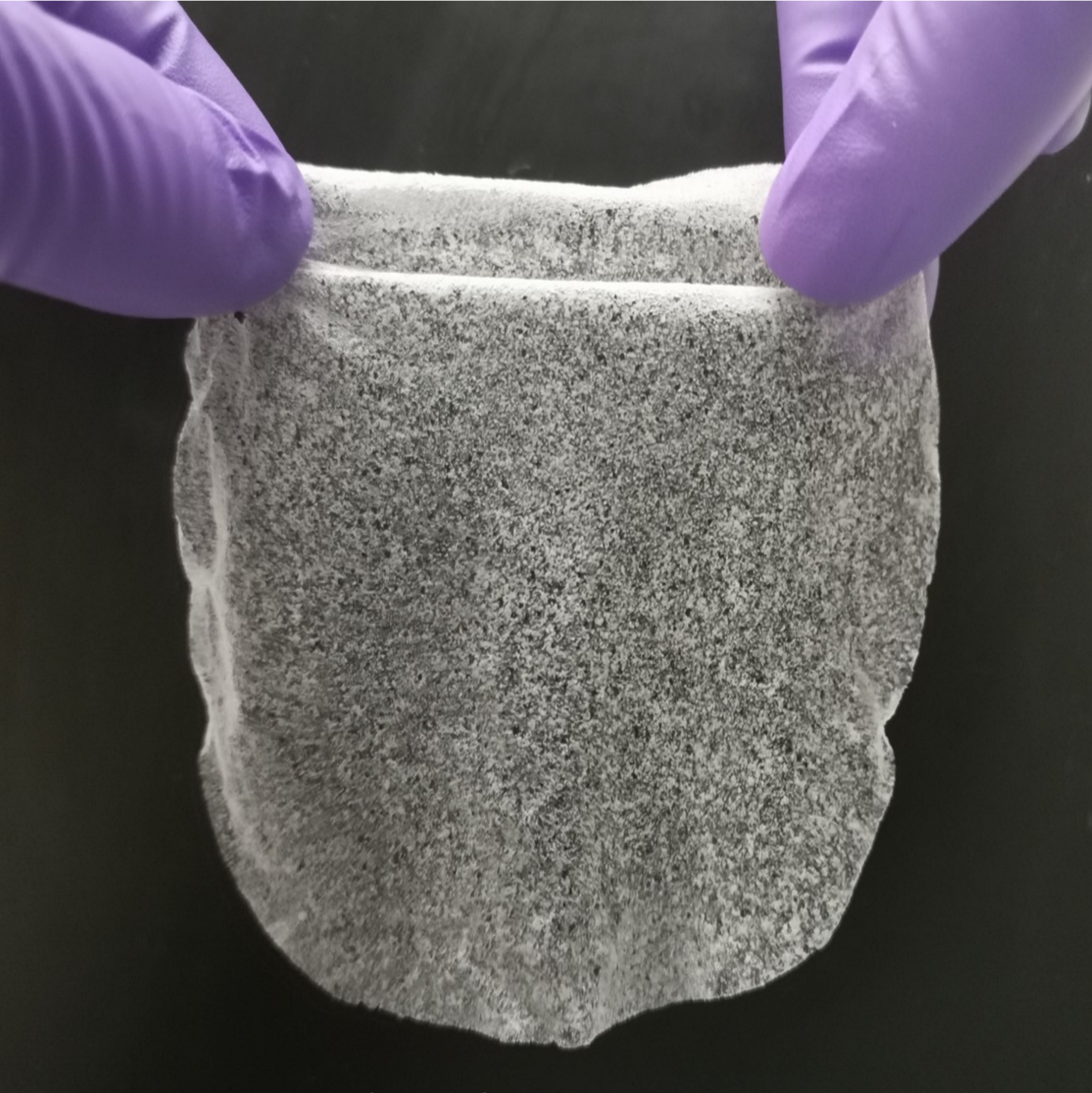


ACADEMIC YEAR 2021 - 2022

The University of Texas at Austin
Texas Materials Institute

NEWSLETTER

Greetings from the Director

ON THE COVER

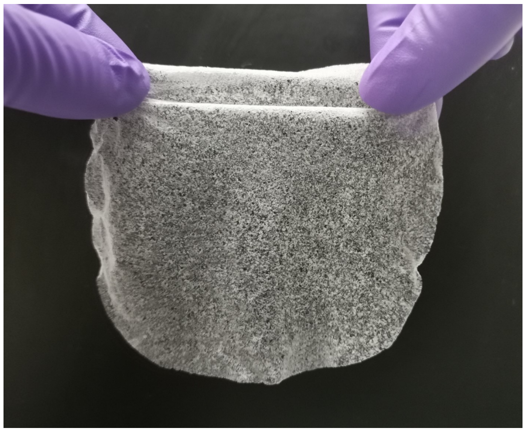


Image of water capturing polymer material. Guihua Yu group (see page 13).

Greetings!

It is with great pleasure that I present the Materials Science and Engineering Program and Texas Materials Institute Newsletter for the 2021-2022 academic year. During this past year, we saw the gradual transition back to full operation at UT Austin, hopefully ending an extremely challenging period for everyone during the pandemic. The effort from Faculty, Staff and Students has been tremendous, bringing us back to capacity. TMI is again buzzing with energy, optimism, enthusiasm, and activity for research and teaching. I am thankful and grateful to all those who have worked so hard to get us back to full capacity.

In July 2022, I began my appointment as the new Director of TMI, taking over from Professor Arumugam Manthiram who served as Director of TMI for more than a decade. Ram led TMI to new highs and successes, expanding the characterization facilities to be world-class, while continuing to enhance the graduate program to ever increasing rankings and status. I hope to continue this incredible journey of TMI success set by Ram and thank him for his tremendous service to Materials Science and Engineering at UT Austin and in particular TMI.

Our research facilities continue to expand, with the installation of a new X-ray photoemission spectroscopy instrument, led by Dr Filippo Mangolini's NSF MRI award. A new cryo-handling system was installed for Focused Ion Beam Milling and Transmission Electron Microscopy, which allows studies of delicate energy storage materials beyond conventional approaches. Students and postdoctoral scholars have continued to excel in all areas of research and scholarship. 6 PhD students and 3 M.S students graduated from our Materials Science and Engineering Graduate Program. These students faced unprecedented challenges in completing their studies during a global pandemic and deserve extra congratulations for their resilience to push on and complete their studies. We wish them all the best for the future careers ahead.

I look forward to the year ahead and the exciting new activities that TMI will be engaging with and launching!

Sincerely,

Jamie Warner
Director, Texas Materials Institute

IN THIS ISSUE

CONGRATULATIONS TO OUR 2021-2022 GRADUATES!

FALL 2021

Emily Ann Dukes Brady, Ph.D.
Plastic Flow and Microstructure Evolution in Niobium at Elevated Temperatures
Supervisor: Dr. Eric Taleff

Jingang Li, Ph.D.
Optothermal Approaches to Architected Functional Nanomaterials and Nanostructures
Supervisor: Dr. Yuebing Zheng

Kirutiga Srikanda Prabanna Balan, M.S.E
DFT Informed Electrochemical Engineering Modeling of Nanostructured Foil Anode for Next-Generation Batteries
Supervisor: Dr. Venkat Subramanian

SPRING 2022

Aniket Marne, M.S.E
NT/NR
Supervisor: Dr. Venkat Subramanian

Hongwoo Jang, Ph.D.
Graphene E-Tattoos: Design, Fabrication, Characterization, and Applications as Wearable Sensors
Supervisor: Dr. Nanshu Lu

Zixuan Li, Ph.D.
Reactivity and Interfacial Properties of Phosphonium Phosphate Ionic Liquid on Steel Surfaces
Supervisor: Dr. Filippo Mangolini

SUMMER 2022

Amruth Bhargav, Ph.D.
Organosulfur Materials for Rechargeable Metal-Sulfur Batteries
Supervisor: Dr. Arumugam Manthiram

Hwijong Lee, Ph.D.
Synthesis and Characterization of Compound Crystals with Weak Phonon Couplings
Supervisor: Dr. Li Shi

Patrick Crowley, M.S.E
Diffusional Lithium Trapping as a Failure Mechanism of Aluminum Foil Anodes in Lithium-Ion Batteries
Supervisor: Dr. Arumugam Manthiram

Editing and Design
Katherine Morales

John B. Goodenough Turns 100

John B. Goodenough at his 100th birthday celebration in Austin, Texas. Photo by CSE communications.

John Goodenough has been a part of rarified air for decades now. And this week he joined another exclusive club. The lithium-ion battery pioneer and Nobel Prize winner turned 100. To celebrate, battery leaders from around the globe, many of whom have been influenced by Goodenough's breakthroughs, gathered virtually and in person at a symposium at The University of Texas at Austin to share stories and discuss the next generation of battery research.

Goodenough identified and developed the critical materials that provided the high-energy density needed to power portable electronics, initiating the wireless revolution. Today, batteries incorporating Goodenough's cathode materials are used worldwide for mobile phones, power tools, laptops, tablets and other wireless devices, as well as electric and hybrid vehicles.

"He is a symbol of ingenuity, strength and excellence in the Cockrell School," said Sharon Wood, executive vice president and provost at UT Austin and former dean of the Cockrell School of Engineering, at the event. "His mere presence inspires students and encourages our faculty to succeed. He has unequivocally and quite literally changed the world with his inventions. And he has the biggest laugh on campus, so you always know when you are in John's presence." In 1979, Goodenough showed that by using lithium cobalt oxide as the cathode of a lithium-ion rechargeable battery, it would be possible to achieve a high density of stored energy with an anode other than metallic lithium.

This discovery led to the development of carbon-rich materials that allow for the use of stable and manageable negative electrodes in lithium-ion batteries.

Goodenough began his career at the Massachusetts Institute of Technology's Lincoln Laboratory in 1952, where he laid the groundwork for the development of random-access memory (RAM) for the digital computer. After leaving MIT, he became professor and head of the Inorganic Chemistry Laboratory at the University of Oxford. During this time, Goodenough made the lithium-ion discovery.

After retiring from Oxford in 1986, Goodenough joined UT Austin, where he serves as the Virginia H. Cockrell Centennial Chair of Engineering in the Cockrell School.

He holds faculty positions in the Walker Department of Mechanical Engineering and the Department of Electrical and Computer Engineering.

Dating back to his time at MIT, Goodenough developed a reputation for working closely with others, Arumugam Manthiram, professor of mechanical engineering at UT and a 30-plus-year colleague of Goodenough, said during his remarks at the event. The distinguished group of attendees was a perfect example.

Leading battery experts who were influenced by Goodenough and worked directly with him talked about the history of batteries and where we go from here. Audience members, many of whom are now professors themselves after learning from Goodenough, engaged in spirited debates with presenters about their work on batteries.

"All you have to do is work one step at a time." - John B. Goodenough

This communal aspect of his work speaks to Goodenough's personality, said Manthiram, who delivered the Nobel Lecture in Chemistry in 2019 on behalf of Goodenough. He can talk to anyone, about practically anything. And it showed in his research and willingness to work with others. A physicist by training, Goodenough often worked with chemists and experts from other disciplines, Manthiram said.

"He recognized the importance of interdisciplinarity, before many others gave it much thought," Manthiram said. Speakers touted Goodenough's longevity, with his research portfolio and academic tree stretching more than 70 years. Goodenough joined UT Austin at age 67, a time when most people have already hung it up, or at least started to wind down.

This ongoing ambition inspired Tien Duong, senior technical advisor at the U.S. Department of Energy, who manages DOE's Advanced Battery Materials Research Program and the Battery500 Consortium at the Vehicle Technologies Office. He was also inspired by Goodenough's advice he received at an event over a decade ago: to focus on simple but important things like children and family.

"Not only should John be admired for his technical accomplishments, but he's also a man to be admired for his humanity," Duong said.

Midway through the symposium, representatives from the Electrochemical Society presented Goodenough with a new award named for him.

They also gave him a hard copy of the first-ever combined issue of the Journal of Solid State Science and Technology and Journal of The Electrochemical Society, an edition released in May that was solely dedicated to Goodenough. It includes more than 80 invited papers celebrating and honoring the life, legacy and contributions of Goodenough.

Goodenough, seated front and center in the packed Mulva Auditorium in the Cockrell School's Engineering Education and Research Center, accepted the award, gave a wave and sent the battery luminaries, his former students and other attendees off to lunch with some sage advice: "All you have to do is work one step at a time." Simple enough.

Article by Cockrell School of Engineering Communications Team.

John B. Goodenough pictured with College of Engineering students, faculty and staff.

John B. Goodenough receives a copy of the first-ever combined issue of the Journal of Solid State Science and Technology and Journal of the Electrochemical Society.

Awards and Recognition

STUDENT AWARDS

Yixian Wang– ***David Mitlin Research Group***
- Walker Department of Mechanical Eng. Research Award, Spring 2022
- Sensors RIG Student Committee: Seminar Series, Fall 2021/Spring 2022

Maitri Uppaluri– ***Venkat Subramanian Research Group***
- UT Graduate School Continuing Fellow, Spring 2022

Aminur Chowdhury – ***Tanya Hutter Research Group***
- Sensors RIG Student Committee: Seminar Series, Fall 2021/Spring 2022
- GAIN Research Award, Spring 2022

Sivasakthya Mohan – ***Liechti & Akinwande Research Group***
- Student Leader Award: Engineering Student Life, Spring 2022

Aniket Marne – ***Kenneth Liechti Research Group***
- CDCM MRSEC Mentorship Program Travel Grant Award, Spring 2022

Wei Hao – ***Gyeong Hwang Research Group***
- IUMRS- Frontier Materials Graduate Student Award, *Spring 2022*
- Battery Division Travel Grant, *Spring 2022*
-George J. Heuer, Jr. Ph.D. Endowed Graduate Fellow, *Fall 2021*

Yifei Liu– ***Donglei (Emma) Fan Research Group***
- Professional Development Award, Fall 2021

Xiao Zhang– ***Guihua Yu Research Group*** - Professional Development Award, Fall 2021

Huaizhi Li– ***Donglei (Emma) Fan Research Group***
- Professional Development Award, Fall 2021
- Harry and Rubye Gaston Graduate Scholarship, Fall 2021
- Materials Research Society Spring Meeting, Symposium SD13 Best Presentation for Novel Materials or Fabrication

Youngsun Kim– Yuebing Zheng Research Group
- University Graduate Continuing Fellow

Rohit Unni- Yuebing Zheng Research Group
- Cockrell School of Engineering Fellow

Erik Cheng– ***Gyeong Hwang Research Group***
- Professional Development Award, Summer 2022
- John Coburn and Harold Winters Award Finalist, Summer 2022
- National Student Award Finalist, American Vacuum Society, Summer 2022
- Graduate Engineering Travel Grant, Summer 2022
- ALE Student Poster Award, 2nd place, AVS, Summer 2022
- ALE Best Student Paper Award Finalist, AVS, Summer 2022
- Burnt Orange Research Award, Summer 2022
- Engineering Doctoral Fellow, Spring 2022

Robert Chrostowski–***Filippo Mangolini Research Group***
- Professional Development Award, Summer 2022

Nicolas Molina – ***Filippo Mangolini Research Group***
- Alfred and Nellie King Graduate Fellowship, Fall 2022

Nirmalay Barua – ***Tanya Hutter Research Group***
- Sensors RIG Student Committee: Seminar Series, Fall 2021

David King – ***Tanya Hutter Research Group***
- Sensors RIG Student Committee: Seminar Series, Fall 2021

Tse-Ang Lee– ***Tanya Hutter Research Group***
- Sensors RIG Student Committee: Seminar Series, Fall 2021

Hyungmok Joh– ***Donglei (Emma) Fan Research Group***
- Cullen M. Crain Endowed Scholarship in Engineering, Fall 2021

Jie Fang– Yuebing Zheng Research Group
- George J. Heuer, Jr. Ph.D. Endowed Graduate Fellow, Fall 2021
- Finalist (Top 4) Nano Letters Seed Grant, North America Region, Fall 2021

TMI Joins JAXA and NASA for Asteroid Explorer Hayabusa2 Mission

The exploration of our Solar System and beyond for celestial bodies (asteroids) that could endanger life on Earth has recently found a renewed interest among astro scientists. To date, using a wide range of telescopes scientists have discovered over 1 million asteroids in our Solar System, some of them, with diameters larger than 1 km, having the potential to end life on Earth. These asteroids have an ample size distribution and are composed of rocks, metal or ice, while holding no atmosphere. Their classification is related to their general composition: carbonaceous (C-type), metallic (M-type), and silicaceous (S-type). Knowing the composition and structure of these asteroids, especially the massive ones, is critical to developing a planetary defense strategy.

Aiming to clarify the origin and evolution of the Solar System, including the beginnings of life, the Hayabusa2 deep space mission was developed by Japan Aerospace Exploration Agency (JAXA) in collaboration with NASA and other Space Agencies around the world. The main purpose of this mission is to send a space probe to two asteroids, touch down and collect samples from their surface, and return the specimens to Earth for extensive analysis. Launched in December 2014, the Hayabusa2 mission has been, so far, very successful. The space probe was able to touch down twice (in 2018 and 2019) on the surface of a class C asteroid (Ryugu) and collect invaluable specimens that were returned to Earth in 2020 during a flyby.

Currently, the Hayabusa2 probe is on route to a fast-rotating asteroid, 1998 KY26, that will be reached in 2031, besides a flyby around another asteroid, 2001 CC21, scheduled for 2026. Another very important goal of the Hayabusa2 mission is to attempt a close proximity flyby of asteroid 2001 CC21 without collision to verify the navigation technologies that could be used to modify the trajectories of potentially dangerous asteroids by direct collision, a very important step in developing a planetary defense strategy. Consequently, the ability to measure the physical characteristics of these asteroids and establish operation methods in their vicinity will deepen the knowledge about these asteroid classes and provide us with useful information for designing countermeasures against an Earth collision.

Article by Andrei Dolocan, TMI Facility Manager.

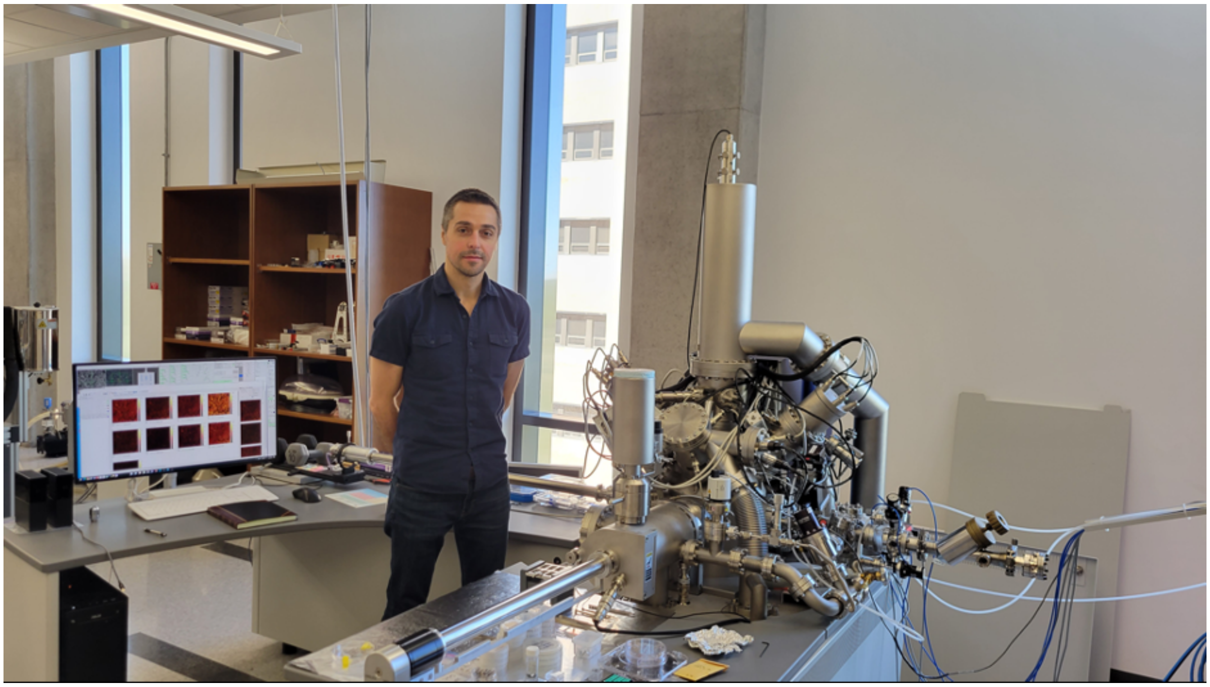


Figure 1. Dr. Andrei Dolocan and the TOF-SIMS instrument at TMI.

During the touch down on the surface of the asteroid Ryugu, 17 grains of material were collected and returned to Earth for extensive analysis. TMI scientists, Dr. Andrei Dolocan and Dr. Raluca Gearba, have joined the Hayabusa2 STONE Team in analyzing one of the Ryugu grains. Although representing only a small part of the international effort in studying the Ryugu material, the TMI analysis was critical to understanding the material properties of Ryugu, which ultimately led to the discovery of its origin. The TMI team, joined by Dr. Michael Zolensky (NASA) and Dr. Robert Bodnar (Viginia Tech), has used the time of flight secondary ion mass spectrometer (TOF-SIMS) and the focused ion beam (FIB) facilities at TMI to reveal the buried chemical composition of the Ryugu grain.

In particular, Dr. Dolocan (Fig.1) has performed high-resolution depth profiling on the TOF-SIMS to reveal the composition of fluid inclusions trapped inside the Ryugu grain. Due to the volatile nature of the fluid under vacuum environment the grain was kept at cryogenic temperatures (-140 ° C) during the data acquisition. The analysis of the trapped fluid inclusions in the hexagonal pyrrhotite (that is, iron sulphide) crystal, which formed most of the grain, by cryo TOF-SIMS revealed that the fluid consisted of water and CO_2, as well as sulphur species and organic molecules (Fig.2).

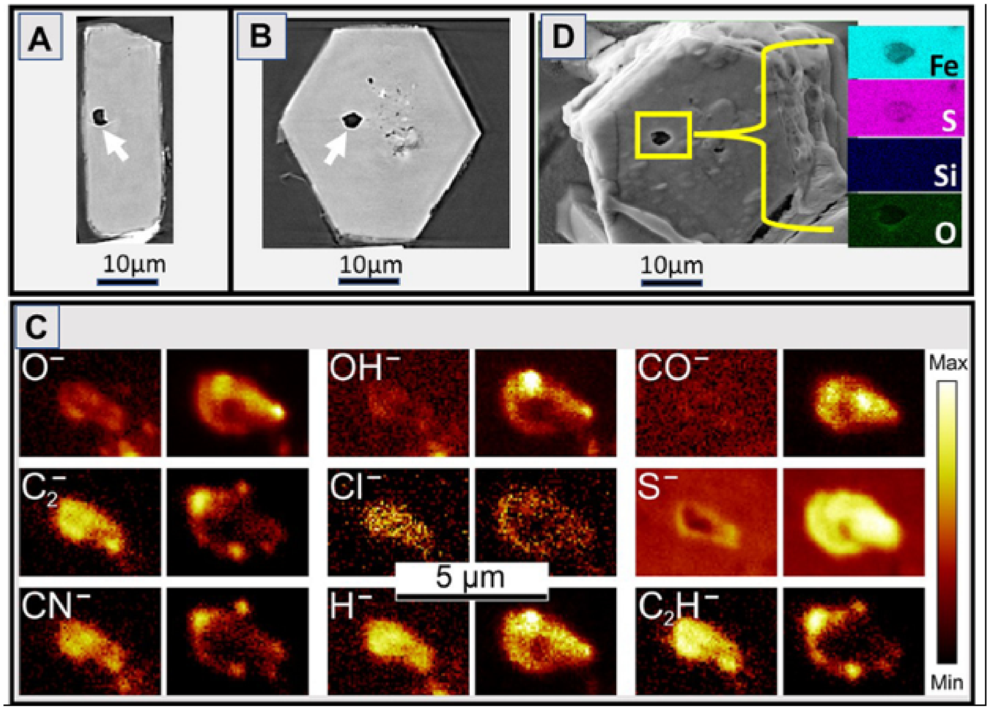


Figure 2. Analysis of the Ryugu grain consisting of pyrrhotite (iron sulphide) crystal. A. and B. Slices through the grain crystal with Synchrotron Radiation X-ray Computed Tomography (SR-CT) indicating the location of a buried fluid inclusion. C. TOF-SIMS analysis of the fluid inclusion. D. Energy Dispersive X-Ray Spectroscopy (EDS) analysis of the empty hole left after the TOF-SIMS analysis of the fluid inclusion. Source: Science (Sept. 2022) DOI: 10.1126/science.abn8671

The presence of water and CO_2 indicates that Ryugu's parent body formed far away from the Sun, where H_2O and CO_2 could freeze into solids that could be included in the asteroid. This is a fundamental discovery, quoting Prof. Tomoki Nakamura of Tohoku University, the lead scientist on the publication: "The finding of a tiny amount of water and CO_2 in a small crystal by Andrei and his colleagues clearly indicates that Ryugu formed at outer region of solar nebula. It is very important to understand the formation of asteroid Ryugu and its composition".

Importantly, the cryo TOF-SIMS analysis implies that both water and more complex organic material are a regular part of type-C asteroids, which further suggests life on Earth might have an extraterrestrial origin.

The analysis results of the Hayabusa2 STONE Team, including the work performed at TMI, have been recently published in the prestigious journal Science (DOI: 10.1126/ science.abn8671).

Article by Andrei Dolocan, TMI Facility Manager.

Faculty & Student Spotlight

DR. YUEBING ZHENG

Yuebing Zheng is an Associate Professor of Materials Science & Engineering and Mechanical Engineering at the University of Texas at Austin. He is holding Temple Foundation Endowed Teaching Fellowship in Engineering #2 and serving as a Graduate Adviser in Materials Science & Engineering Program. Yuebing received his B.Sc. in Applied Optics from Nankai University (China) in 2001, M.Sc. in Physics from National University of Singapore (Singapore) in 2004, and Ph.D. in Engineering Science and Mechanics (with Prof. Tony Jun Huang) from the Pennsylvania State University (USA) in 2010 where he was a recipient of Alumni Association Dissertation Award and Graduate School Alumni Society Early Career Award. He was a postdoctoral researcher (with Prof. Paul S. Weiss) at the University of California, Los Angeles (USA) from 2010 to 2013. Zheng Research Group (https://zheng.engr.utexas.edu) innovates optical manipulation and measurement for the nanoscale and biological world.

Their specific research aims are to:

- improve fundamental understanding of nanoscale light-matter interactions and opto-thermo-fluidic multiphysics,
- advance machine learning methods for inverse design and data analysis in optics and nanophotonics,
- invent new optical manipulation and measurement technologies to advance the frontiers of biology and nanoscience, and
- further leverage optical manipulation and measurement as platform technologies to develop new materials and devices for broader applications.

The group received IEEE NANO Best Poster Award, University Co-op Research Excellence Award for Best Paper, Materials Today Rising Star Award, National Institute of Health (NIH) Director's New Innovator Award, National Aeronautics and Space Administration (NASA) Early Career Faculty Award, Office of Naval Research (ONR) Young Investigator Award, and Beckman Young Investigator Award. Yuebing is a fellow of the Institute of Physics and a fellow of the Royal Society of Chemistry.

STEVEN LEE

Steven Lee is a 4th year Ph.D. candidate working with Professor Arumugam Manthiram on lithium-ion battery research. He acquired his bachelor of science in chemical engineering from University of California, San Diego. Upon graduating, Steven conducted battery research in Wildcat Discovery Technologies for leading battery industry partners. He was amazed by the immense research effort that is necessary to further propel battery performance towards practical applications like vehicle electrification. This inspired him to pursue a doctoral degree in materials science and engineering. His research focuses on enabling high-nickel and no-cobalt cathode active materials, which is an essential component to the electric vehicle revolution. During his 1st year, he collaborated with a post-doctoral fellow Wangda Li on synthesizing and characterizing a novel cathode material that showed promising electrochemical performance to its cobalt-containing analogues. He revealed synergistic benefits of the manganese-aluminum co-doping in strengthening the surface and bulk properties of this high-energy cathode materials through a post-mortem analysis of spent batteries. This paved ways to several publications and an issue patent that started TexPower, a spinoff company from the Manthiram Laboratory that aims to scale up and commercialize this cobalt-free cathode composition. Currently, Steven strives to understand the impact of synthesis conditions and particle morphology to the electrochemical performance of high-nickel, no-cobalt cathodes. He aims to design new cathode manufacturing strategies that reduces production cost and water waste. This endeavor is widely recognized by the Department of Energy as a critical technological advancement that will ensure a robust domestic supply of low-cost lithium-ion batteries for the U.S. electric vehicle sector. Steven's achievements in research and in graduate courses are awarded with the Cockrell School of Engineering Fellowship and the University Graduate Continuing Fellowship. Outside of research, Steven is a music and fitness enthusiast and loves to enjoy what Austin has to offer.

Meet the New Scanning Probe XPS System

The acquisition of a state of the art instrument for the Surface Analysis Facility at the Texas Materials Institute (TMI) in a major turning point in the research of surface analysis of material science. This facility is located in the new Engineering Education and Research Center (EER) building as part of the main campus of the University of Texas-Austin. TMI now houses two X-ray photoelectron spectrometers (XPS) and access to these two XPS instruments has distinctive advantages.

"God made the bulk; surfaces were invented by the devil", Wolfgang E. Pauli (Nobel Prize in Physics in 1945). The surface behavior of materials is crucial to our lives. Corrosion problems are often overcome by surface treatments. The optical behavior of glasses can be modified by surface coatings. The surface chemistry of polymers can be tuned so that they cling for packaging, are non-sticky for cooking, or can be implanted into our bodies to feed in drugs or replace body components. Catalysts are masterpieces of surface chemistry and vital for ~90% of the output of the chemical industry. Thus, whether one considers a car body shell, a biological cell, tissue or implant, a battery, a catalyst, a solid-state electronic device, or a moving component in an engine, it is the surface that interfaces with its environment.

An in-depth understanding of the basic science of surfaces requires a system that can accurately and quantitatively evaluate the composition of the first few atomic layers of materials and characterize the bonding configuration of the elements with atomic-scale depth resolution. X-ray photoelectron spectroscopy (XPS) is one of the most powerful weapons in the surface-analytical arsenal as it allows for identifying and quantifying the chemical states of the elements in the near-surface region (3-10 nm in depth from the sample surface), while enabling the characterization of the electronic structure of core and valence bands.

The recent acquisition of a new versatile, high-resolution scanning XPS microprobe (VersaProbeIV, Physical Electronics Inc., USA) for the 2D and 3D surface chemical characterization will pave the path for unprecedented experimental work as it combines several key analytical capabilities onto a single platform: (i) high throughput traditional surface chemical analysis with extremely high sensitivity; (ii) micro-area chemical characterization and mapping of laterally heterogenous surfaces; (iii) analysis of elemental distribution as a function of depth from the sample surface with minimal damage; (iv) accurate surface chemical analysis of insulators; and (v) in situ evaluation of surface and interface processes (e.g., at elevated temperatures or under applied electrical potential).

Article by Hugo Celio, TMI Facility Manager.

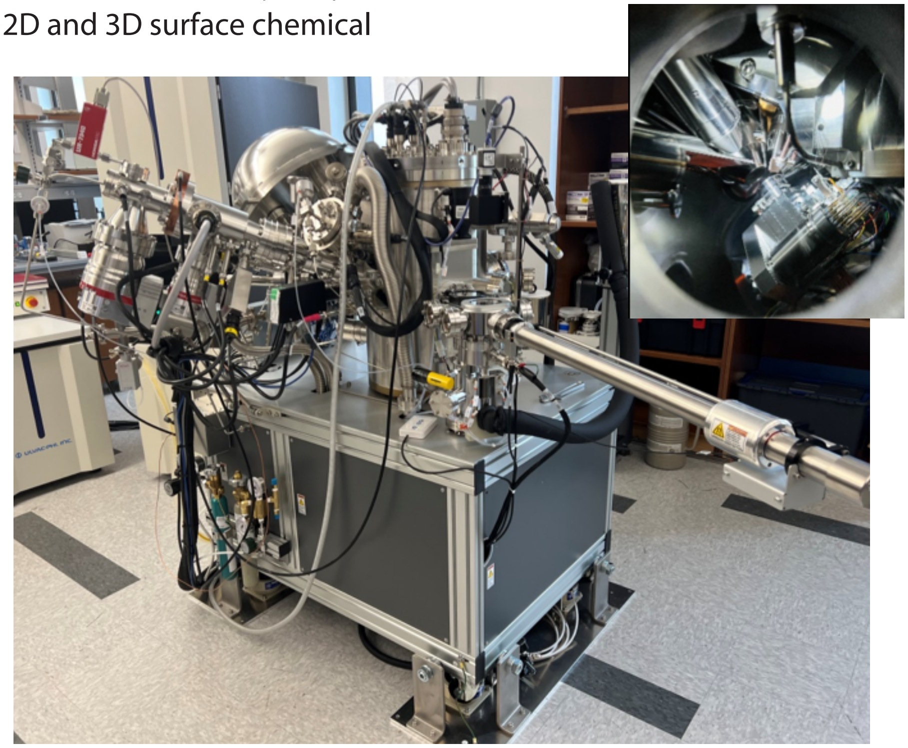


Figure 1

According to the leading investigator of this grant, Dr. Filippo Mangolini, assistant professor in Mechanical Engineering, "the instrument will significantly enhance research activities at UT-Austin in several areas, including the development of low-cost, efficient materials for solar cells, fuel cells, batteries for transportation and grid storage, solar-to-fuel conversion, carbon dioxide capture, nano-electronics, additive manufacturing, 2D microfluidics, pharmaceuticals, drug deliver, while also serving as a critical regional research facility for universities and industries in the Southern US". Figure 1 shows the final installation and configuration, which was completed in the summer of 2022, of the PHI VersaProbe IV located in EER 6.636. According to the manufacturer (Physical Electronics, Inc.), the model acquired by UT-Austin is unmatched due to the number of accessories installed. Figure 2 shows high-resolution scanning XPS Al 2p spectra acquired using a 10 micron X-ray beam spot from a cross marker (inset shows SEM image the cross) of a patterned chip. The red spectrum, which was taken at the center of the cross, shows that the cross is composed of metallic aluminum, Al(0), and aluminum oxide, Al2O3 and it is surrounded by silicon dioxide pads (green spectrum). The linewidth of the aluminum cross is 10 micron and its composition confirmed with XPS, while the pads do not contain aluminum or other contaminants.

"God made the bulk; surfaces were invented by the devil" - Wolfgang E. Pauli

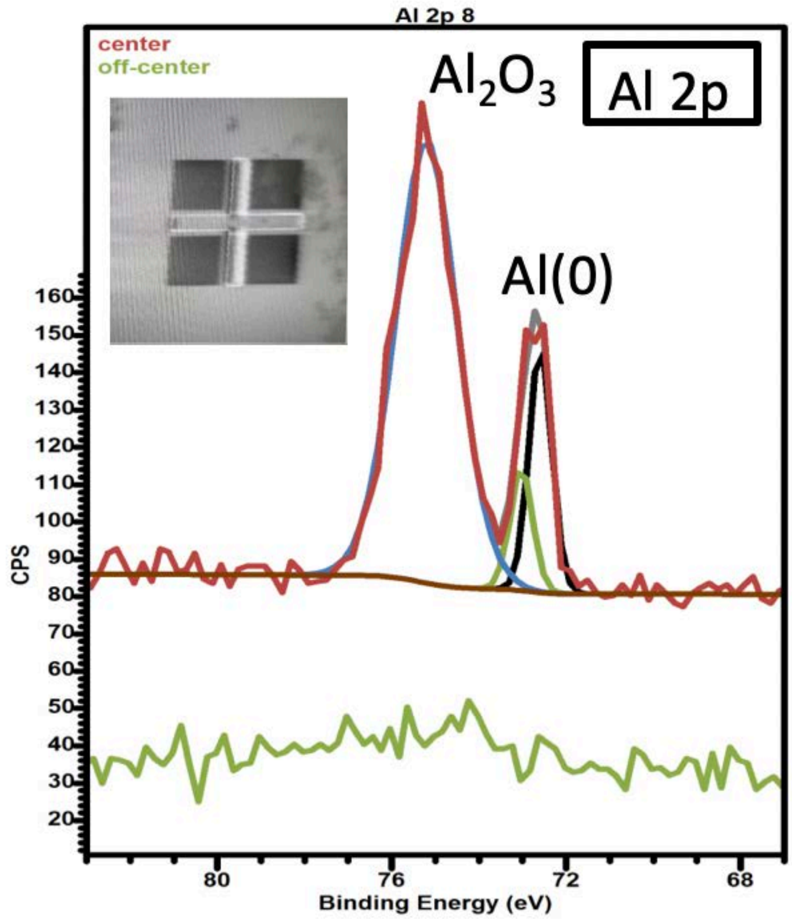


Figure 2

In summary, the new instrument, which complements and extend the capabilities of the Kratos Axis Ultra XPS system that has served the UT-Austin research community for the last decade, will allow new cutting-edge research. As Dr. Mangolini states: "To maintain the scientific and technological leadership that UT-Austin has in key areas and to carry out truly transformative research, having access to an advanced, state-of-the-art instrumentation like the PHI VersaProbe IV is critical. The new capabilities of the instrument will not only pave the way towards the characterization of laterally heterogeneous samples or specimens with limited dimensions (e.g., particles), but also provide unprecedented opportunities for transformative research, development, and innovation enabled by an advanced surface spectroscopic facility".

Article by Hugo Celio, TMI Facility Manager.

FACULTY AWARDS

Filippo Mangolini
- ASME Burt L. Newkirk Award, 2022

Laxminarayan Raja
- Moncrief Grand Challenge Faculty Award, 2022

Xiuling Li
- AAS Fellow, 2022
- IEEE Pioneer Award in Nanotechnology, 2022

Jean Anne Incorvia
- Intel Rising Star Faculty Award, 2021
- Junior IDEA Award, 2022

Deji Akinwande
- African Academy of Sciences Fellow, 2022

Allan MacDonald
- NIMS Medal, 2021

Yi Lu
- Fellow of the National Academy of Inventors, 2021

Venkat Ganesan
- Distinguished Alumni of Indian Institute of Technology, 2022

Tanya Hutter
- Female Founder Pitch Competition Award, 2021
- Fellow of Royal Society of Chemistry, 2022

James Chelikowsky
- TMS, John Bardeen Award, 2021

Arumugam Manthiram
- Battery Division Technology Award from ECS, 2021
- Web of Science Highly Cited Researcher, 2021

Mehran Tehrani
- NASA Early Stage Tech Innovations Award, 2021
- First Stage CABLE Conductor Manufacturing Prize, American Made Challenge, 2021

Zachariah Page
- ACS PMSE Young Investigator Award, 2022
- Cottrell Scholar Award, Research Corporation for Science Advancement, 2022
- International Advisory Board Member for Macromolecular Chemistry and Physics, 2021
- RedLaunch Award, 2021
- 3M Non-Tenured Faculty Award, 2021

Richard Crooks
- Eastern Analytical Symposium Award for Outstanding Achievements in the Fields of Analytical Chemistry, 2022

Yuanyue Liu
- Scialog Award, 2022

Guihua Yu
- Blavatnik National Award for Young Scientists, 2022
- Fellow of the Materials Research Society, 2022
- Norman Hackerman Award in Chemical Research from the Welch Foundation, 2022

Michael Haberman
- DARPA Young Faculty Award, 2022

Mitchell Pryor
- Fulbright U.S. Scholar Program Award, 2022

Wen Song
- NSF CAREER Award, 2022

Nanshu Lu
- U.S. NAM Healthy Longevity Global Competition Winner, 2021

Nicholas Peppas
- Elected Member of the Academy of Romanian Scientists, 2022
- Award Honorary Doctorate, Polytechnic University of Bucharest, Romania, 2022

Donglei (Emma) Fan
- John Hopkins Whiting School of Engineering Ilene Busch-Vishniac Lectureship, 2022
- National Science Foundation Mid-Career Advancement Award, 2022

Jean Anne Incorvia
- EA Award from ECE Department for Contributions to Divesrity, Equity, and Inclusion, 2022

Low-Cost Gel Film Can Pluck Drinking Water from Desert Air

More than a third of the world's population lives in drylands, areas that experience significant water shortages. Scientists and engineers at The University of Texas at Austin have developed a solution that could help people in these areas access clean drinking water.

The team developed a low-cost gel film made of abundant materials that can pull water from the air in even the driest climates. The materials that facilitate this reaction cost a mere $2 per kilogram, and a single kilogram can produce more than 6 liters of water per day in areas with less than 15% relative humidity and 13 liters in areas with up to 30% relative humidity.

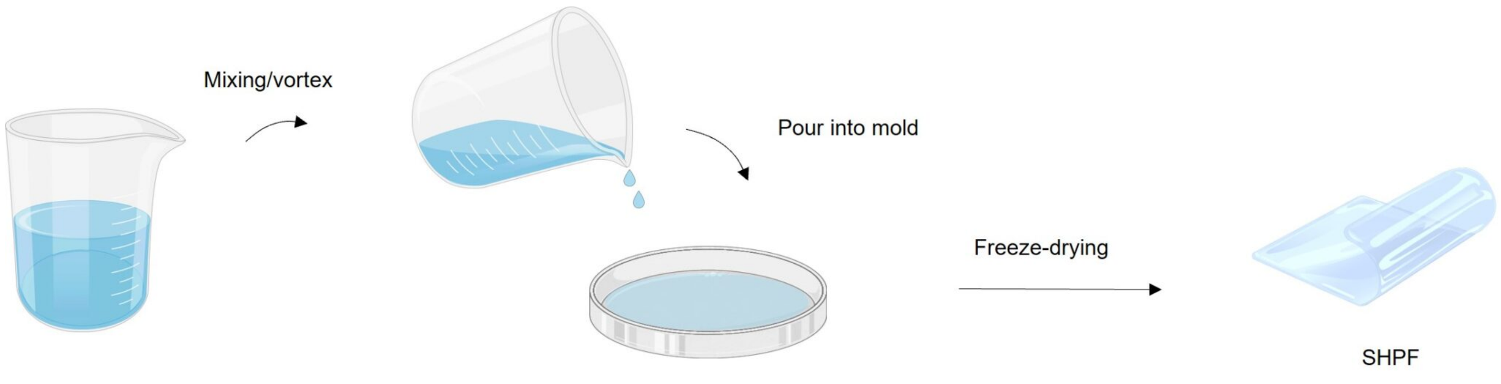
The research builds on previous breakthroughs from the team, including the ability to pull water out of the atmosphere and the application of that technology to create self-watering soil. However, these technologies were designed for relatively high-humidity environments.

This new work is about practical solutions that people can use to get water in the hottest, driest places on Earth," said Guihua Yu, professor of materials science and mechanical engineering in the Cockrell School of Engineering's Walker Department of Mechanical Engineering. "This could allow millions of people without consistent access to drinking water to have simple, water generating devices at home that they can easily operate."

The researchers used renewable cellulose and a common kitchen ingredient, konjac gum, as a main hydrophilic (attracted to water) skeleton. The open-pore structure of gum speeds the moisture-capturing process.

Article by UTNEWS

"This could allow millions of people without consistent access to drinking water to have simple, water generating devices at home that they can easily operate." - Guihua Yu



The process of creating the water-capturing film from its ingredients.

"This is not something you need an advanced degree to use" - Youhong 'Nancy' Guo

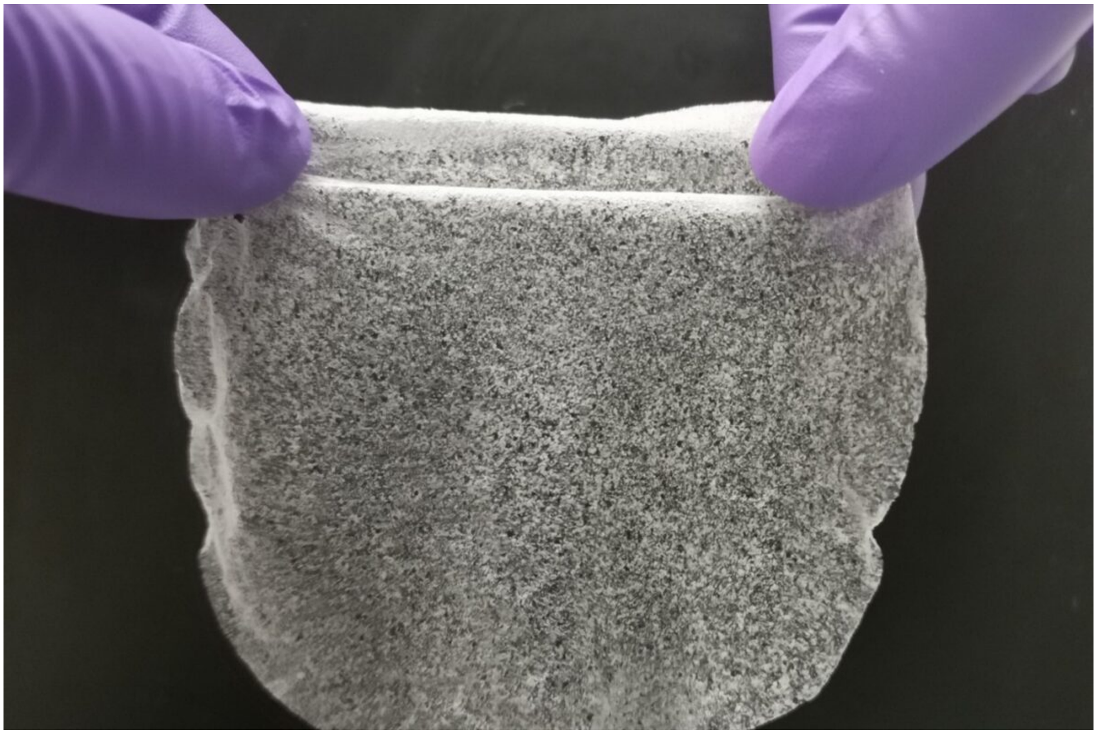


Figure 1. Image of water capturing polymer material. Guihua Yu group

Another designed component, thermo-responsive cellulose with hydrophobic (resistant to water) interaction when heated, helps release the collected water immediately so that overall energy input to produce water is minimized.

Other attempts at pulling water from desert air are typically energy-intensive and do not produce much. And although 6 liters does not sound like much, the researchers say that creating thicker films or absorbent beds or arrays with optimization could drastically increase the amount of water they yield.

The reaction itself is a simple one, the researchers said, which reduces the challenges of scaling it up and achieving mass usage.

"This is not something you need an advanced degree to use," said Youhong "Nancy" Guo, the lead author on the paper and a former doctoral student in Yu's lab, now a postdoctoral researcher at the Massachusetts Institute of Technology. "It's straightforward enough that anyone can make it at home if they have the materials."

The film is flexible and can be molded into a variety of shapes and sizes, depending on the need of the user. Making the film requires only the gel precursor, which includes all the relevant ingredients poured into a mold. "The gel takes 2 minutes to set simply. Then, it just needs to be freeze-dried, and it can be peeled off the mold and used immediately after that," said Weixin Guan, a doctoral student on Yu's team and a lead researcher of the work.

The research was funded by the U.S. Department of Defense's Defense Advanced Research Projects Agency (DARPA), and drinking water for soldiers in arid climates is a big part of the project. However, the researchers also envision this as something that people could someday buy at a hardware store and use in their homes because of the simplicity.

Yu directed the project. Guo and Guan co-led experimental efforts on synthesis, characterization of the samples and device demonstration. Other team members are Chuxin Lei, Hengyi Lu and Wen Shi.

Seminar Series

TMI hosted two seminars during the Fall 2021 and Summer 2022 semester under the Goodenough Materials Lecture Series. We hosted fourteen seminars as part of our annual seminar series.

FALL 2021

Dr. Aleksey Kolmogorov
Binghamton University, SUNY
Development of Machine Learning Interatomic Potentials for Acceleration of Structure Prediction

Dr. Jagdish (Jay) Narayan
North Carolina State University
Discovery of Q-Carbon and Record BCS High-Temp Superconductivity in B-Doped Q-Carbon

Dr. Maarten de Boer
Carnegie Mellon University
Progress Towards a New Platform for Thin Film Mechnical Property Testing

Dr. Thomas F. Jaramillo
Stanford University
Developing Catalysts and Processes for Chemical Transformations and Global Sustainibility

Dr. Dionisios Vlachos
University of Delaware
AI-Enabled Prediction of Single Atom and Subanometer Catalyst Chemistry, Stability, and Dynamics

Dr. Nan Ma
Helmholtz-Zentrum

Dr. Izabela Szlufarska
University of Wisconsin
The Role of Interfaces in Mechanical Response and Radiation Resistance of Materials

Dr. Haiyan Wang
Purdue University
Novel Function Ceramics by Nanostructured Design and Advanced Processing

SPRING 2022

Dr. Andrew Peterson
Brown University
An Atom's Eye View of a Renewable, Electrochemical Future

Dr. Philippe Sautet
University of California, Los Angeles
Dynamics and Restructuring of Catalytic Active Sites

Dr. Boris Kozinsky
Harvard University
From Dynamics of Electrons to Billions of Reacting Molecules: Combining Computational Physics with Machine Learning

Dr. Ismaila Dabo
Pennsylvania State University
First-Principles Optimization and Discovery of Materials for Energy Conversion and Storage

Dr. Orlin D. Velev
North Carolina State University
Colloidal Engineering of Novel Classes of Functional Soft Matter by Means of Magnetic, Capillary, and Interfacial Binding

Dr. Sefaattin Tongay
Arizona State University
The Synthesis and Engineering of Two-Dimensional Janus Quantum Layers

Dr. Betar Gallant
M.I.T
Interplays of Composition and Function at the Interphases of Lithium and Calcium Metal Anodes

SUMMER 2022

Dr. Jeff Dahn
Dalhousie University
Long Lived Li-Ion Cells

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Texas Materials Institute

Materials Science and Engineering
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