initiative of the foundation. "Helping these researchers find resources and adopt practices to enhance equity and inclusion is an important way the foundation can help all group members produce their best science."

Tetard received her doctorate in physics from the University of Tennessee, Knoxville, and joined UCF's NanoScience Technology Center and Department of Physics, part of UCF's College of Sciences, in 2013. She also has been a recipient of the U.S. National Science Foundation's CAREER grant, an award given to early career scientists and engineers with high promise of leading major advances in their respective fields and who will serve as academic role models.

Written by Robert Wells.

To learn more about Tetard's work, visit bit.ly/Tetard.

Christina Drake ‘07PhD



From left: Mason Mincey ‘23 and Derek Saltzman ‘23.

The Knight Stuff

Materials Science Alumni Secure Top Wins in Venture Competition

The event may have been hosted by Rollins College, but it was dominated by University of Central Florida Knights with materials science and engineering backgrounds. Two alumni-led startups took first and second place at the Crummer Graduate School of Business’ 2023 Venture Plan Competition, one of Central Florida’s largest pitch competitions.

Kismet Technologies, led by Christina Drake ‘07PhD, won the top prize of $50,000, while Soarce, founded by Derek Saltzman ‘23 and Mason Mincey ‘23, came in second place and received $25,000.

Drake founded Kismet Technologies in 2019 with the goal of creating disinfectant materials that can make the world a safer place. In addition to the Venture Plan Competition win, Drake and Kismet co-founder Shari Dingle Constantini received the 2023 Fire Award from the Orlando Business Journal earlier this year. They also opened a larger manufacturing facillity in Orlando and secured $5 million in seed funding from investors.

Saltzman and Mincey co-founded Soarce as undergraduate materials science students. Mincey said the win is a victory for Soarce, which uses seaweed to develop leathers and fabrics for clothing that are fire resistant and UV protectant.

“It feels great, especially since we only made it to the semifinals last year,” Mincey says. “It reminded us how far we have come in such a short time.”

The Venture Plan Competition, now in its eighth year, is open to all startups that are headquartered in Central Florida. The businesses compete for mentorship, funding and exposure to the region’s most successful entrepreneurs. The UCF Knights bested 15 other finalists in the competition, including Fluix, a computer cooling company created by UCF aerospace engineering alumnus Abhishek Sastri ‘20.

Over the past eight months, Soarce has worked with leAD, a Lake Nona-based sports and health technology accelerator that was co-founded by the grandson of the creator of Adidas. Through their partnership, Soarce has secured over $650,000 from grants and investors.

With the prize money in hand, the UCF Knights will further develop their manufacturing setup in Lake Nona and run pilot studies with recognizable brands. They also plan to apply for a Small Business Innovation Research grant through the National Science Foundation, and of course, participate in more pitch competitions.

Earlier this year, Soarce also participated in the Synapse Summit and won $20,000 at the event’s Innovation Awards ceremony. The Knight-led business was also named one of 10 startups to watch by the Orlando Business Journal.

Written by Marisa Ramiccio

Learn More:

Watch the 2023 Venture Plan Competition at bit.ly/UCFVenture.

To learn more about Soarce, visit soarceusa.com.

MSE BY THE NUMBERS

The UCF Department of Materials Science and Engineering has seen tremendous growth over the past several years. From faculty research to student growth, take note of these impressive numbers.

4.2M

External research funding
2022-23

3.8M

External research funding
2021-22

4.5M

Five-year external funding
average

75

Number of journal articles
produced by MSE faculty
2022-23

9

Number of conference papers
produced by MSE faculty
2022-23

112

Number of talks given by
MSE faculty
2022-23

37

Number of invited talks given
by MSE faculty
2022-23

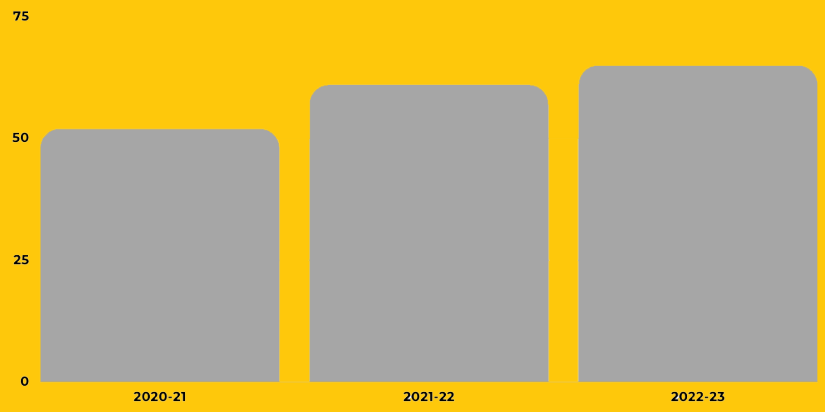
13

Number of patents issued to
MSE faculty
2022-23

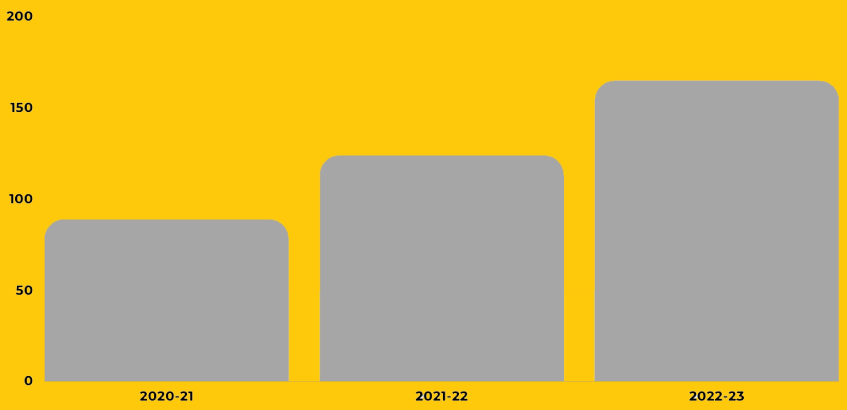
23

Number of core faculty and
adjuncts
2022-23

Growth of Pending MSE Students

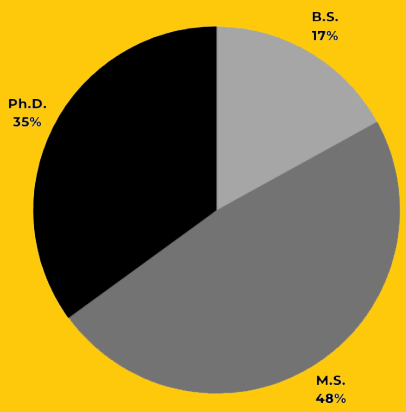


Growth of Undergraduate MSE Students



Total Number of Graduates By Program

2020-2023



To learn more about the department, visit mse.ucf.edu.

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