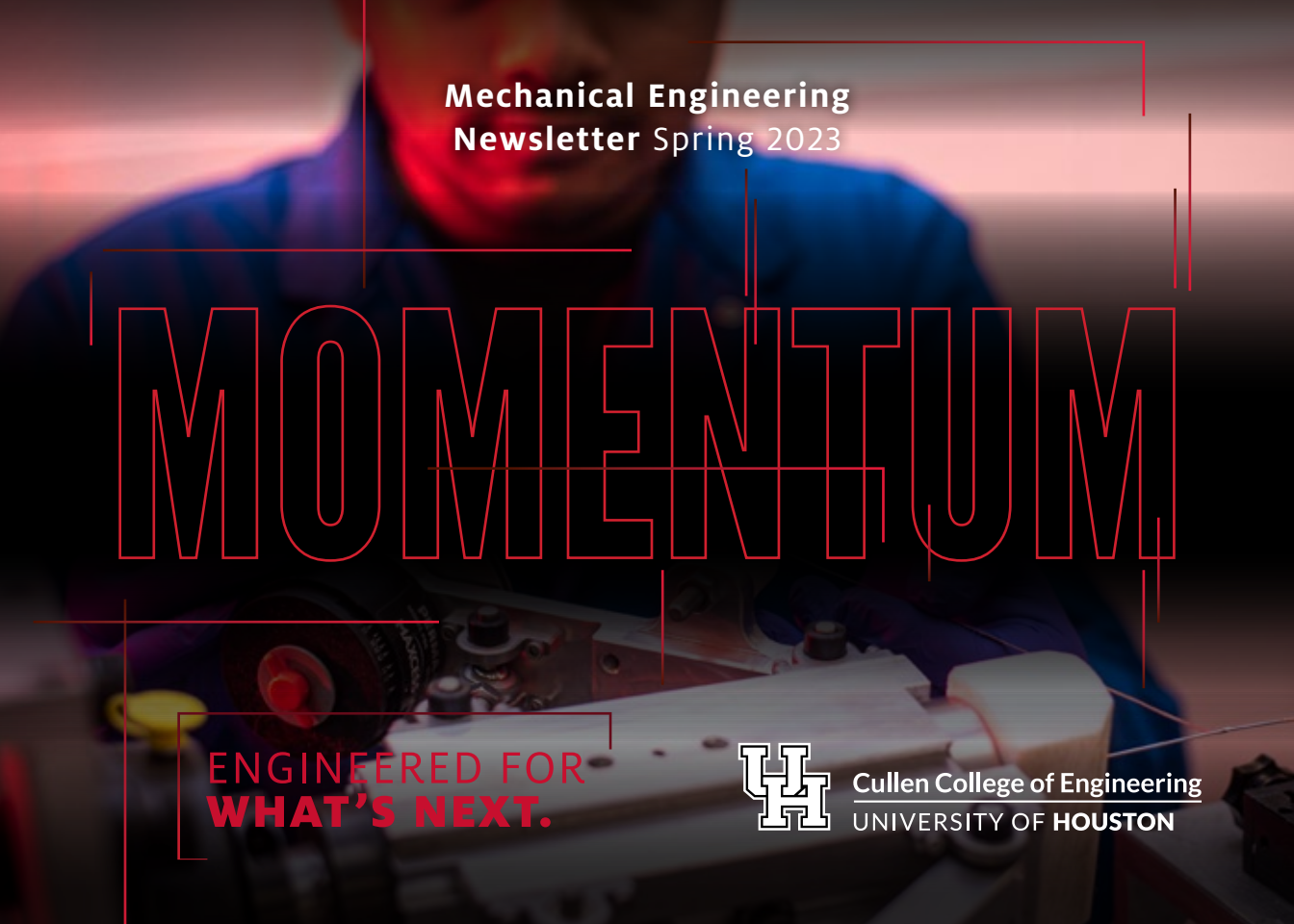


Mechanical Engineering
Newsletter Spring 2023

MOMENTUM

ENGINEERED FOR
WHAT'S NEXT.

Cullen College of Engineering
UNIVERSITY OF **HOUSTON**

Letter from the Chair

Dear Colleagues,

Greetings! I hope you are well. I am delighted to share some of the highlights and accomplishments of the UH Mechanical Engineering department's esteemed faculty and industrious students. There are many exciting developments in progress in our department, and I invite you to come visit us in person when you can. When we collaborate, we have the potential to make great strides in innovation.

Warm Regards,

Pradeep Sharma, Ph.D.
Hugh Roy and Lillie Cranz Cullen Professor and Chair
Mechanical Engineering
Cullen College of Engineering
University of Houston

UH ME **BY THE NUMBERS**

FACULTY *(FALL 2022)*

4 NATIONAL ACADEMY OF ENGINEERING MEMBERS

2 NATIONAL ACADEMY OF INVENTORS FELLOWS

1 NATIONAL ACADEMY OF INVENTORS SENIOR MEMBER

ENROLLMENT *(FALL 2022)*

1021 UNDERGRADUATE STUDENTS

504 GRADUATE STUDENTS

LEARN MORE ABOUT ME PROGRAMS:
www.me.uh.edu

DEGREES AWARDED *(FALL 2022)*

204 B.S. **53** M.S. **27** PH.D.

FACULTY

ACCOLADES

YASHASHREE KULKARNI

Yashashree Kulkarni, Bill D. Cook Professor of Mechanical Engineering and Director of Research Computing for the Cullen College of Engineering, has earned the prestigious BRITE award for about $410,000 as well as another $266,000 grant for collaborative research from the National Science Foundation.

The BRITE award is for Kulkarni's research on developing "An Integrated Theory of Continuum and Statistical Mechanics of Active Soft Matter." The second grant is for her collaborative research on "Interface Enabled Plasticity In High-Strength Co-Based Intermetallics."

The BRITE award focuses on active biological membranes. Biological membranes are interfaces that separate cells from their environment and naturally play a crucial role in processes such as mechanical response of cells, transmission of messages through electro-chemical signals, or exchange of nutrients. To date, most mechanics-based studies have treated biological membranes as "passive" (or "dead") since they are believed to fluctuate due to thermal vibrations of molecules only. Kulkarni's research will focus on understanding the mechanics of membranes that are "active" (or "alive") and which exhibit fluctuations using their own energy sources. This will possibly pave the way to better understand, control, and even mimic active biological matter for biotechnology and healthcare applications.

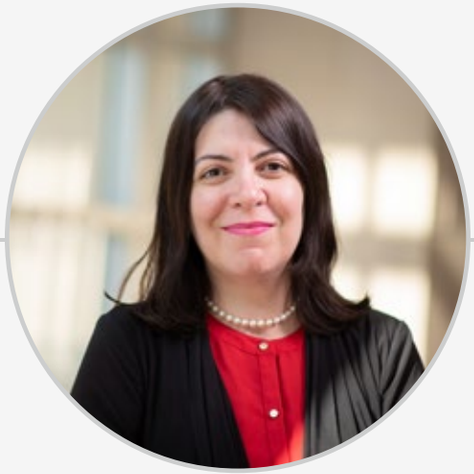
Her second grant focuses on intermetallics and is a collaboration with Xinghang Zhang, Professor at Purdue University's School of Materials Engineering. With their remarkable properties of high mechanical strength and high melting temperatures, intermetallics are excellent candidates for next-generation structural applications that can transform the nation's defense systems and industries like aerospace, automotive and energy. However, conventional intermetallics are very brittle at room temperature, which adversely impacts their potential as structural materials.

Integrating atomistic simulations and experiments, Kulkarni and Zhang aim to understand the mechanical behavior of nanocrystalline intermetallics with a novel core/shell architecture that endows them with simultaneous high strength and unprecedented deformability at room temperature.

FACULTY

ACCOLADES

HALEH ARDEBILI



Haleh Ardebili, the Bill D. Cook Professor of Mechanical Engineering and the Director of the Cullen College of Engineering Innovation and Entrepreneurship Program, has been named a Fellow of the Society of Engineering Science (SES).

The SES Fellow honor is highly selective and recognizes members of the society who have contributed significantly to the activities of the SES and who have had a major impact on the advance of the engineering sciences by independent, original research or who have rendered some other exceptional service to the cause of the sciences. She will be officially recognized at the annual SES meeting in October 2023 in Minneapolis.
Ardebili performs research in the broadly defined area of materials for energy storage and has made several impactful contributions to the development of stretchable and flexible lithium-ion batteries that may even be integrated in clothes and wearable devices.

"I feel very honored and humbled for this recognition by my scientific community," Ardebili said. "The support of my department, college, students and colleagues is what has made this possible."

Ardebili joined the Cullen College of Engineering in 2010. In 2018, she was appointed as the Director of Innovation and Entrepreneurship Program. She is an author of two books and created 19 radio episodes of "Engines of Our Ingenuity." She currently serves as an Associate Editor for the ASME Journal of Applied Mechanics, and she is the recipient of several awards, such as the Abraham E. Dukler Distinguished Engineering Faculty Award and the W.T. Kittinger Teaching Excellence Award.

NEWLY FUNDED RESEARCH

Pictured: *Hadi Ghasemi*

MECHANICAL ENGINEERING

$500K GRANT AWARD

TO EXPAND THIN-FILM COOLING RESEARCH

Hadi Ghasemi, Cullen Associate Professor of Mechanical Engineering, has earned another significant, six-figure award to expand his research into cooling the high-temperature and hot-burning machines that now power modern life.

The Office of Naval Research awarded a $500,000 grant to Ghasemi for his proposal, "Physics-informed machine learning-driven hierarchical structures for thin-film cooling."

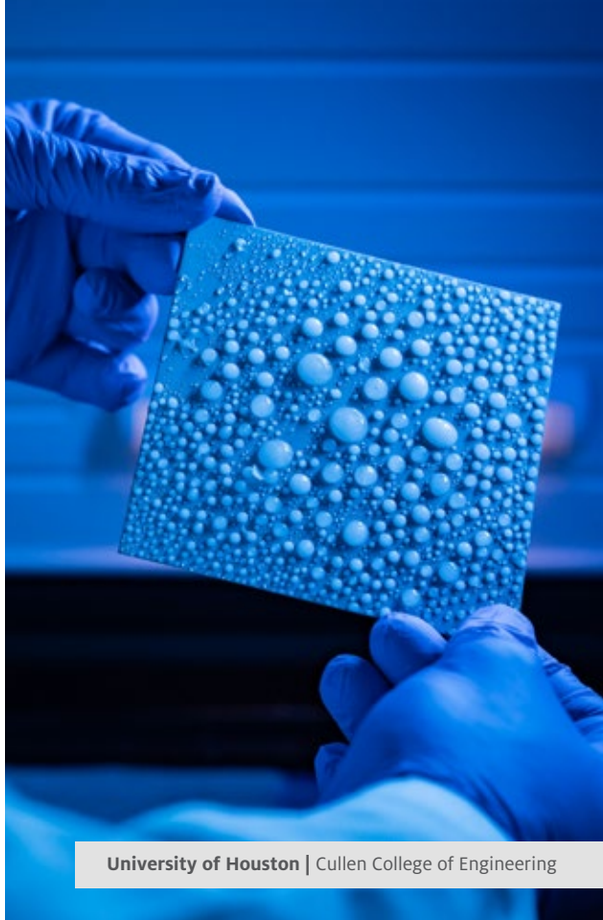
Ghasemi said that this would be new research. His ongoing work on "icephobic" coatings has attracted multiple funding sources, including a $750,000 grant in March 2021 from the Air Force Research Laboratory. *Elemental Coatings* is the business entity for Ghasemi's commercial applications.

According to an abstract written by Ghasemi, he highlights the need for more efficient cooling structures for the advancement of power generation, electronics, photonics, battery modules for electrical vehicles and other applications.

"In this program, we plan to address this long-standing challenge by providing a new platform to discover high-performance micro/nano/molecular structures for thin-film evaporation and to understand the physics behind these high-performance structures," he wrote. "Through a comprehensive physic-informed machine-learning (ML) platform, we aim to predict heat transfer characteristics of a material structure before fabrication and experimentation. The governing variables on heat flux including geometrical dimensions of the material structure and properties of the working fluid will be determined."

He added, "Through optimization, we will find the optimal material structures for each working fluid. These structures will be fabricated and experimentally tested to validate this new platform. Furthermore, this platform enables us to reveal new fundamentals of liquid-vapor phase change at nano/molecular scales including the role of interface curvature on mass flux, wetting characteristic and momentum transport in confined geometries."

The research will span about three years, from December 2022 through November 2025.



University of Houston | Cullen College of Engineering

Pictured: *Bo Zhao, Kalsi Assistant Professor of mechanical engineering, and his doctoral student, Sina Jafari Ghalekohneh*

MECHANICAL ENGINEERING

NEW DISCOVERY BREAKS **SOLAR HARVESTING EFFICIENCY RECORD**

A University of Houston professor is continuing the historic quest, reporting on a new type of solar energy harvesting system that breaks the efficiency record of all existing technologies. And no less important, it clear the way to use solar power 24/7.

"With our architecture, the solar energy harvesting efficiency can be improved to the thermodynamic limit," reports **Bo Zhao**, Kalsi Assistant Professor of mechanical engineering and his doctoral student **Sina Jafari Ghalekohneh** in the journal *Physical Review Applied*. The thermodynamic limit is the absolute maximum theoretically possible conversion efficiency of sunlight into electricity.

Finding more efficient ways to harness solar energy is critical to transitioning to a carbon-free electric grid. According to a recent study by the U.S. Department of Energy Solar Energy Technologies Office and the National Renewable Energy Laboratory, solar could account for as much as 40% of the nation's electricity supply by 2035 and 45% by 2050, pending aggressive cost reductions, supportive policies and large-scale electrification.

JOURNAL PUBLICATION

ME'S FLORYAN FINDING SIMPLICITY
WITHIN COMPLEXITY

A University of Houston professor is reporting a new method to describe complex systems with the least number of variables possible, sometimes reducing the possibility of millions to a minimal amount, and just one on rare occasions. It's an advancement that can speed up science with its efficiency and ability to understand and predict the behavior of natural systems, and it has implications for speeding up an array of activities that use simulations from weather forecasting to production of aircraft.

"In the example of the grandfather clock, I can take a video of the pendulum swinging back and forth and from that video, automatically discover what is the right variable. Accurate models of system dynamics enable deeper understanding of these systems, as well as the ability to predict their future behavior," reports **Daniel Floryan**, Kalsi Assistant Professor of Mechanical Engineering, in the journal Nature Machine Intelligence.

Pictured: *Daniel Floryan*

OUTSTANDING JUNIOR, ME'S LEE BALANCES BUSINESS, ACADEMICS

Pictured: *Jakob Lee*

Juggling assignments and managing responsibilities isn't anything new for **Jakob Lee**, the Outstanding Junior at the Cullen College of Engineering for 2022-23. After all, you learn a thing or two about schedule and personality management when you're running your own business.

After his freshman year in 2019-20, the Mechanical Engineering student became the owner and operator of Surfside Beach Lawn Service in July 2020. The business services more than 200 commercial and residential properties, and Lee manages three employees.

"Freshman year, I didn't have any source of income as a student, and I was struggling to pay for gas to get to and from campus, so I decided to get a summer job," Lee said. "I was cutting grass full time for a guy in his 60s who was basically ready to retire. Within three months of working for him, I was running everything. He came to me saying he wanted out."

Becoming a business owner in their late teens or early 20s would be intimidating to some. But Lee knew he had the work ethic and skills to not just take over the business, but to help it thrive.

"We wrote up a contract, and I purchased the company with a loan. Since then, I was able to expand the company to about 250 percent of what it was when I purchased it and paid back the loan while maintaining full-time enrollment. I think there's an obvious comparison between my dedication for school and work. I have never been one to half-ass anything, so when I took over the company I did it head on, while never sacrificing my grades in school."

He attributes the development of his work ethic to his experiences growing up.

"I think back to my weekends as a child. My stepdad would wake up early and we'd spend the entire day outside doing yard work," Lee said. "Taking the day off was never an option. Starting at about 15, my mother and stepdad both worked in offshore oil and would be gone for months at a time. I think because of this I've always had a very 'sink or swim' mentality."

With a parent offshore, it meant that Lee was asked to take care of more of the household chores than some of his peers, which he said made him mature fast. However, this in turn made him confident he could handle the workload of a business, and he's gotten more comfortable with three years under his belt.

"Learning to operate a business was extremely stressful, let alone while still in college. I finally feel as if the fruits of my hard work are finally in harvest as I get to relax and focus on school while my company supports all of my financial endeavors."

Lee hasn't just survived a challenging course load, he's thrived while completing it. He has been a member of the Dean's List for his entire time at UH, and attributed his success to his support network.

"I would like to shout out my wonderful girlfriend Grace for always supporting my decisions and growth, and my brother Jr. for convincing me to never give up on my company no matter how hard it got," he said. "My mother and step-dad helped me financially at the beginning of the company, and so did my grandmother when it came to the equipment."

Perhaps not so surprisingly, Lee has plans for his short and long-term futures, regardless of his age.

"I plan to graduate in 2024, and get an engineering job in Houston. As for the field, or job in mind, I am very open," he said. "My girlfriend is also a junior and Mechanical Engineering student at UH. Within the first five years after graduation, she and I plan to heavily invest our three incomes – from the landscaping business and our two engineering jobs – into commercial real estate. Ideally, we'd like to be 100 percent financially free within 15 years of graduation through investments, so we can fulfill our dream to travel around the world full-time."

Pictured: *Aki installs a modification kit on the ISS during Expedition 66 in 2021*

ME ALUM, ASTRONAUT HOSHIDE

MAKES MARK IN SPACE

A University of Houston professor is continuing the historic quest, reporting on a new type of solar energy harvesting system that breaks the efficiency record of all existing technologies. And no less important, it clear the way to use solar power 24/7.

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Pictured: *Akihiko "Aki" Hoshide*

The University of Houston
Cullen College of Engineering

The University of Houston Cullen College of Engineering addresses key challenges in energy, healthcare, infrastructure, and the environment by conducting cutting-edge research and graduating hundreds of world-class engineers each year. With research expenditures topping $40 million and increasing each year, we continue to follow our tradition of excellence in spearheading research that has a real, direct impact in the Houston region and beyond.

Cullen College of Engineering
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