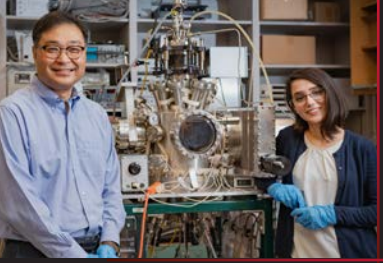
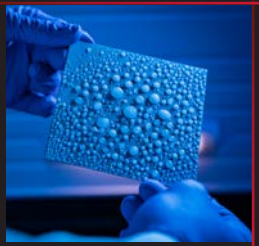


Mechanical Engineering Newsletter Spring 2022

MOMENTUM



ENGINEERED FOR
WHAT'S NEXT.

CULLEN
COLLEGE OF ENGINEERING
UNIVERSITY of HOUSTON

Letter from the Chair

Dear Colleagues,

I am delighted to share with you all some exciting research developments and noteworthy accomplishments made by our faculty and students over the past six months. From Super Cool Conductors to pushing the limits of when water freezes, there is no shortage of groundbreaking work going on in our department. I hope that you enjoy reading through these highlights, and if you see an opportunity for collaboration, do not hesitate to reach out.

Please continue to take care, and I invite you to come visit our department to learn more about what we have to offer.

Warm Regards,

Pradeep Sharma, Ph.D
M.D. Anderson Professor and Chair
Mechanical Engineering
Cullen College of Engineering
University of Houston

UH ME **BY THE NUMBERS**

FACULTY *(FALL 2021)*

4 NATIONAL ACADEMY OF ENGINEERING MEMBERS

2 NATIONAL ACADEMY OF INVENTORS FELLOWS

1 NATIONAL ACADEMY OF INVENTORS SENIOR MEMBER

ENROLLMENT *(FALL 2021)*

958 UNDERGRADUATE STUDENTS

199 GRADUATE STUDENTS

LEARN MORE ABOUT ME PROGRAMS:
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DEGREES AWARDED
(FALL 2021)

246 B.S. **42** M.S. **13** PH.D.

HADI GHASEMI
HAS BEEN NAMED A

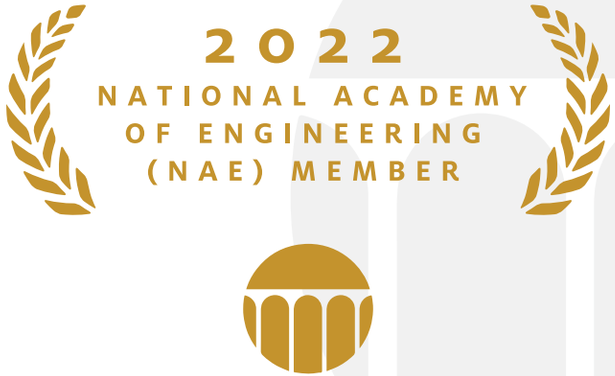
2022
NATIONAL ACADEMY
OF INVENTORS (NAI)
SENIOR MEMBER

HADI GHASEMI CLEARS PATH TO **NAI SENIOR MEMBER STATUS**

For many academics, there can be a disconnect between the fundamental research being done and the commercial applications of that research. But for **Hadi Ghasemi**, Ph.D., Cullen Associate Professor of Mechanical Engineering, he sees this as a vital component when it comes to research benefiting society.

"The fundamental research that we do is important, but it's much harder to take that fundamental science and to develop something that can benefit society," he said. "In my research, over the last eight years now, I have been working on anti-icing surfaces and we had done lots of fundamental research on that one. It was important that we could commercialize several technologies, and some of these technologies have been implemented."

Ghasemi is the co-founder and CTO of Elemental Coatings, which applies his and his team's research to anti-icing products. In addition to private investments, the company received a $750,000 grant from the Air Force Research Laboratory and Boeing recently as well. It is this innovation and inventiveness that was recognized by his election to the National Academy of Inventor's (NAI) 2022 class of Senior Members. According to the NAI, the class of 83 members this year hails from 41 research universities, and are named inventors on more than 1,090 U.S. patents.



PRADEEP SHARMA ELECTED TO

NATIONAL ACADEMY OF ENGINEERING

For actors, there are Oscars. Singers have Grammys. And for engineers? The highest award, the most coveted lifetime honor, is election into the National Academy of Engineers. They don't elect many. Of the millions and millions of engineers in the world, this year the NAE chose 111 new members and 22 international members.

One of them is Elon Musk, founder and chief executive of SpaceX and Tesla Motors. One is Satya Nadella, chairman and chief executive of Microsoft Corp., following Bill Gates. One of them is the co-founder and chairman of vaccine giant Moderna, Inc., Noubar B. Afeyan.

And one of them is **Pradeep Sharma**, M.D. Anderson Chair Professor and department chair of Mechanical Engineering at the University of Houston Cullen College of Engineering. Sharma's election brings to 16 the number of NAE members at the University of Houston.

In announcing Sharma's election, the academy noted his establishing the field of flexoelectricity, leading to the creation of new materials and devices and insights in biophysical phenomena. Sharma employs theoretical and computational approaches to understand physical phenomena across multiple disciplines—from materials science to biology. He uses methods of applied mathematics, continuum mechanics, atomistic and quantum simulations, among others, to carry out his research.

'SUPER COOL CONDUCTOR' ADVANCES IN DOE COMPETITION

As the world embarks upon the energy transition, improved electrification will be key to powering an efficient low carbon global economy. The development of superconductors, materials that can revolutionize the way electricity is generated, transmitted, stored and efficiently used for technologies fundamental to modern life at scale and low cost, will be central to this transition.

The University of Houston is contributing to the energy transition through its research efforts on superconductors.

The Super Cool Conductor from UH's Selva Research Group was recently one of ten competitors to win the first stage of the U.S. Department of Energy's prestigious Conductivity-enhanced materials for Affordable, Breakthrough Leapfrog Electric and thermal applications or CABLE Prize. The three-stage competition will award up to $4.5-million to spur development of new materials that enhance conductivity. The research group is headed by **Venkat Selvamanickam**, M.D. Anderson Chair Professor of Mechanical Engineering at UH's Cullen College of Engineering, and director of the Advanced Manufacturing Institute.

The DOE CABLE Prize is for researchers and inventors who are working to develop and manufacture breakthrough conductivity-enhanced materials that will speed the U.S. energy and manufacturing industries use of these materials. The conductors must demonstrate "an electric conductivity enhancement an unprecedented seven to eight times larger than that of today's best copper- and aluminum-based conductors" according to the DOE's Office of Energy Efficiency and Renewable Energy.

Research funded by:

AMERICA'S NAVY | U.S. DEPARTMENT OF ENERGY

nature

Read Journal Publication Online:
Freezing of few nanometers water droplets

NATURE:
www.nature.com

PUSHING THE LIMIT OF WHEN WATER WILL FREEZE

Though it is one of the great mysteries of science, the transformation of water into ice often escapes people's minds as it is just assumed that's what happens. But how and why it happens is the subject of intense scrutiny by ice scientists like **Hadi Ghasemi**, Cullen Associate Professor of Mechanical Engineering at the University of Houston.

In order to watch the process of crystallization of water into ice at the molecular level, Ghasemi is reporting the best look yet at the process: water-ice phase transformation down to 2 nm (nanometers) in diameter.

Then when Ghasemi examined these tiny particles, he made another discovery. He could break the limit of when water freezes and maintain the tiny droplets as liquid by putting them in contact with soft interfaces, like gels or lipids.

"We found that if a water droplet is in contact with a soft interface, freezing temperature could be significantly lower than hard surfaces. Also, a few-nanometer water droplet could avoid freezing down to -44 C if it is in contact with a soft interface," Ghasemi reports in *Nature*.

Previously Ghasemi created an ice-repelling material for aerospace applications using a new concept called stress localization. His current findings contribute to a greater understanding of natural phenomena and provide guidelines for further design of anti-icing systems for aviation, wind energy and infrastructures and even cryopreservation systems.

Pictured Above: *Hadi Ghasemi (right) and a doctoral student (left) showcase a sample of Elemental Coatings*

SEMICONDUCTOR **IMPROVEMENT**

A graduate student at the University of Houston is one of two lead co-authors for a paper by the Ryou group about combining the best qualities of semiconductors to make them cheaper and higher quality.

"Flexible single-crystalline GaN substrate by direct deposition of III-N thin films on polycrystalline metal tape" was published in *Journal of Materials Chemistry C*. **Mina Moradnia**, a doctoral student of **Jae-Hyun Ryou**, Ph.D., Associate Professor of Mechanical Engineering, served as one of the primary authors for the paper. **Shahab Shervin**, Ph.D., formerly a research assistant professor of Mechanical Engineering and now a senior materials scientist and engineer at ASML, served as the other primary author.

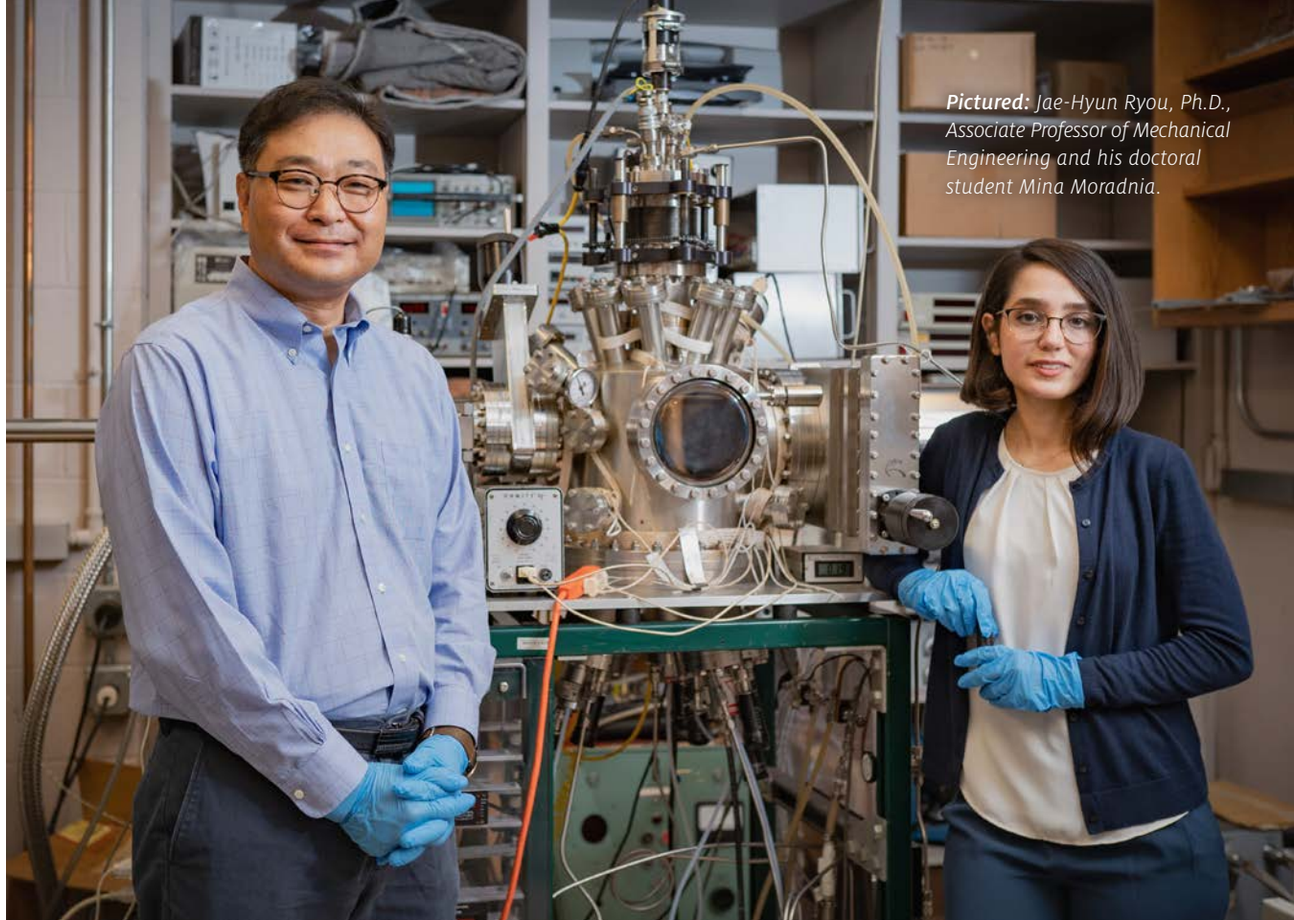
Additional contributors from UH included **Jie Chen**, **Sara Pouladi**, **Kamrul Alam**, **Tain Tong**, **Jiming Bao**, **Rebecca Forrest** and Ryou. Additional authors include Mi-Hee Ji, Russell D. Dupuis and Theeradetch Detchprohm of the Georgia Institute of Technology.

Moradnia described her work as attempting to bridge the gap between high performance, "single-crystalline" semiconductors and low-cost, "non single-crystalline" semiconductors.

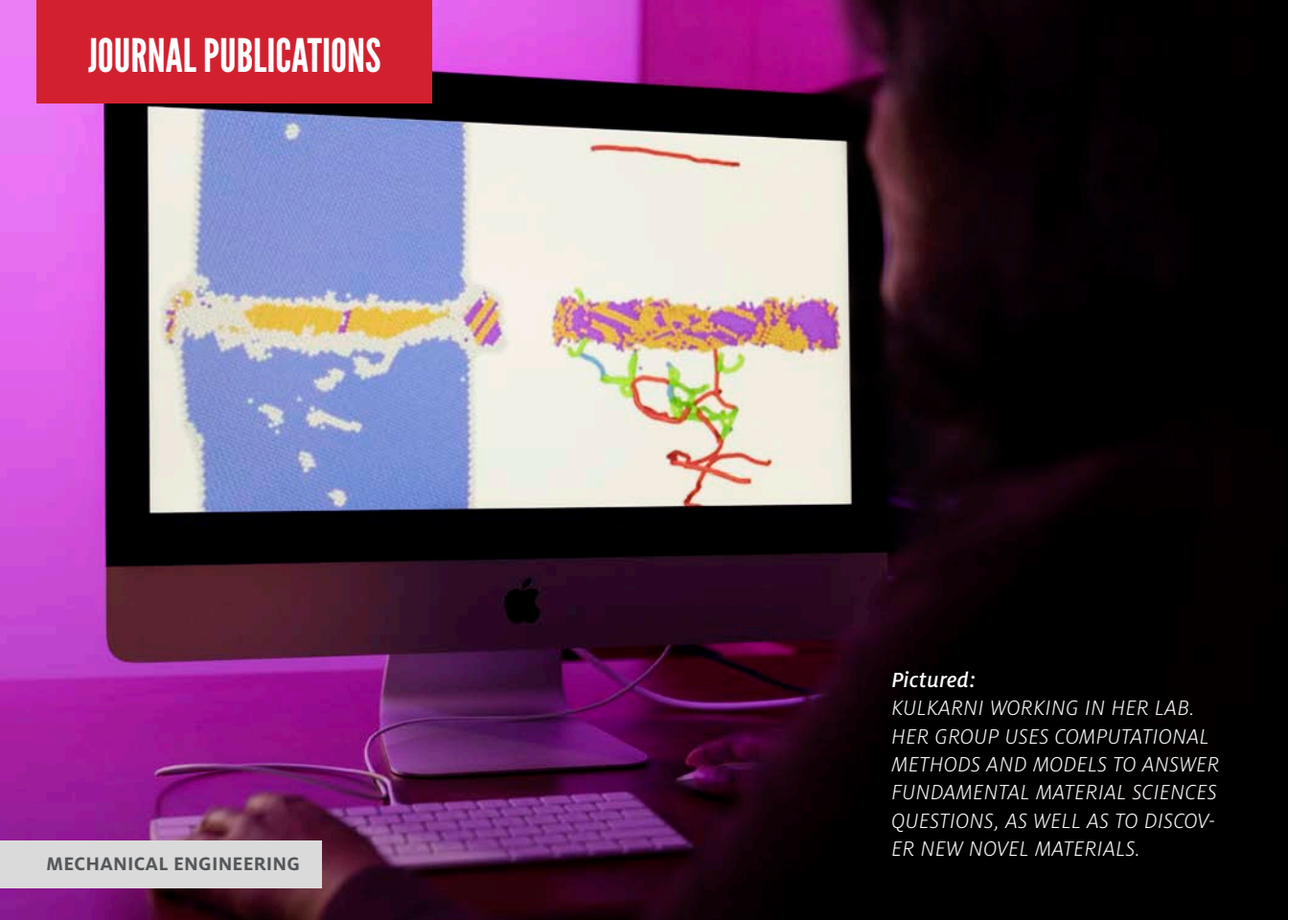
ROYAL SOCIETY OF CHEMISTRY

Read Journal Publication Online:
Flexible single-crystalline GaN substrate by direct deposition of III-N thin films on polycrystalline metal tape

JOURNAL OF MATERIALS CHEMISTRY C:
pubs.rsc.org/en/journals



Pictured: *Jae-Hyun Ryou, Ph.D., Associate Professor of Mechanical Engineering and his doctoral student Mina Moradnia.*



Pictured:
KULKARNI WORKING IN HER LAB. HER GROUP USES COMPUTATIONAL METHODS AND MODELS TO ANSWER FUNDAMENTAL MATERIAL SCIENCES QUESTIONS, AS WELL AS TO DISCOVER NEW NOVEL MATERIALS.

MECHANICAL ENGINEERING

NEW METHODS FOR INTERMETALLIC STRENGTH

Nobody would want to drive a car made of a very strong material that shatters in a collision, so the design of materials with high strength as well as high ductility – or less brittleness – has been the holy grail of materials science since the beginning of mankind. It was important for survival then, between making tools, weapons and eventually machines, and it is just as relevant now when we think of next-generation airplanes, turbines, spacecrafts and nuclear power systems.

Because of this, the quest for ultra-high strength materials with ductility is still an active area of research. For example, research over the past few decades generated a lot of excitement about the discovery of intermetallics, a special class of metallic alloys formed from two metals and having their own crystalline order. Although they have great mechanical properties such as high strength, they are inherently brittle, which has severely dampened the enthusiasm surrounding intermetallics.

In a paper published recently in *Science Advances*, two Cullen College of Engineering researchers – **Dajla Neffati**, Ph.D., a recent graduate, and **Yashashree Kulkarni**, Ph.D., Bill Cook Professor of Mechanical Engineering – offer a novel solution with their collaborators at Purdue University.

The group shows that intermetallics can exhibit ultra-high strength as well as improved ductility when they are designed with grains (regions with different crystalline orientation) only a few hundred nanometers in size separated by thick grain boundaries (boundaries between adjacent grains with different orientations).

Science Advances

Read Research Paper Online:
High-strength nanocrystalline intermetallics with room temperature deformability enabled by nanometer thick grain boundaries

SCIENCE ADVANCES
www.science.org/doi/10.1126/sciadv.abc8288

FACULTY

ACCOLADES

HALEH ARDEBILI

Haleh Ardebili, Ph.D., Bill D. Cook Professor of Mechanical Engineering, was recognized at the Cullen College of Engineering and Engineering Alumni Association's annual Alumni Awards Gala. She received the Abraham E. Dukler Distinguished Engineering Faculty Award.

The award was established to recognize and honor Cullen College of Engineering faculty who have made significant contributions to society and whose accomplishments and careers have brought credit to the University of Houston Cullen College of Engineering.

Additionally, Ardebili was also one of three professors recognized with the Undergraduate Research Mentor Award in 2021. The award recognizes the mentorship efforts of UH faculty at all stages of their careers, and faculty who are making a significant impact in their field by supporting and mentoring undergraduate students in research and scholarship endeavors.

FAOUZI TAHTOUH NAMED CULLEN COLLEGE

OUTSTANDING JUNIOR

When **Faouzi Tahtouh** reflects upon being recognized as the Cullen College of Engineering Outstanding Junior for the 2021-22 academic year, he can't help but feel a bit surprised and a bit humbled. The Mechanical Engineering student attributed his success to his work ethic. At UH, Tahtouh attributed much of his academic success to **Holley Love**, Ph.D., instructional assistant professor of Mechanical Engineering. He noted that she was the one who informed him about the Outstanding Junior award.

Tahtouh cited the good reputation of the Cullen College of Engineering and the industry opportunities of Houston as prominent reasons why he chose UH. He was drawn to Mechanical Engineering specifically because he's always had a fascination with how things "go" and move about in the world.

Tahtouh has lined up his first internship for the summer with a multinational, Fortune 500-level company. After graduating in 2023, Tahtouh hopes to explore opportunities for working in industry.

Pictured:
Faouzi Tahtough at UH central campus

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.

UNIVERSITY of HOUSTON | ENGINEERING

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MOMENTUM