



## Department of Materials Science and Engineering

A. James Clark School of Engineering

# TECHTRACKS NEWSLETTER

SPRING 2020

## Chair's Message

First of all, I hope you and your family are safe and healthy during the COVID-19 pandemic which has fundamentally changed our education, research and daily operations. While our facilities are mostly empty and we are hunkering down at home, I want to share good news in hope of bringing some positivity to this unprecedented time.

Liangbing Hu's new ultra-fast high-temperature synthesis graced the May 1 cover of *Science* (his second *Science* cover) - his elegant invention will have a substantial impact on future materials synthesis. Hu is recently bestowed with the title of Herbert Rabin Distinguished Professor of Engineering and is the Founding Director of the new Center for Materials Innovation, which will bolster collaborative materials development to address global challenges.

Eric Wachsman is leading the U.S. side of a \$18.4 million project awarded by the Binational Industrial Research and Development (BIRD) Foundation. This is a major win for us and it will continue to elevate our excellence and impact of energy technology.

It was exhilarating for me to witness our undergraduate student team win the Alumni Cup. Our students and postdocs have won numerous awards in the past few months, including the highly competitive 2020 MRS Postdoctoral Award (Tian Li) and one of *Nature's* five Emerging Stars in the field of materials science (Emily Hitz).

Thank you for reading, and please support our students and our Department.

- J.C. Zhao, UMD MSE Chair

## Hu Research Group Makes Cover of *Science*

A study led by MSE Professor **Liangbing Hu** was published on the May 1 cover of *Science*. Hu and his research team have developed an innovative approach to fabricate ceramic materials, having promising applications for solid-state batteries, fuel cells, 3D printing technologies and more. The method of ultrafast high-temperature sintering offers high heating, up to 3,000 degrees Celsius, and high cooling rates, and even temperature distribution. The process takes less



than 10 seconds, which is more than 1,000 times faster than the traditional furnace approach.

The team 'sandwiched' a pressed green pellet of ceramic precursor powders between two strips of carbon that quickly heated the pellet through radiation and conduction, creating a high temperature that forced the ceramic powder to consolidate quickly, a process that can be applied to virtually any material. To learn more: <https://go.umd.edu/ivP>

## UMD to Lead U.S. Side of \$18.4M U.S./Israel Energy Project

The Maryland Energy Innovation Institute (MEI2) has been selected to lead the U.S. side of a \$18.4 million project, awarded by the U.S./Israel Energy Center and managed by the Binational Industrial Research and Development (BIRD) Foundation, to conduct research, development and commercialization of innovative energy technology.

MEI2 participants **Eric Wachsman** (MSE/ChBE Professor & MEI2 Director), **Gary Rubloff** (MSE Professor), **Paul Albertus** (ChBE Assistant Professor & MEI2 Associate Director) and **Sang Bok Lee** (Chem/Biochem Professor & UMD

NanoCenter Director) will lead the five-year project, the focus of which will be on the development of solid state batteries for both Na- and Li-metal chemistry. These batteries offer a breakthrough in terms of energy per unit mass and volume at the cell level, cost, safety and an ability to serve numerous end-use sectors. The goal of the U.S.-Israel Energy Center is to promote energy security and economic development through R&D of innovative technology.

To learn more:

<https://go.umd.edu/MEI2-Israeli-project>

## MSE's Rising Star, Emily Hitz

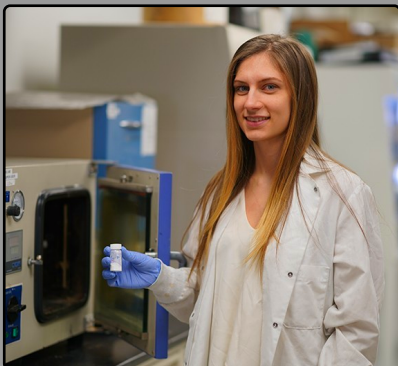
The journal *Nature* named MSE Ph.D. student, **Emily Hitz**, as one of its five emerging stars in the field of materials science.

Hitz, whose research focuses on solid-state battery innovation, is currently investigating applications for this technology on the moon as part of her three-year NASA fellowship. According to *Nature*, Hitz "stood out from more than 10,000 researchers identified in the League of Scholars database as having five or more publications since 2015 in six materials-science-specific journals tracked by the *Nature* Index."

Li-ion batteries use flammable liquid or gel electrolytes. Solid-state batteries boasting solid electrodes and electrolytes made from ceramic, polymer or glass, are far more stable. "NASA is obviously interested in having very safe batteries," says Hitz.

Hitz is interested in how new energy technology can become more accessible by incorporating low-cost and easy-to-manufacture resources. "One day we might literally be using a block of wood to make a battery," she said. "We use whatever we can to make it work."

Hitz, advised by MSE Professors **Liangbing Hu** and **Gary Rubloff**, has a degree in electrical engineering, but made the transition to MSE because she wanted the opportunity to discover highly desirable material properties by having a stronger chemistry focus in her work. "I wanted to change the materials I was working with, to change their properties," she said.



## MSE Wins 2020 Alumni Cup



ramp, the team did an amazing job tying it all together!

"This was my fourth alumni cup," said MSE Senior, **Shannon Donaldson**. "I loved getting to lead this team of spectacular engineers, going through the design process, playing off of each-other's strengths, and seeing the

The 2020 MSE Alumni Cup team built a 'Space Jam'-themed Rube Goldberg machine that successfully "dunked" a basketball for the ultimate win! It started by playing the Space Jam theme song, the vibrations of which knocked a ball off a platform. Next, the machine went through a series of steps and energy transfers, from a ball falling down a band gap, to the "secret stuff" flowing down the hydrophobic

hard work and dedication pay off in the best way possible: with a machine that not only looked better than it ever had before, but also with getting a perfect run and a first place win. This competition really provides opportunity to get hands-on experience not typically found in the classroom, apply concepts we've learned to a big picture project and make new friends, which is why I look forward to it every year!"

## SUPPORT UMD STUDENTS IN CRISIS

UMD giving initiatives continue to have a profound impact, most especially on its students. Given the current global climate, many of our students are struggling to make ends meet. Financial aid resources remain limited and are geared primarily towards research. Currently, our students need help simply to pay rent and eat. The University's Student Crisis Fund is nearly gone and *we need your help* to replenish the funds - *engineering students have the highest number of pending requests* - any amount will help!

Please visit [crisisfund.umd.edu](https://crisisfund.umd.edu)

now to submit your gift today. To learn more about what the A. James Clark School of Engineering is doing in response to the COVID-19 crisis, please visit the following page: [clark.covid.umd.edu](https://clark.covid.umd.edu)

Alternatively, you may submit a gift to MSE directly by visiting our giving page: [mse.umd.edu/giving](https://mse.umd.edu/giving).

If you have any questions, please don't hesitate to contact **Tamika Hodnett** ([thodnett@umd.edu](mailto:thodnett@umd.edu)) or **J.C. Zhao** ([jczhao@umd.edu](mailto:jczhao@umd.edu)), Professor and Chair, for more information.

Thank you in advance for your support and be well.

## 3D Printing & Ti-Ni Metal Bolster Cooling Technology

An international research team led by MSE Professor **Ichiro Takeuchi** has developed an improved elastocaloric cooling material using a blend of nickel and titanium metals, forged using a 3D printer, that is not only potentially more efficient than current technology, but is completely 'green.' Moreover, it can be quickly scaled up for use in larger devices. **The study was published in Science** recently.

"In this field of alternative cooling technologies, it's important to work on both the materials end, as well as the systems end – we are fortunate to have a highly-qualified team of experts at UMD to work on both ends," said Takeuchi. "It's only when these two efforts closely align that you make rapid progress, which our team was able to do."

There are three classes of caloric cooling technology: magnetocaloric, electrocaloric and elastocaloric. Magnetocaloric has been under development for 40 years and is just now on the verge of being commercialized. "The need for additive technology, otherwise

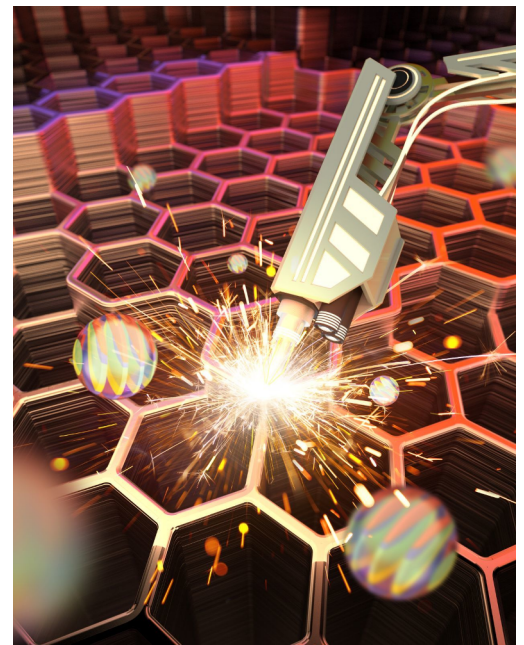
known as 3D printing, in this field is particularly acute because these materials also act as heat exchangers, delivering cooling to a medium such as water," Takeuchi said.

Takeuchi has been developing this technology for almost a decade – he received the **UMD Outstanding Invention of the Year** for this research in 2010, and the DOE ranked elastocaloric cooling, also known as thermoelastic cooling, #1 as the **'most promising' of alternative cooling technology in 2014** – and it is closer to commercialization.

"The key to this innovation that is fundamental, but not often discussed, is that materials fatigue – they wear out," said Takeuchi. "This is a problem when people expect their refrigerators to last for a decade, or longer. So, we addressed the problem in our study."

The team tested their creation heavily over a four-month period, and it still maintained its integrity.

"Some known elastocaloric materials start showing degradation in cooling behavior after just



hundreds of cycles," said Huilong Hou, who served as first author of the study. "To our surprise, the new material we synthesized showed no change after one million cycles."

The metal additive manufacturing mixes metals in powder form, and then uses a laser to melt them into a specified shape. By controlling the powder feed, the team was able to produce nanocomposites, which gave rise to the robust mechanical integrity in the material.

## Center for Materials Innovation (CMI) Launched

The UMD Clark School of Engineering announced the launch of the Center for Materials Innovation (CMI), a multidisciplinary research center that aims to encourage collaboration between faculty members and national partner institutions to develop innovative materials addressing current global challenges. "CMI will strive to facilitate materials innovations via close collaborations amongst campus faculty

members and interactions with national labs and federal agencies in the D.C. area, and to accelerate the development and marketing of materials technology innovated at UMD," said MSE Professor and CMI Founding Director, **Liangbing Hu**. Having 18+ years of research experience in materials innovation and technology development, Hu has made headlines repeatedly over the last several years for his research on

next-generation batteries, wood-based nanotechnology and extreme materials. Hu also co-founded two startup companies, Inventwood and HighT-Tech, to commercialize his technology. The Center, supported by MSE, the Clark School and the UMD Offices of the Vice President for Research and the Provost, will be located in the Kim Engineering Building. To learn more, visit the CMI website: [cmi.umd.edu](http://cmi.umd.edu)



## Tian Li, Off to Purdue

Tian Li, an MSE Research Associate, has accepted a full-time position as an assistant professor at Purdue University, beginning on August 17, 2020.

For nearly ten years, Li has carried out her postdoc research at UMD while advised by MSE Professor, **Liangbing Hu**. "I want to thank my amazing advisor, Dr. Hu," said Li. "He deals with countless tasks each day, yet he still finds time for his students when they need help with projects, papers, or even life advice. In addition to being brilliant, Dr. Hu is kind and works hard - he always says to us, 'work hard and smart, dream big and put your heart to it,' and he models this behavior every day. If I've learned one thing from him, it's that researchers are willing to step out of their comfort zone and push boundaries to develop fearless ideas."

Li earned her Ph.D. in electrical engineering under UMD Professor Mario Dagenais. "Dr. Dagenais is one of the most energetic faculty members that I've ever known. His passion affects his students greatly - many of his students have gone on to hold key positions in Fortune 500 companies such as Google and Intel. I am very proud to be one of his students."

Li also would like to thank all of the students, staff and faculty members across campus whom she has interacted with over the years. "I look forward to collaborating with my UMD colleagues in my future career!"



## MSE Ranked #23 by USNWR

MSE is ranked at #23 for 2021 U.S. MSE graduate school programs according to U.S. News and World Report, its highest ranking to date. MSE faculty members,



students and researchers alike have been performing high visibility materials research in areas such as energy and energy storage, sustainability and nanotechnology.

MSE Professors **Liangbing Hu**, **Tim Koeth**, **Yifei Mo** and **Ichiro Takeuchi** continue to make headlines and covers of top-tier journals, such as *Science*, *Nature* and *Physics Today*. Multiple professors continue to bring in large research grants every year, including **Eric Wachsman**, Director of the Maryland Energy Innovation

Institute, most recently with the \$18M U.S. - Israel Energy Center project. The average annual research expenditure reached \$0.8M per faculty member. Current students, researchers and alumna - for example, **Jacob Garnett**, **Tian Li** and **Ashley Ruth** - consistently receive honors and awards for outstanding contributions.

In 2019, our Department ranked #18 among U.S. university MSE departments according to the *Nature Index*, a more data-driven ranking.

## MSE Honors and Awards

### STUDENTS:

- **Naila Al-Hasan** (advised by I. Takeuchi): 2019 MRS Graduate Student Silver Award
- **Emily Hitz** (advised by L. Hu): 3 year NASA Fellowship; Nature Early Career Research Award in Materials Science. [Learn more...](#)
- **John Howard** (advised by M. Leite): 2019 MRS Fall Meeting Best Poster Award
- **Tian Li** (advised by L. Hu): 2020 MRS Postdoctoral Award. [Learn more...](#)
- **Kang-Yi Lin** (advised by G. Oehrlein): best presentation award at the 2019 AVS International Conference on ALD/ALE. [Learn more...](#)
- **Scott Moroch** (advised by T. Koeth): 2020 Barry Goldwater Scholarship.
- **Adelaide Nolan** (advised by Y. Mo): 2020 Harry K. Wells Energy Scholarship; 2019 Engle North America Chuck Edwards Memorial Fellowship, College Park Foundation; NSF Graduate Research Fellowship Honorable Mention. [Learn more...](#)
- **Adam Pranda** (G. Oehrlein): 2019 John Coburn and Harold Winters Student Award, AVS. [Learn more...](#)
- **Z. Warecki, J. Chao** (advised by J. Cumings): 2nd place in SciVid/MRS '19 Fall Meeting

### FACULTY:

- **Liangbing Hu**: 2020 USM Regents Faculty Award; 2019 'Highly Cited' Researcher, Web of Science Group. [Learn more...](#)
- **Raymond Phaneuf**: 2019 APS Fellow. [Learn more...](#)
- **Manfred Wuttig**: 2020 Clark School Poole & Kent Teaching Award for Senior Faculty
- **J.C. Zhao**: 2021 William Hume-Rothery Award, offered by TMS. [Learn more...](#)