TEXAS A&M UNIVERSITY

Artie McFerrin Department of Chemical Engineering

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CHEMICAL ENGINEERING

2024

Letter from the
Department Head

Howdy, from the Artie McFerrin Department of Chemical Engineering!

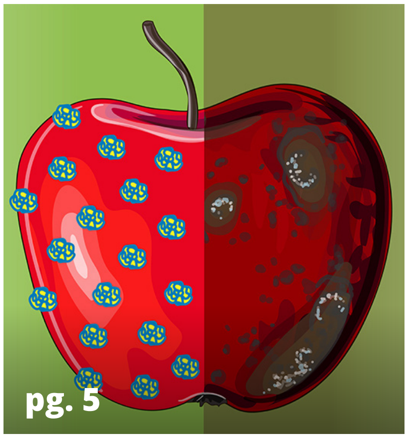
First, let me introduce myself. My name is Faisal Khan. On May 1st, 2024, I took responsibility as the Head of Artie McFerrin Department of Chemical Engineering. Four years ago, I came to Texas A&M University as the Mike O'Connor Chair II Professor and Director of Mary Kay O'Connor Process Safety Center (MKOPSC). I am deeply honored to serve this outstanding department. We have exceptional colleagues, outperforming students and staff who are committed to serving. Our researchers focus on investing in solving problems that will have generational impacts on clean and safe energy, better health for all, novel materials, and integrated solutions for the processing industries. I am thankful to our alumni for their help and support; and to the Industry Advisory Council for providing valuable guidance to ensure we remain on track in serving our students and community.

Our department continues to gain major research grants to support our research. Dr. Jeetain Mittal has been successful in securing multiple research grants, one being from the 2024 National Institute of Health for his work with multiscale computational models that investigate the role of phase separation. Likewise, a team led by Dr. Faruque Hasan received a $1.5 million grant from the Inflation Reduction Act to address climate-damaging hydrofluorocarbons funded by the United States Environmental Protection Agency. This year, we had a research expenditure of over 35 million. While we had significant success in individual and collaborative grants, we continue to lead multi year consortium programs, such as the Ocean Energy Safety Institute (OESI) supported by the Department of Energy, Department of Interior and the Electrified Processes for Industry without Carbon (EPIXC) Institute supported by the Department of Energy as part of the Manufacturing USA initiative led by Dr. Mark Barteau and Dr. Efstratios Pistikopoulos.

Our colleagues continue to make impactful discoveries and transformational work. Dr. Joseph Sang-Il Kwon, has developed a crystallization simulator named "CrystalGPT" that combines AI and chemical engineering to impact the medicinal manufacturing process. Also, Drs. Perla Balbuena and Jorge Seminario have developed a method to understand the impact of external pressure on lithium-metal batteries using quantum mechanics. This collaboration with Pacific Northwest National Laboratory to reach the goals made by the Department of Energy.

Our students continue to make us proud with their outstanding achievements. Dr. Yuhe Tian, a doctoral student from 2016 to 2021 (under the supervision of Dr. Stratos Pistikopoulos), has been recognized with the Outstanding Doctoral Dissertation award. These achievements are a testament to the quality of education and research opportunities we provide. We are grateful for the continued support and engagement of our alumni and staff. These successes would not be possible without your support and continued engagement.

Dr. Faisal I Khan
Professor and Mike O'Connor Chair II
Professor, Chemical Engineering
Director, MKO Process Safety Center
Director, Ocean Energy Safety Institute
Affiliated Faculty, Industrial & Systems Engineering
Affiliated Faculty, Ocean Engineering



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FACTS **SHEET**

RANKINGS
(*U.S. NEWS & WORLD REPORT*, PUBLIC)

#12 Undergraduate *(2024)*

#14 Graduate *(2025)*

DEGREES AWARDED
(2022-2023 School Year)

331 Total

239	**63**	**29**
Bachelor's	Master's	Ph.D.

ENROLLMENT (Fall 2023)

985 Total

719	**125**	**141**
Undergraduate	Master's	Doctoral

FACULTY

45 Total Faculty | **5** Endowed Professorships

8 Chair Holders | **6** Endowed Faculty Fellows

RESEARCH AREAS

- 1.Biomedicine and biomolecules
- 2. Catalysis and Reaction
- 3. Energy
- 4. Sustainability
- 5. Materials and Nanotechnology
- 6. Process Systems
- 7. Process Safety

U.S. NEWS AND WORLD REPORT 2024-25 GRADUATE SCHOOL RANKINGS

ENGINEERING A COATING FOR DISEASE-FREE PRODUCE

Dr. Mustafa Akbulut, professor of chemical engineering, has teamed up with horticultural science professor Luis Cisneros-Zevallos to engineer longer-lasting, bacteria-free produce. According to Akbulut's recent publication in Current Research in Food Science, the global fruit and vegetable market loses over 50% of agricultural fruit production during various stages of produce handling and post-harvest treatments.

Many fruits and vegetables already have a layer of food-grade wax that is applied for cosmetic reasons and to prevent water loss. Akbulut's research combines such wax with nano-encapsulated cinnamon-bark essential oil in protein carriers to enhance them with antibacterial properties.

"We are living in an age where technology has advanced so much," Akbulut said. "However, the food industry has not competed with these advances, and there are continuous problems with food safety. News about foodborne diseases and outbreaks reporting hundreds of people becoming sick from unhygienic food frequently appears at the national level."

Akbulut's wax coating technology bolsters the safety of fresh produce and provides enhanced protection against bacteria and fungi. This composite coating provides both immediate and delayed antibacterial effects, according to the article.

Foodborne pathogens are especially problematic for fruits and vegetables that are consumed raw or minimally processed due to the lack of high temperatures that can inactivate them.

Development of this coating gives better understanding of the interactions between the wax and undesired microorganisms, Cisneros-Zevallos said.

"I think that the impact that these wax coatings will have on the industry is very big because the industry is looking for new technologies," Cisneros-Zevallos said. "This is one of those tools that we are developing that could actually help the industry face these challenges against human pathogens and spoilage organisms."

Nano-encapsulated essential oil makes it harder for bacteria to attach and survive on fruits or vegetables. The delayed release of the essential oil increases the half-life of active ingredients and produce compared to its unencapsulated counterparts, according to the article.

"When bacteria are exposed to essential oil it can break down the bacterial wall," Akbulut said. "This technology is going to basically help us inactivate the bacteria and fungi to extend the shelf life."

Doctoral student Yashwanth Arcot ran experiments to support the research.

"This coating was also inhibiting the fungal attachment," Arcot said. "We have tested this system against *Aspergillus*, a fungus responsible for the spoilage of food commodities and the onset of lung infections in humans. We were successful in preventing its growth on the hybrid coatings."

Arcot said this is the first development of hybrid technologies for killing bacteria and fungus using nano-encapsulated essential oil in food waxes.

The chemicals used to produce this hybrid wax are antibacterial agents that are FDA-approved.

"These hybrid wax coatings are easily scalable and can be implemented in food processing industries," Arcot said.

Additional contributors to the research include Dr. Matthew Taylor from Department of Food Science and Technology, Dr. Younjin Min from the University of California, Riverside, and Dr. Alejandro Castillo from the Department of Food Science and Technology.

This research received partial funding through the Food Manufacturing Technologies Program provided by the United States Department of Agriculture (USDA). Additionally, funding comes from the USDA National Institute of Food and Agriculture - Specialty Crop Research Initiative.

TEXAS A&M RECEIVES GRANT FROM INFLATION REDUCTION ACT

Texas A&M has been announced as a recipient of a $1.5 million grant from the Inflation Reduction Act to address climate-damaging hydrofluorocarbons.

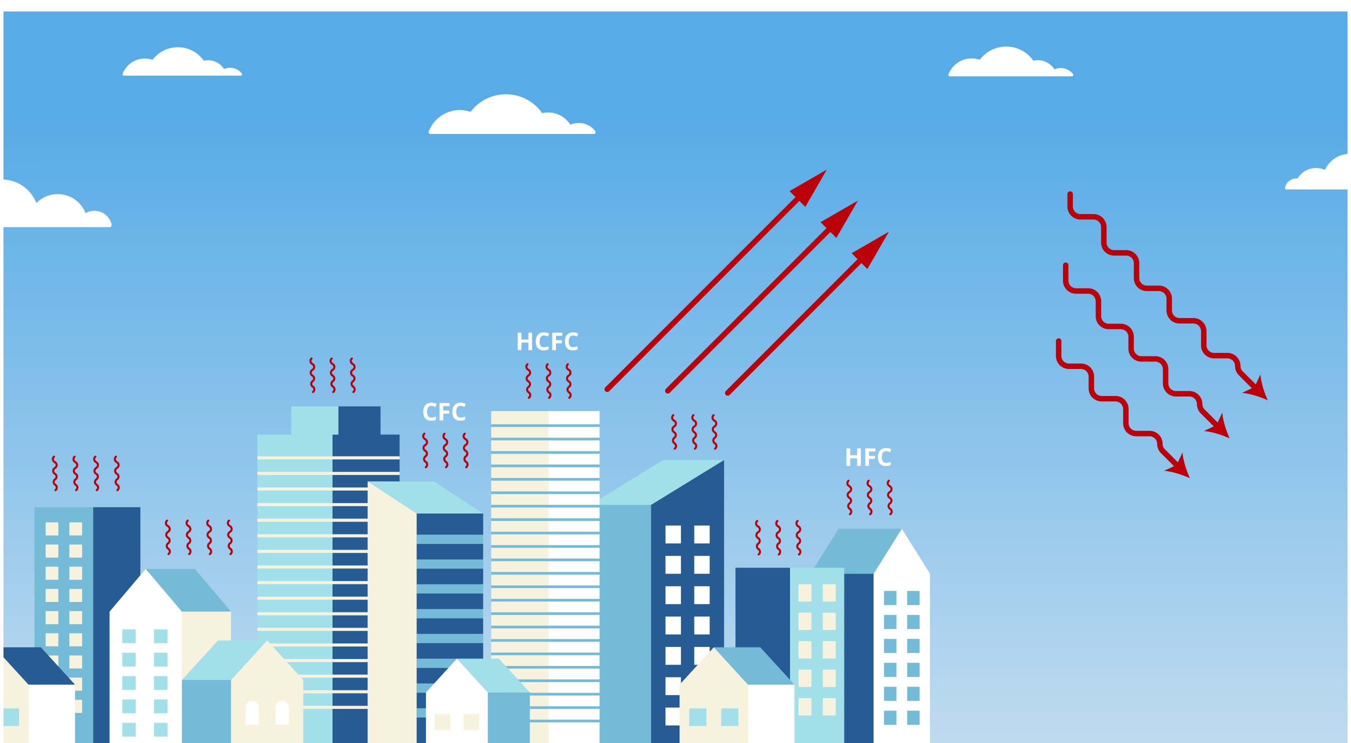
The grant is among the five projects funded by the United States Environmental Protection Agency (EPA) totaling $15 million and includes three other universities: the University of Washington, Drexel University and the University of California- Riverside, along with the Air Conditioning, Heating and Refrigeration Institute.

Dr. Faruque Hasan, associate professor of chemical engineering and assistant director of the Texas A&M Energy Institute, is leading the research team from Texas A&M that is combatting climate change by reclaiming and destroying hydrofluorocarbons.

"It's about addressing different greenhouse gases that have adverse effects on the climate," Hasan said. "One of them is a mixed refrigerant that we use for air conditioning and other applications, which is called hydrofluorocarbon or HFC."

Texas A&M's project aims to reduce the time and cost of reclaiming HFCs in two ways. First is designing and testing a technology capable of separating a range of HFC mixtures, according to the United States Environmental Protection Agency.

Professor Hasan's group specializes in mathematical modeling and computational optimization for the design and discovery



of new processes and technologies for advanced gas separation, decarbonization of energy systems, and chemical supply chains. “This selection for the grant highlights the important research that we are doing at Texas A&M at the intersection of energy and the environment,” Hasan said.

Part two of the project includes incorporating a machine learning-based data-driven decision framework for reverse logistics with high supply chain visibility that includes quality, cost efficiency, changing market dynamics, stakeholder collaboration, safety, and environmental regulation, according to the EPA.

Overall, this project intends to achieve a 30% increase in reclaimed HFC and a 25% reduction in cost from the baseline operation. The project is expected to last five years.

With air conditioning, you need a refrigerant, and there is a push to replace refrigerants with high global warming potential because of their negative impact, according to Hasan.

“We also emit a significant amount of carbon dioxide, but the refrigerants that we use, if vented to the atmosphere, are several thousand times more potent as a greenhouse gas than carbon dioxide,” Hasan said.

According to the EPA, by increasing the reuse of existing HFCs, selected projects are expected to further reduce our economy’s need for new HFCs and reduce overall HFC impacts on our climate.

There are many different types of HFCs, and if collected in the same tank they will be contaminated. Furthermore, some HFCs form azeotropes that are extremely difficult and energy-intensive to separate in their pure forms and cannot be used for a better purpose.

“To address these, we will develop an advanced decision-making and optimization framework for HFC reclamation and reverse logistics,” Hasan said. “We’re also going to test a new technology for separating the reclaimed HFCs to see whether that technology is robust.” As part of the project, Professor Hasan is collaborating with Professor Eleftherios “Lefteris” Iakovou from the Department of Engineering Technology and Industrial Distribution, and Icorium Engineering, an industrial partner focusing on HFC technology.

This grant’s goal is to find pathways for efficient, economic, and more sustainable reclamation of these greenhouse gasses. “This is why both the process modeling, design and supply chain decision-making comes into play. We call the framework SMART-RECLAIM, which comes from Scalable, Modular and Adaptable Reclamation Technology for Hydrofluorocarbon Refrigerant Enhancement, Circular Logistics, and Intelligent Manufacturing,” Hasan said.

EPA anticipates that grants to the selected applicants will be finalized and awarded in the summer of 2024 once all legal and administrative requirements are satisfied. Selected applicants will begin projects in the fall and winter of this year.

Funding for this research is administered by the Texas A&M Engineering Experiment Station (TEES), the official research agency for Texas A&M Engineering.

CrystalGPT: Researcher Combines AI and Engineering **to Improve Medicine**

Dr. Joseph Sang-Il Kwon has developed a crystallization simulator named CrystalGPT that impacts the manufacturing process for drugs.

CrystalGPT is the first model that combines well-established physics models and reactor models with a next-gen AI model for a novel 'best-of-both-worlds' approach, according to Kwon, a chemical engineering associate professor in Texas A&M University's Artie McFerrin Department of Chemical Engineering.

When he first started using GPTs, Kwon noticed that despite their popularity, there were hardly any applications in the chemical engineering space. "This realization triggered a month-long brainstorming session that resulted in different ways to build-upon existing transformer models

for chemical engineering application," Kwon said. "My group is one of the few groups in the chemical engineering space that has expertise in this field."

CrystalGPT and the hybrid crystallization model that integrates with CrystalGPT allow high-accuracy prediction of key process variables in the industrial crystallization process, Kwon said.

The current industrial process is not highly adaptive to various process disturbances or changes to product specifications. As a superior AI-based platform, CrystalGPT will have a huge impact on manufacturing better drugs for the American public.

The goal is not drug discovery, Kwon explained, but to focus on the manufacturing process of already discovered drugs. He hopes to design a manufacturing process that is cost-effective and allows precise control of drug properties.

"Since CrystalGPT can function as a highly accurate and speedy prediction tool, it can highly expedite the process of simulating a manufacturing process," Kwon said. "All of these activities result in heavy cost-savings for the drug development process. The exact numbers will vary with company and drug type."

Kwon said that improved drug manufacturing will mean cheaper production costs while still adhering to the high standards for quality set by the U.S. Food and Drug Administration.

"Given that currently in the U.S. there is a general concern for the increasing cost of life-saving and basic over-the-counter drugs, increased scale and efficiency in the drug manufacturing process will help in reducing the costs and increasing the quality of these drugs," Kwon said.

A key factor for better drugs is precise control of the specifications, such as crystal size and shape. These specifications can be improved using CrystalGPT by looking at the dominance of the efficacy, side effects, and potency of the drug.

CrystalGPT has shown enhanced system-to-system transferability across crystal systems and has been demonstrated for high-precision model prediction, along with being integrated with established chemical engineering principles to form AI-enabled hybrid models for implementation in the industry.

“CrystalGPT is the first such model that modifies the large language models to include a ‘time’ component to predict complex reactor dynamics,” Kwon said. “The inclusion of temporal dynamics within a transformer model has been performed by only a handful of researchers in this field, and this will be a pivotal development going forward.”

Because CrystalGPT is fully data-driven, Kwon said that to make it suitable for pilot testing and implementation it was combined with reactor models for crystallization. Kwon then developed an AI-enabled hybrid model that can estimate the hidden process kinetics of any given crystal system.

“This research is also highly relevant to the federal government and US DOE’s recent initiatives on AI,” Kwon said.

Its implementation could increase the economic competitiveness of U.S. industries and boost the welfare of the public, according to Kwon.

“From an advanced manufacturing perspective, CrystalGPT and its hybrid modeling sibling allow better prediction and control of industrial crystallization, thereby establishing a lead over other countries regarding the development of more efficient and precision-heavy processes,” Kwon said.

PIPELINE INTEGRITY AND MICROBIAL CORROSION RESEARCH EARNS BEST PAPER AWARD

Years of previous research are coming back into focus with Dr. Faisal Khan's risk-based pipeline integrity management work.

Because of the significance of the work, the Artie McFerrin Department of Chemical Engineering interim department head's *Science Direct* published article has recently been honored with the Best Paper Award by KeAi (a subsidiary of *Elsevier*) Publishing.

Originally published in 2021 in the *Journal of Pipeline Science and Engineering*, Khan said the paper presents a deeper understanding of the corrosion mechanism driven by microbial activities.

When research is published, KeAi monitors the use of the material, and based on the citation and the relevance of the research, they award the paper for being the most widely downloaded and used paper in the journal.

Khan's work attracted attention for its practical relevance to the field, resulting in the award. Typically, it takes four to five years for the researched work to become scientifically relevant, he said.

It is a recognition by subject matter experts on corrosion and pipeline engineering highlighting the impact of this work, Khan said.

“The work itself is applied and gets attention early on compared to other work,” he said. “The award highlights how certain published research is used by scientists and practitioners. This article provided a foundational understanding of localized corrosion damages ethics.”

According to the article, pipeline integrity is important for a sustainable future along with vital energy-transportation mediums of today’s energy-intensive economies.

“The paper analyzed data from a range of pipelines operated by major oil and gas companies for localized corrosion and especially the signature of microbially influenced corrosion,” Khan said.

Additional work came from Edison Sripaul, technical lab manager and safety officer for the chemical engineering department, who reviewed and wrote the paper’s energy carriers and storage section.

With his knowledge of safety, Sripaul explained the need to enforce safety measures in developing new technologies and processes aimed at achieving decarbonization.

“The goal is to control risks and introduce preventative and protective risk-reducing measures in the development of new technologies to meet decarbonization demands,” Sripaul said. “To demonstrate, hydrogen, whose hazardous properties are quite well known as it is already many decades in use as an energy carrier, but addressing the safety issues still in nascent stages is shown as an example.”

The ideal is inherently safe and sustainable products and processes, he said, as well as products that, by recycling, contribute to humanity’s benefit.

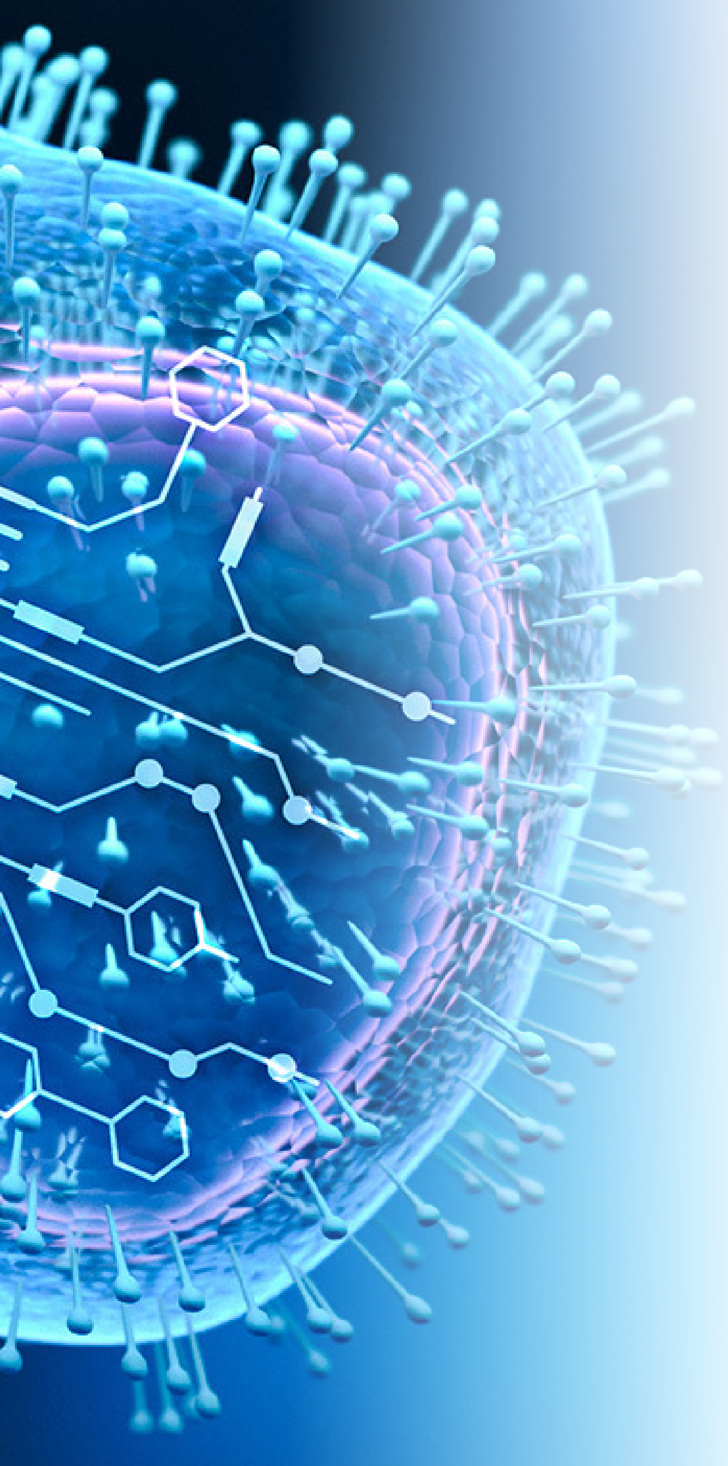
“The research aims to identify the intricacy of localized corrosion, especially microbial-influenced corrosion mechanisms and the mathematical formulation that best described its likelihood of occurrence and rate of growth,” Khan said. “The proposed mathematical formulations could be used to study localized corrosion in oil and gas assets, especially oil and gas pipelines.”

According to the article, pipeline integrity is tied to environmental, societal and economic failures if not handled properly. Khan’s research aims to capture the evolution of risk-based methods in integrity management, focusing on the last two decades.

“I hope this provides a deeper understanding of the localized corrosion-induced failures and how these corrosion mechanisms can be modeled in a probabilistic framework so that it helps in predicting and preventing failures,” Khan said.

This collaborative work was supported by Genome Canada and TU Delft Netherlands researcher Dr. Rioshar Yarveisy. This work was part of Dr. Yarveisy’s graduate work at Memorial University, Canada, under the supervision of Dr. Faisal Khan (former professor and Canada Research Chair Tier I at Memorial University, Canada) and Dr. Rouzbeh Abbassi of Macquarie University, Australia.

REVOLUTIONIZING CANCER TREATMENT THROUGH PROGRAMMABLE BACTERIA



What if a single one-dollar dose could cure cancer?

A multi-university team of researchers, supported by federal funding, is developing a highly efficient bacterial therapeutic to target cancer more precisely to make treatment safer through a single $1 dose.

Traditionally, cancer therapies have been limited in their efficacy in treating patients. Some, like radiation and chemotherapy, cause harmful side effects, while others tend to result in low patient responsiveness, not to mention the cost it takes to receive treatment. Findings from the American Cancer Society Cancer Action Network recorded that 73% of cancer survivors and patients were worried about how they were going to pay the cost of their cancer care, and 51% said they were in medical debt from treatment. For example, state-of-the-art cancer therapy can cost up to $1,000,000.

Texas A&M University and the University of Missouri are leading the effort to develop a low-cost, safe, and controlled cancer treatment. Researchers received a $20 million grant from the Advanced Research Projects Agency for Health(ARPA-H) to fight cancer. The four-year project is part of the current administration’s Cancer Moonshot initiative, an effort to advance and increase funding for cancer research. It is one of the first projects funded by the newly established agency that aims to accelerate better health outcomes for everyone by supporting the development of high-impact solutions to society's most challenging health problems.

Rapidly analyzing cells

$12 million of the grant will go to the Texas A&M Engineering Experiment Station/ Texas A&M, where co-principal investigators Drs. Arum Han, Jim Song and Chelsea Hu are developing synthetic programmable bacteria for immune-directed killing in tumor environments (SPIKEs). The idea is to engineer bacteria to help T cells kill cancerous tissue, destroy itself once the cancer is gone, and leave the body safely as human waste.

"SPIKEs can specifically target tumor cells," said Han, the Texas Instruments Professor in the Department of Electrical and Computer Engineering. "And since it's only targeting cancerous tissue and not the surrounding healthy cells, the safety of the patient is exponentially increased. It's a great honor to be on this team, tackling a major health problem that affects a lot of people."

Han's lab is developing high-throughput microfluidic systems that can rapidly process and screen massive bacterial therapeutic libraries, one cell at a time, to quickly identify the most promising treatments. These systems are enabled by integrating microfabrication methods and biotechnology to achieve a pico-liter-volume liquid handling system that can accurately analyze single cells with high precision and high speeds, creating devices to analyze individual cells quickly.

"The major challenge is figuring out how to actually develop these sophisticated microdevices that allow us to conduct millions and millions of fully automated tests with almost no manual or human intervention," Han said. "That's the engineering challenge."

Rescuing anti-tumor immune cells

While Han innovates and designs microdevices, Song — an immunologist with a background in microbial pathogenesis, T cell biology and T cell-based immunotherapy — has been working on bacteria immunotherapy for the past five years. A certain bacteria known as *Brucella Melitensis* can manipulate the microenvironment of the human body and promote T cell-mediated anti-tumor immunity to treat at least four types of cancers.

"We are working to improve B*rucella Melitensis* to more efficiently prevent or suppress tumor growth," said Song, a professor at the Texas A&M School of Medicine. "Our current approach involves finding out how to engineer bacteria to rescue anti-tumor immune cells, enhancing their effectiveness in killing tumor cells."

"Data so far shows that *Brucella's* efficiency is dramatically higher than other cancer treatments, such as Chimeric antigen receptor T cell therapy and T-cell receptor therapies, with a more than 70% responsiveness rate," Song said.

Safe and controllable therapeutics

While Song continues to test the bacteria's efficiency using cancer models, Hu, an assistant professor in the Artie McFerrin Department of Chemical Engineering and a synthetic biologist, is working to ensure the living bacterial therapeutic is safe and controllable.

"The *Brucella* strain we're using has been shown to be safe for the hosts because it is an attenuated version, meaning a key gene that is required for bacteria virulence has been deleted," Hu said. "Ultimately, we want to control the bacterium's rate of growth, where it grows within the tumor environment, and its ability to self-destruct when its mission is completed."

To control the growth rate, the bacterium's genes will be altered to regulate its population and oscillate around a specific setpoint. Hu also plans to engineer biosensors into the bacteria, enabling them to differentiate between healthy tissue and tumor tissues to ensure they grow only within the tumor microenvironment.

The bacterium will be engineered to have a receptor to ensure that once the cancer is gone, the patient can take antibiotics that will signal the bacterium to essentially cut itself into pieces and be removed safely from the patient's body.

"As humans, we're actually covered in bacteria, and a lot of diseases are caused by an imbalance in these bacterial communities," Hu said. "For instance, while some people have incredibly fragile stomachs, others have robust ones. The science behind it is that those people with strong immune and digestive systems have a healthy community of bacterial cells in their gut. There's a lot of potential in living therapeutics."

"It's a really great opportunity to have an incredible team who have expertise and can push this technology to the front line," Hu said. "So that sort of goal is to reach the clinic and provide patients with an effective cancer treatment at less than $1 per dose."

Attacking difficult issues using unconventional approaches

Other collaborators include Dr. Zhilei Chen at the Texas A&M Health Science Center and Dr. Xiaoning Qian in the Department of Electrical and Computer Engineering, along with the principal investigator, Dr. Paul de Figueiredo, from Missouri University.

"The three key advantages to this work are high safety, low cost and specific targeting of cancerous tumors," Han said. "We are very excited that we are one of the first teams that

are getting support from ARPA-H, which is a brand-new agency established and supported by Congress to really tackle hard problems in broad areas of health. We're attacking difficult issues using unconventional approaches. High risk, high impact is the hallmark of our approach."

And the future applications of engineering bacteria that this research unlocks are limitless.

> "For our next big project, we will work together to engineer bacteria against autoimmune diseases such as type 1 diabetes and rheumatoid arthritis," Song said. Bacterium-based immunotherapy represents a groundbreaking frontier in medicine, offering the potential to revolutionize the treatment of autoimmune diseases. With the power of beneficial microbes harnessed to modulate the immune system, we are on the verge of changing the future of medicine. Our research and expertise hold the promise of transforming the lives of millions of people, providing them with new hope and healthier tomorrows."

GIVING BACK: WHAT IT MEANS TO BE AN AGGIE

The annual Buck Weirus Spirit Award is given to 65 students in recognition of their leadership, involvement and positive impact while enhancing the core Aggie values. Chemical engineering doctoral candidate Ifeoluwa Babalola is one of this year's recipients.

Throughout her time at Texas A&M, Babalola has exhibited the Aggie Core Values of Excellence, Integrity, Leadership, Loyalty, Respect and Selfless Service.

"I am so excited and grateful for the opportunity to serve fellow Aggies, graduate students, future Aggies, and engineers," Babalola said.

Babalola came to Texas A&M in 2021 after receiving her master's degree in the Department of Chemical and Environmental Engineering at the University of Toledo in Ohio. When she arrived, she began fully embracing the community and looking for outreach opportunities.

"When I got here, I really enjoyed the Aggie community and wanted to share my vision and plans," Babalola said. "We really have a great community of students, and I was really motivated to start up the West African Graduate Student Association."

Another way she gave back to the Aggie community was by mentoring 20 junior high school students and facilitating science workshops for 12 elementary teachers in 2023 in collaboration with Spark! PK-12 Engineering Education Outreach (the K-12 STEM outreach of the College of Engineering).

"I am committed to raising the next generation of engineers and have offered my service in this regard," Babalola said. "I am intentionally looking at my hands to make an impact."

Volunteering to do the workshop resonated with Babalola, who is passionate about merging education and chemical engineering and encouraging future engineers.

"Facilitating a section of the workshop for the elementary science teachers and mentoring the junior high students resonates with my research interests and dreams," Babalola said. "This award was genuinely humbling because I did those activities out of passion and love for what I do."

Babalola's research ties into her work. Her studies in microfluidics revolve around chemical engineering education research. She describes it as bringing laboratory research into the classroom. Babalola has students do experiments in the classroom to incorporate active learning.

When Babalola graduates next year, she plans to stay involved with an alumni group to continue supporting STEM education and outreach.

"Through her dedicated efforts in crafting innovative, hands-on instructional tools, Ifeoluwa has not only significantly enhanced the learning experience in our classrooms but has also set a high standard of excellence for her peers," said Dr. Victor Ugaz, chemical engineering professor and Babalola's faculty advisor. "Her commitment to inspiring Aggies across all levels epitomizes the spirit of service and excellence we strive to foster in our department."

FELLOWSHIP AWARD
Energizes Efficient Research

Chemical engineering Ph.D. candidate Jenna Vito will receive the 2024 National Science Foundation Graduate Research Fellowship for her research in zeolite catalysis.

"There are a lot of professional development opportunities with this award, as well as networking," Vito said. "Overall, it's exciting and a pretty prestigious award."

Vito's goal is to work toward making industrial processes more energy efficient and adopt greener chemistry-related practices.

"Making those greener processes more economically feasible compared to the current processes we have now that aren't always super benign to the environment," Vito said.

Specifically, Vito's research focuses on how to design zeolite confined catalysts for selective hydrocarbon transformations.

"My project is looking at how we can deconvolute the steric and electronic effects that appear as a result of confinement," Vito said. "I use acetylene hydrogenation as a model reaction for this. I synthesize the catalysts and test them against controls to see the impact of parameters like acidity and pore size on reaction outcomes."

Vito's goal is to work toward making industrial processes more energy efficient and adopt greener chemistry-related practices.

Additionally, Vito extends this to studying kinetics and hydrogen activation to see how confinement affects this system on a molecular level.

Dr. Manish Shetty, a chemical engineering professor and Vito's faculty advisor, believes this fellowship will help Vito achieve her research goals and venture into more high-risk research areas.

The two components of the application are the research statement and the personal statement. Vito said that the personal statement holds tremendous weight regarding involvement in professional organizations, volunteering, outreach, and the ability to contribute to the scientific community at large.

Vito's community outreach involves motivating kids to be excited about engineering and science.

She volunteers with a campus program that offers a day camp for kids covering different engineering branches. She also brings STEM activities and experiments to the classroom to supplement students' learning.

"Jenna came to us with a great undergraduate background from West Virginia University," Shetty said. "In our group, she works on making industrial olefin production efficient with precise catalyst design. In and outside the lab, she has been a champion for safety, and has been actively involved with CheGSA and outreach activities through the Society of Women Engineers. Importantly, I hope this serves as a stepping stone for future academic and professional success."

ENGINEERING ALUMNI HONORED

WITH OUTSTANDING DOCTORAL DISSERTATION

Dr. Yuhe Tian is being honored with the Outstanding Doctoral Dissertation Award.

Tian was a Texas A&M chemical engineering doctoral student from 2016 to 2021. Her faculty advisor for her dissertation was Dr. Stratos Pistikopoulos, professor of chemical engineering. Tian will be receiving her award at The Foundations of Computer-Aided Process Design (FOCAPD) Conference.

FOCAPD is the premier international conference focusing exclusively on the fundamentals and applications of computer-aided design for the process industries. It allows the process design community to come together and discuss the biggest trends in the field from a big-picture perspective.

"Receiving very strong support from my advisor and also my committee members is definitely a great guide for my work," Tian said. "To receive this award is a testament to the high quality of the research we're conducting in the Texas A&M chemical engineering department."

The award recognizes Dr. Tian's outstanding contributions to the field with her Ph.D. research, which is oriented around a computer-aided process intensification framework. Process intensification offers the potential to substantially improve chemical and manufacturing processes with step changes in energy savings, cost reduction, and environmental impact minimization.

"What interested me most is that this research is built on a novel perspective to synergize generalized phenomena-based representation with state-of-the-art process optimization, thereby driving systematic process design intensification via computational discoveries," Tian said.

The holistic scope of the research aims to incorporate process safety and control considerations into process design, which is key for chemical process operations, particularly in the digital era, according to Tian.

"An integrated process and safety systems engineering approach, like the one developed by Dr. Tian, has the ability to deliver a process design that is cost-optimal, flexible, controllable and safe at the same time," said Pistikopoulos.

Pistikopoulos also explained that this type of AI-based method is becoming more relevant as we seek to safeguard systems and operations against unforeseen events in real time.

"We have taken this work to a level not only to perform computer-based simulations but also close-the-loop by performing experiments for validation, monitoring and further optimization," Pistikopoulos said.

Right after graduation, Tian joined the Department of Chemical and Biomedical Engineering at West Virginia University as an assistant professor. Winning this award is a great motivation for Tian to continue her work, she said.

Tian will continue her research with process intensification, along with developing new research areas for microwave-assisted energy production and safety-critical cyber-physical systems control.

"I am very proud of her; she went directly out of Ph.D. studies to an academic position, which is quite unusual," Pistikopoulos said. "That's a token of how good she is. It's a very competitive field, and getting an award from her peers is obviously something to be proud of."

MASTERS STUDENTS LOOK TO *LEVEL UP THEIR RESEARCH*

As a stepping stone to their future careers and someday world-changing research, 10 chemical engineering master's students from the Artie McFerrin Department of Chemical Engineering at Texas A&M University have received the 2023/2024 Francine & James Srygley '54 I Fellowship.

This year's students include Raj Panthesh Bhavsar, Jitendra Choudhary, Gladden Chukwu, Madeline Demny, Aovi Deshpande, Sayyam Deshpande, Jason Mangalidan, Suraj Panicker, Savanah Pas and Vignesh Shankar.

With research being a primary factor of the fellowship, each student described their field of study and the progress they have made with it.

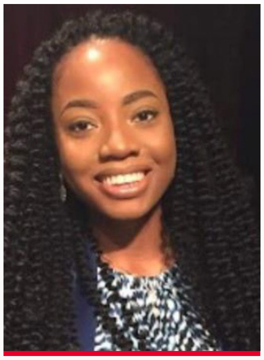
Raj Panthesh Bhavsar is an enthusiastic graduate student pursuing a master's degree in the Artie McFerrin Department of Chemical Engineering. He is keen on using the extensive resources available at the university to advance his research. He enjoys working on his thesis in Dr. Joseph Kwon's research lab, where he works on projects like microwave reactor modeling and optimizing the material design of the CO2 adsorbent that is used for Direct Air Capture Process. Bhavsar appreciates the support and camaraderie of his lab mates and values the support of his advisor in the journey of graduate school. He believes that research and the will to practice it sincerely go hand in hand.

Microwave reactor modeling is the focus of Bhavsar's research regarding modeling the adsorbent process for material design. Bhavsar said this project works on modeling microwave physics to design and optimize adsorbent material.

"The carbon dioxide is captured using the direct air capture process, wherein we directly capture carbon dioxide from the surroundings in the open environment," Bhavsar said. "Once the carbon dioxide is adsorbed, the tough task is to regenerate the sorbent that adsorbs CO2 (carbon dioxide) . Using microwaves helps in saving energy costs when compared to conventional heating for regeneration. Along with energy savings, this methodology of regeneration also prevents the adsorbent from material degradation."

After defending his master's thesis, Bhavsar plans on doing a deeper dive into his research and then using his technical skills in the chemical engineering industry after he gets his doctorate.

Jitendra Choudhary, a graduate student in chemical engineering under the supervision of Dr. Sreeram Vaddiraju, specializes in synthesizing nanowire foams and multifunctional shape memory composites for space and biomedical applications. He holds a B.S.-M.S. in chemical engineering with a minor in chemistry from IISER Bhopal, where he was recognized for outstanding academic performance with a proficiency gold medal. Choudhary has garnered prestigious accolades, including the Most Versatile Chemical Engineering Student in India for 2023 from IIChE, the Acharya P.C. Ray Award from IIChE and the Sir J.C. Bose Best Master's Thesis Award from ISEES in 2022.



Gladden Chukwu is one of the recipients of the Francine & James Srygley '54 Fellowship award. She completed her bachelor's degree in chemical engineering and mathematics from the Texas A&M University-Kingsville in 2019. She is currently in her first year of her master's degree in chemical engineering. Chukwu is passionate about energy, sustainability and learning new concepts and ideas. Her passion has stemmed her research interest in the degradation of plastics using biological materials. She is undertaking this research under Dr. Qing Sun.

Chukwu said the fellowship helped further her research but also gave her a better understanding.

"I knew that the fellowship was going to be very helpful in the next semester because that's when I'll be intensely focusing on my research," Chukwu said. "Having more time to focus has made me understand my research better. I had to meet with Ph.D. students in my lab and that really opened my eyes and gave me more insight into my fellowship."

Madeline Demny is a recipient of the Francine & James Srygley '54 III Graduate Fellowship. She received her bachelor's degree in chemical engineering from Texas A&M University and continued into graduate studies through the fast track master's program at Texas A&M. She is working with Dr. Phanourios Tamamis, an associate professor in the chemical engineering department. Demny's research interests include using computational methods to understand rules of life in protein folding and recognition of modified RNA. She has co-authored one paper and is a recipient of the Craig C. Brown Outstanding Senior Engineer Award.

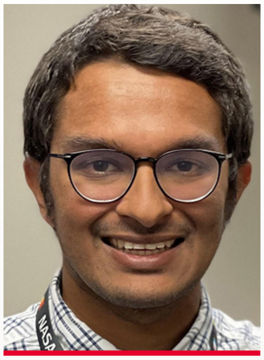
For Demny, the finances associated with the fellowship have allowed her to stay at Texas A&M to continue her research, which might not have been possible otherwise. She is considering staying in academia to share her knowledge with future researchers.

"My goal is to be a professor," Demny said. "I enjoy teaching, and I want to share the knowledge that I have of chemical engineering and be able to pass it on to the next generation."

Aovi Deshpande is currently pursuing my master's in chemical engineering with a focus on process systems optimization. Her current work revolves around resilience assessments for facilities and its integration in water, energy and food nexus. Her motivation for research in the field of technology scale up, process engineering and optimization originates from her passion for creating tangible solutions to real-world problems. She is driven by the prospect of applying scientific principles, conducting experiments and gathering data to uncover new insights to address critical issues, such as resource optimization, sustainability and process efficiency.

Depending on the project, Deshpande said she would consider continuing her education with a doctorate.

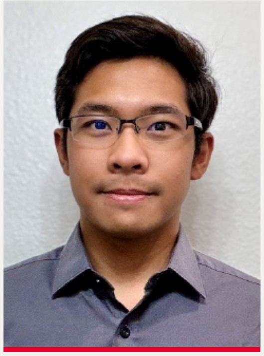
"If I get a Ph.D., I would like to go into industry," Deshpande said. "I personally would like projects on energy and process systems optimization. I'm really interested in the process of scaleups so picking technology from a lab scale to commercialization, that's something that really excites me."



Sayyam Deshpande received his bachelor's degree in chemical engineering at the University of Mumbai, India in 2021 and joined the chemical engineering master's program at Texas A&M in spring 2022. During his undergraduate studies, his research focused on wastewater treatment technologies and modified atmospheric packaging. He received the Francine & James Srygley '54 III graduate fellowship in fall 2023. His research now focuses on developing structural battery electrolytes for low-temperature applications in aircraft and spacecraft. He interned at NASA as a battery engineer in summer 2023 working on a battery safety-related project to enable the safe application of lithium metal anodes in pouch cells.

Deshpande's research also focuses on recycled plastic. Most specifically, the carbon nanomaterials from developing applications for industrial carbon nanotubes derived from sustainable sources.

"It's a dream of industry to take your mission products and develop them into something very usable for the environment and use them in electrochemistry," Deshpande said. "We've been able to develop a system that can operate safely at minus 40 degrees centigrade. We've been able to share great different compositions of a system in which we created a two-phase electrolyte."



Jason Mangalindan is the recipient of Francine and James Srygley '54 Graduate Fellowship. He earned his bachelor's degrees in chemical engineering and chemistry from Mapúa University, Philippines, and performed his undergraduate research at National Cheng Kung University, Taiwan. He then worked with the research and development team of a semiconductor company for three years before joining the chemical engineering master's program at Texas A&M in 2023. He is currently working in the Catalysis and Sustainable Technologies Laboratory under the supervision of Dr. Manish Shetty. Mangalindan's research focuses on the hydrogenation of carbon dioxide to dimethyl ether by utilizing bi-functional catalysts.

Suraj Panicker received his bachelor's degree in chemical engineering from Birla Institute of Technology and Science Pilani, Hyderabad in 2021. He joined Texas A&M as a master of science student in fall 2022. Since then, he has been a part of Dr. Manish Shetty's research group. His research aims to provide a potential solution for the problems faced with the disposal of plastics by taking an alternate route of establishing a sustainable circular plastic economy where polymer chains can be broken down into useful smaller chain alkanes. Apart from this, he has also interned at Siemens Energy, where he worked on designing pressure relief valves and analyzed relations between feed properties in specific cases of overpressure scenarios.

"My research is in the field of catalysis," Panicker said. "This work involves upcycling plastics in a way to convert plastics into more useful products. Obviously, plastic is one of the biggest problems today, and how we convert them into useful products, and how we can do this effectively by utilizing the cobalt catalyst system in this. This will help in the recycling process."

Savanah Pas received her bachelor's degree from Texas A&M in December 2022 in chemistry and applied mathematics and joined the master's program in spring 2023. She is working with Dr. Micah Green in the chemical engineering department. Pas' research interests include synthesis of Ti MXenes and their applications. Pas was an intern at Texas Instruments in summer 2023 as a process engineer.

The variety of the students' research expands to 2D nanomaterials from Pas, who is currently working on 2D Carbon transition metal materials called MXenes.

"These properties of both carbon and the transition metal specifically, the one we look at most of the time is titanium," Pas said. "We're looking at how the properties can be used in industrial applications, specifically electrochemical applications, and looking at the degradation over time and analyzing how we can prevent degradation of materials."

Pas also acknowledged how the fellowship opportunity has given her more time in the lab for her research, allowing more time for characterization and analysis.

Vignesh Shankar is a researcher at Texas A&M, co-advised by Dr. Micah Green and Dr. Benjamin Wilhite. His passion lies in advancing the energy transition to cleaner sources, particularly green hydrogen. His work includes a groundbreaking master's thesis on laser-induced graphene for selective separation of hydrogen gas. He also had an impactful internship as an electrolyzer cell development co-op at Electric Hydrogen.

Additional research from Shankar includes a focus on the selective separation of hydrogen gas using Laser Induced Graphene (LIG) membrane technology.

Ultimately the aim of Shankar's research is to contribute to the scaling up of industrial blue and green hydrogen production, he said. In ongoing work, Shankar plans to explore the selectivity of hydrogen gas in the presence of higher multi-component gas mixtures.

With the recognition from this award, Shankar believes it could significantly impact his career trajectory along with enhanced research opportunities.

"As more people become aware of my work, my opportunities for career advancement and research funding may increase. The recognition can open doors to research opportunities that might not have been available otherwise contribute to the expansion and diversification of my research portfolio," Shankar said. "It signifies that my research is of high quality and has the potential to make a significant impact. It demonstrates that experts in my field recognize the value and potential of my work."

STUDENTS PARTICIPATE IN **NASA'S ANNUAL MITTIC COMPETITION**

In NASA's annual MITTIC Competition, students pick one of NASA's patents and create a product or service with commercial applications.

After a successful first round in the competition, Dr. Sreeram Vaddiraju and a group of chemical engineering students presented their version of one of NASA's patents at Johnson Space Center for round 2. Team members include Arda Arikan (team lead), Sohaib Attalla, Amy Delgado, and Aarya Patel.

After finding out about the competition through Students for the Exploration and Development of Space, Attalla said the team believed it was an opportunity to expand their knowledge and test their skills.

In phase 1 of the competition, the team selected a patent and submitted a proposal for their product. The team used a NASA patent that would help farmers recycle water and extract important contaminants from it, such as fertilizer and ammonia, Attalla said. This process was designed to be simple and cost-effective.

One of the problems with ammonia is that it's in fertilizer that people put on their lawn, and when it rains it causes runoffs in the water supply. When fertilizer is used in agriculture, it causes bigger runoffs.

"The idea they had is a patent to remove ammonia in water and urine in space," said Dr. Sreeram Vaddiraju, associate professor of chemical engineering and advisor for the team. "When you take ammonia and water, how do you remove the ammonia and immediately reuse the water, that's the question."

A closed system would give the team the ability to clean and reuse the water and lessen the runoff, Vaddiraju said. This patent was developed for that application and the team plans on transferring it to a terascale application.

For the second phase of the competition, the teams gave a virtual preliminary pitch review before delivering their final presentation at the Johnson Space Center. While there, they experienced the NASA facility tours, a poster session, and networking opportunities with NASA employees, business partners, and subject matter experts.

The experience was a way for the students to understand what NASA does and how the technology it develops can be used in other ways than space exploration.

"The opportunities this gave the team were not only the chance to tour the actual JSC, but we were also able to meet teams from across the country, NASA employees themselves, and just learn new skills throughout the process," Attalla said.

Although the team did not make it past the second round, they received high praise for their project, and they have plans for prototyping and working on it with potential investors, Attalla said.

"This competition was the first major extracurricular activity I did since college started, and I'd love to have more people sign up for it because it really is a wonderful experience," Attalla said. "Get a team together, research an idea, write the proposal up and you'll have a wonderful chance to have the same experience we had.

2023 ANSYS PARTICLE TECHNOLOGY FORUM SERVICE AWARD

RECOGNIZING A LIFETIME OF CONTRIBUTIONS TO PARTICLE TECHNOLOGY

Industrial Advisory Board member and former visiting professor, Dr. Bruce Hook is the 2023 Ansys Particle Technology Forum Service Award winner from the American Institute of Chemical Engineers.

This award recognizes a forum member's lifetime outstanding scientific/technical contributions, as well as leadership in promoting scholarship, research, development, service and/or education in the field of particle technology.

Hook joined the Artie McFerrin Department of Chemical Engineering advisory council in 2023. His goal is to support the mission of providing the best education and research possible by speaking with students and faculty and working to influence positive change within the department and college.

"Dr. Hook has represented Texas A&M well through his leadership both in industry and in AIChE, and it is exciting to see that he is being recognized for that leadership," said Dr. Faisal Khan, interim department head. "We also sincerely appreciate his continuing work with our department as a member of our advisory board."

Hook has been a visiting professor in the department twice, in 1998 and 2010, teaching a particle technology class. He also helped recruit Texas A&M students for Dow Chemical during his 30-year career with the company.

“Dr. Hook exemplifies the kind of leadership and excellence that Aggie chemical engineers bring to industry,” said Dr. Micah Green, associate department head of external engagement. “He has also been a great ally of the department by collaborating in research and recruiting.”

Hook has been active with AIChE programming for most of his career by serving on committees and as chair/co-chair at sessions for over 25 of the last 34 annual meetings.

He has also received 23 granted patents, several peer-reviewed publications and given over 20 presentations at conferences or invited talks. He is also an elected industrial liaison to the Particle Technology Forum (PTF) executive committee. The PTF is a global organization that brings researchers in the particle technology space for various manufacturing industries together and aligns with AICHE.

At Dow, Dr. Hook focused on process development and process improvement for a variety of chemical processes, many dealing with particle technology.

“Particle technology is an area that continues to be underserved by most chemical engineering departments because of little instruction on material handling, storage, and transport of solid materials, which behave very differently from gasses and liquids,” Hook said.

Hook said most challenges with new plant startups and many operational issues with existing plants are due to solids handling or particle technology issues. Often, plants can lower production costs and become more efficient with more reliable plant designs, which require fewer interventions, he said.

“We do a lot of work on making plants more efficient, increasing capacity for existing plants with minimal capital infusion,” Hook said. “Most of our environmental opportunities for the future will ultimately be solved by applying some form of chemical engineering principles.”

Hook has 40 years of research and development and process design experience, including work in process optimization for new product development, process scale-up, particle engineering, particle coating fluidization, pneumatic conveying and solids handling. He has also contributed to drying and storage, modeling gas-solid hydrodynamics, multiphase and heterogeneous reactor modeling and design, catalyst development, and reaction kinetics for heterogeneous catalytic systems.

> “It’s a recognition of years of helping. Particle technology areas that have those problems and that was one of the reasons why this study was important,” Hook said. “The field is constantly expanding and finding new ways to be applied and to innovate to make our world a better place to live.”

IMPROVED ENERGY:

CHARGED IN SECONDS, POWERED FOR DAYS

Amid the growing demand for renewable energy storage solutions, there is a pressing need to enhance the performance of electrochemical devices such as batteries. These devices are often slow to charge and may pose environmental and safety concerns.

Dr. Abdoulaye Djire, a chemical engineering professor at Texas A&M University, alongside chemical engineering undergraduate student James Kasten, is pioneering the development of new materials for improved energy storage.

This endeavor marks the initial phase toward realizing a new generation of energy storage devices that combine the benefits of current technologies while addressing their limitations.

Djire's team focuses on a compound known as MXenes, which could be a compelling alternative to conventional lithium-ion batteries. Specifically, they are exploring the promising advantages of nitride MXenes.

"In this article, we demonstrated high electrochemical charge storage in $Ti4N3Tx$ nitride MXene using aqueous electrolytes," Djire said. "We hope this work paves the way to the development of energy storage devices that can be fully charged within seconds and that can last for days."

The team's research underscores the potential of nitride MXenes to serve as a dependable option for energy storage devices, with applications spanning from small electronics and large-scale grid storage to electric vehicles.

Djire emphasizes that the long-term objective of advancing energy storage technology is to achieve rapid charging and extended lifespan.

"There's a lot of work that remains to be done prior to the full realization of this energy storage technology," Djire said. "This is the first step of more exciting research that we're going to be doing here at Texas A&M."

Moving forward, the team plans to continue studying the charge storage mechanisms of the nitride MXenes to optimize their performance to meet future energy storage demands.

Djire anticipates that their ongoing research will have a significant impact across various domains reliant on energy storage solutions.

In acknowledgment of their collaborative efforts, the team extends gratitude to other contributors, including Ben Hsiao, Denis Johnson, Bright Ngozichukwu, and Ray Yoo from the Djire lab, as well as Seungjoo Lee and Dr. Ali Erdemir from the Department of Mechanical Engineering at Texas A&M.

ENGINEERING PROFESSORS TEAM UP TO MEASURE MECHANICAL STRESSES AND STRAINS

Texas A&M University researchers have discovered that when charging a supercapacitor, it stores energy and responds by stretching and expanding. This finding can be used to design new materials for flexible electronics or other devices that must be both strong and store energy efficiently.

Dr. Jodie Lutkenhaus, associate department head of internal engagement and chemical engineering professor, collaborated with Dr. Dimitris Lagoudas, professor of aerospace engineering and Dr. James Boyd, associate professor of aerospace engineering in a new paper published in Matter.

“We measured stresses that developed in graphene-based supercapacitor electrodes and correlated the stresses to how ions move in and out of the material,” Lutkenhaus said. “For example, when a capacitor is cycled, each electrode stores and releases ions that can cause it to swell and contract.

Lutkenhaus said this repeated motion can cause the build-up of mechanical stresses, resulting in device failure. To combat this, her research looks to create an instrument that measures mechanical stresses and strains in energy storage materials as they charge and discharge.

This instrument offers insights into measuring the mechanical behavior during an electrode’s charging and discharging, which can be challenging to observe in real-time.

“We are pioneering experimental methods to measure the simultaneous electrochemical and mechanical response of electrodes,” Boyd said. “Our research is now moving from supercapacitors to batteries.”

Mechanical damage limits the cycle life of batteries, so new hardware and models are needed to interpret experimental measurements to separate the effects of mass diffusion, reactions, inelastic deformation and mechanical damage.

Batteries and capacitors can fail through the different effects of internal and external mechanical stresses. Internal stresses occur when batteries develop a repeated cycling of the device, while external stresses can result from impact or penetration of the device.

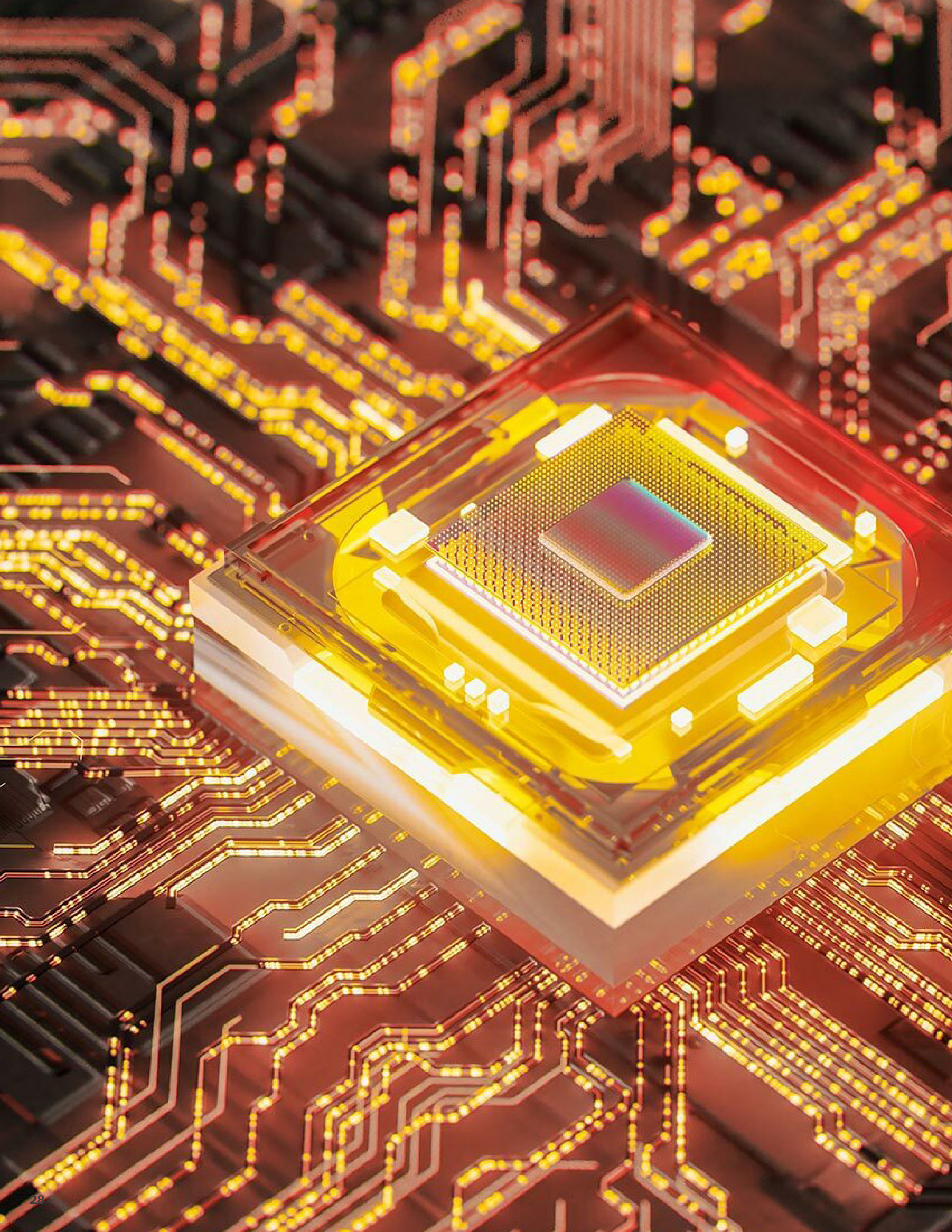
When these stresses happen, the battery needs to be able to withstand the damage. Lutkenhaus said it’s important to understand how mechanical stress develops in the electrochemical state of the device.

“We developed an instrument that can do just that, “ Lutkenhaus said. “By gaining this critical insight, we might be able to design safer energy storage devices that will last longer.”

The research aims to develop energy storage devices that can bear structural loads and eventually replace carbon-fiber reinforced plastics that act as structural panels in aircraft, thus improving energy efficiency.

“This article is the outcome of an ongoing collaboration between chemical engineering and aerospace engineering scientists,” Lagoudas said. “This research provides a unique understanding of how nanomaterials can be used for lightweight and strong energy storage devices for aerospace applications.”

This research was supported by the Air Force Office of Scientific Research.



TEXAS A&M BLAZES TRAIL IN
SEMICONDUCTOR EDUCATION AND TRAINING

From powering mobile phones to safeguarding national defense, semiconductors have become increasingly vital in today's world. The growing demand for skilled professionals calls for semiconductor training.

Starting in Fall 2025, Texas A&M University's Department of Electrical and Computer Engineering will introduce a new Master of Science program focused on microelectronics and semiconductors. This program will blend digital and analog integrated circuit design with semiconductor manufacturing, ensuring students are proficient in both areas and can collaborate effectively between design and fabrication processes. The development of this program is made possible by a $1 million gift from Samsung Austin Semiconductor.

Before its launch, the program must receive approval from the state's Higher Education Coordinating Board and undergo authorization within Texas A&M University.

"We at the Texas A&M System recognize the importance of a highly educated workforce that understands microelectronics and semiconductors," John Sharp, chancellor of the Texas A&M System, said. "I think you will see Aggies leading the way as the country increases the amount of domestic semiconductor manufacturing."

Learn more about the federal funding supporting the semiconductor industry in Texas.

The new degree is in addition to the semiconductor efforts already underway within The Texas A&M University System. The Texas A&M System is at the forefront of semiconductor research and training, establishing the Texas A&M Semiconductor Institute in May 2023 to focus on the need for trained semiconductor professionals and coordinate efforts in response to federal and state CHIPS initiatives. The institute, in conjunction with the Texas A&M Engineering Experiment Station (TEES), is committed to collaborating with semiconductor companies, coordinating system member research and fostering workforce training.

Also, beginning in Fall 2024, electrical and computer engineering will offer three certificates to address the state and national need for trained experts in the field of semiconductors. The certificates are in response to the 2022 U.S. Congress CHIPS and Science Act, a strategic approach for the country to be a leader in domestic manufacturing, create more employment opportunities, fortify supply chains and accelerate future research directions.

"As the demand for semiconductor expertise rises, we remain committed to training the next generation of skilled professionals in this critical sector," said Dr. Robert H. Bishop, vice chancellor and dean of engineering and director of TEES. "Through collaboration with industry partners and the Texas A&M Semiconductor Institute, we are poised to make significant strides in semiconductor research and education."

The certificates include digital integrated circuit design, semiconductor manufacturing and electromagnetic fields and microwave circuit design.

The digital integrated circuit design certificate will be for graduate students in electrical and computer engineering and focus on the design stage of digital integrated circuits (IC). These are circuits designed to perform specific tasks, like signal processing and machine learning computing. After the design stage, the corresponding IC chips are fabricated by the manufacturer.

The semiconductor manufacturing certificate will focus on manufacturing semiconductor chip products and will be offered to electrical and computer engineering undergraduate and graduate students. Students will learn the process by which devices or chips are created, including photolithography (layering transistors and metal wires on silicon wafers), assembly and packaging.

The electromagnetic fields and microwave circuit design certificate will be for any engineering or science graduate student who wants to focus on high-frequency circuit analysis, design and implementation.

"We have proposed new certificates related to semiconductors given the growth of the industry as well as insufficient workforce development," said Dr. Jiang Hu, a professor in the electrical and computer engineering department.

The Artie McFerrin Department of Chemical Engineering will offer a safety in semiconductor processing certificate, which will be available to all engineering and science graduate students. This certificate will be integrated with the Mary Kay O'Connor Process Safety Center. The center's primary role is to spearhead the integration of safety principles into chemical, oil and gas processing and, now, semiconductor manufacturing and energy transition.

"This certificate program gives engineers a new tool to add to their existing portfolio so they can learn how to safely deal with chemicals and processes in the semiconductor manufacturing sector," said Dr. Sreeram Vaddiraju, an associate professor in the Artie McFerrin Department of Chemical Engineering.

The electrical and computer engineering and chemical engineering departments also have two additional certificates in the planning stages: chip design verification and analog chip design.

The integration of the Master of Science degree, certificates and training programs in microelectronics and semiconductor manufacturing serves to bolster the entire spectrum of semiconductor companies in Texas, including GlobalWafers, Samsung Austin Semiconductor, Texas Instruments, NXP, Maxim, Silicon Labs, Cypress and more.

RESEARCHER RECEIVES GRANT FOR WORK ON PHASE SEPARATION

Chemical engineering professor Dr. Jeetain Mittal has received a National Institutes of Health grant to support his work on phase separation.

Mittal's research focuses on developing a multiscale computational framework to investigate the role of phase separation in biology, particularly in the formation of heterochromatin. Heterochromatin condensates are membraneless organelles that help control gene expression.

A key aspect of the proposal is the role of phase separation in chromatin organization, highlighting the need for new models in this area. Mittal's strategy aims to elucidate the molecular origins of phase separation using innovative models and methods tailored to relevant phase separation systems.

According to Mittal, this research could lead to insights into neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, amyotrophic lateral sclerosis (ALS), and frontotemporal dementia. The proposed work aims to develop and utilize multiscale computational methods, from the atomic to the mesoscale level, to build a molecular mechanistic framework.

"In the context of heterochromatin, you're dealing with tightly controlled gene expression," Mittal said. "This process involves the phase separation of proteins and nucleic acids, which helps form these membraneless compartments."

Phase separation plays a role in diverse biological processes and can explain longstanding questions related to cellular organization. The first part of the project will focus on the phase separation of RNA-binding proteins and their role in DNA damage repair and transcriptional condensates formed by fusion oncoproteins.

The team aims to decipher the relationships between amino acid sequence, phase behavior, condensate dynamics, and biological function to leverage phase separation for synthetic biology and understanding cellular function and dysfunction.

The second part of the project will provide a detailed molecular picture of phase-separated protein assemblies in chromatin organization, focusing on the co-phase separation of the heterochromatin protein family.

This research changes the way scientists think about biological organization and can predict which biomolecules or proteins will form membraneless organelles. By building and using computer models, the proposal aims to simulate the process of phase separation in a controllable way, expanding the scope of these models.

Mittal believes that a combination of computer modeling and experimental techniques such as NMR, microscopy, and microrheology can provide the best path toward uncovering the relationship between amino acid sequence and phase separation. The ultimate goal is to push the boundaries of what is possible, gaining insights that will help discover new therapies and bridge the gap between macroscopic observations and macromolecular phase separation.

TEXAS A&M UNIVERSITY

Artie McFerrin Department of Chemical Engineering