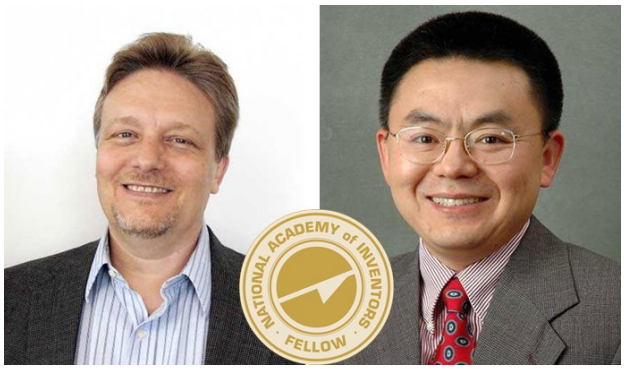
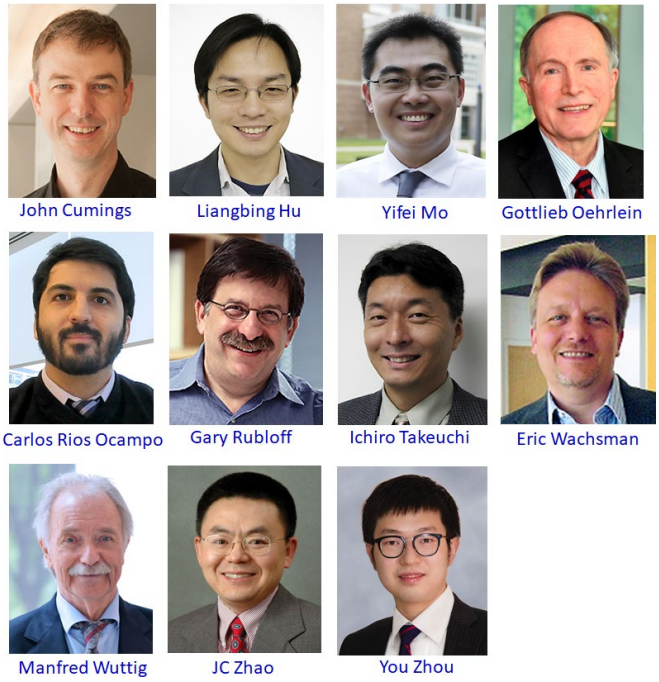
FACULTY HONORS AND AWARDS



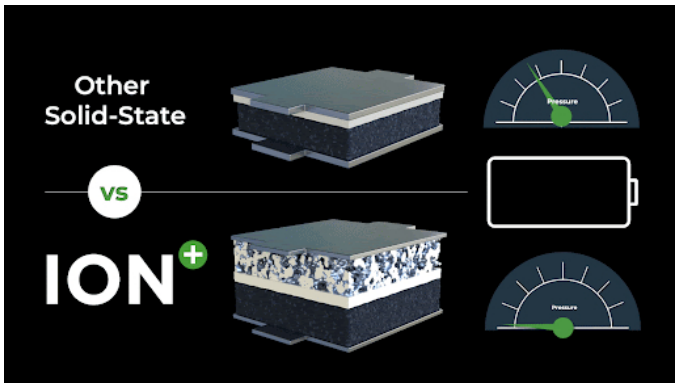
- Profs. Wachsman and Zhao named Fellows of the National Academy of Inventors (NAI)
- Prof. Liangbing Hu named Finalist for 2022 Blavatnik National Awards for Young Scientists
- Prof. Timothy Koeth won DARPA Young Faculty Award (YFA) 2022
- Prof. You Zhou won DOE 2022 Early Career Award



- Eleven MSE Faculty amongst top 2% of world scientists
- Prof. Liangbing Hu won his 4th R&D 100 Award
- Prof. Zhao won Humboldt Research Award and named TMS Fellow
- Prof. Oded Rabin received 2022/23 U.S. Fulbright Scholar Award

RESEARCH NEWS

Professor Eric Wachsman's spin-off company closes $60M investment round including Toyota Ventures



Ion Storage Systems, Inc. (ION) announced the closing of its Series A funding round, exceeding its original target of $30 million. The company welcomed investments from Toyota Ventures, Tenaska, Bangchak Corporation and other investors, in addition to the investments from its lead investors. (View Toyota's full press release: "Rethinking the Architecture of Solid-State Batteries: Our Investment in Ion Storage Systems")

Founded in 2015, ION has developed a groundbreaking 3D ceramic electrolyte architecture that addresses the key issues hindering the growth of solid-state batteries — namely durability and the ability to manufacture at scale. Spun out of the University of Maryland's Energy Innovation Institute, ION's core technology is the brainchild of executive chairman Dr. Eric Wachsman, who founded the company along with chief technology officer Dr. Greg Hitz. The pair's expertise in solid-state batteries and manufacturing, combined with CEO Ricky Hanna's 20+ years of experience in batteries from Apple and Valence Technologies, has enabled the team to meet and exceed performance metrics for ION's next-generation batteries.

"We are thrilled to add this exceptional group of investors and partners to our oversubscribed round to support ION's next phase of growth," said Ricky Hanna, ION's Chief Executive Officer. "As ION prepares to meet the overwhelming demand for safe, cost efficient and energy dense batteries, our team has grown to meet the challenge. ION's battery performance and safety far exceeds what traditional Lithium Ion can offer and will become the benchmark for battery design for decades to come."

For the complete story, click here. For related news:

- Wachsman, Ion Storage Systems featured in the Wall Street Journal
- MPT State Circle Highlights UMD Innovative Energy Technology

InventWood and UMD Receive $20M ARPA-E SCALEUP Award

InventWood®, founded by Dr. Liangbing Hu, Herbert Rabin Distinguished Professor in the University of Maryland (UMD) Department of Materials Science and Engineering (MSE) and director of the Center for Materials Innovation, was recently announced as a recipient of a $20M SCALEUP award from the US Department of Energy's (DOE) innovation agency, Advanced Research Projects Agency–Energy (ARPA-E). With this award, UMD has received over $100M in ARPA-E funding (for 37 awards) since its inception in 2009, making it one of the top three universities in the country in ARPA-E funding and awards received.

On November 22, 2022, the Secretary of Energy Jennifer Granholm announced the award of $100M to fund eight clean energy technology projects that support President Biden's goals to lower emissions through clean energy deployment, reduce dependence on imports of critical minerals, and secure the nation's standing as a global leader of research and innovation. The selected projects, including the one InventWood is leading, will develop novel technologies that enhance existing clean energy infrastructure, such as aircraft electrification, rapid electric vehicle charging, and advanced floating offshore wind turbine technologies.

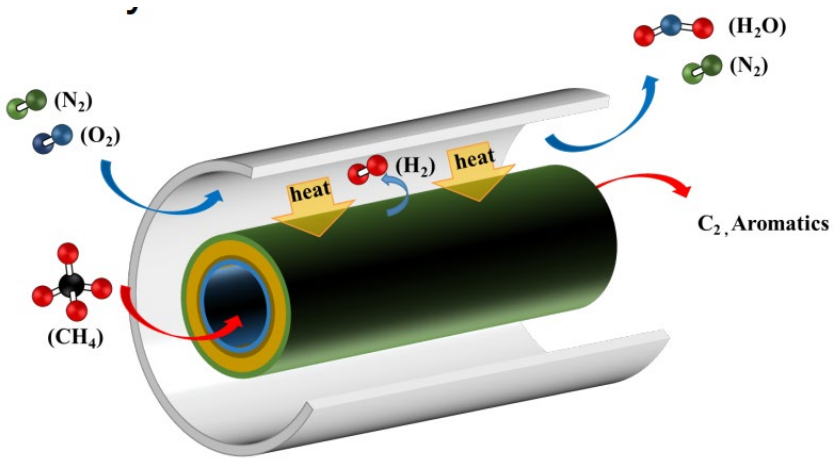
InventWood's SCALEUP project will contribute to the decarbonization of buildings and enable them to store significantly greater amounts of carbon by scaling up a game-changing wood material, MettleWood®, that is 60% stronger than construction grade steel but 80% lighter, much less expensive, and far more sustainable. UMD professors Dr. Liangbing Hu and Dr. Ming Hu are co-PIs of this project.

For the complete story, click here.

Additional news releases related to this include:

- UMD Scientists Develop Wood-MOF for Greater Sustainability

Professor Wachsman's Start-Up, Alchemity, Receives Shell GameChanger Funding



The new University of Maryland (UMD) and Maryland Energy Innovation Institute (MEI^2) start-up company Alchemity is pleased to announce its selection by Shell GameChanger, an accelerator program for start-ups and businesses with promising early-stage technology ideas that have the potential to impact the future of energy. Alchemity is developing technologies and applications in the energy industry using ion-conducting ceramics, from electric *Power* through advanced solid oxide fuel cells (SOFCs) to *Fuels & Chemicals* through integrated catalytic membrane reactors.

Alchemity was selected by Shell GameChanger as one of the winners of the Chemicals Decarbonization Challenge 2021, to receive development funding over a two-year period to demonstrate a single-step catalytic membrane reactor. Alchemity's technology will convert stranded natural gas that might otherwise be flared or vented, a major contributor to greenhouse gas (GHG) emissions, to value-added chemical products. By turning a waste gas source into a liquid commodity chemical, this technology can bring a valuable contribution to reducing the emissions of industrial operations. The integrated design provides a potential step change reduction in capital cost by combining catalysis and separation in a single unit, which also increases overall system energy efficiency and drastically reduces carbon emissions.

For the full story, click here
Additional related stories:

- UMD Researchers Convert Methane Without Greenhouse Gas Emissions
- UMD Researchers to Design Greener Aircraft Engine
- People Love Hybrid Cars. Get Ready for Hybrid Planes

Maryland Engineers Get Cracking on Sustainability with Crab Shell-based Battery

Electric vehicles are a major part of the equation for protecting Earth's climate, but not everything adds up yet: The batteries powering these rolling sustainability solutions aren't always sustainable themselves.

But now University of Maryland engineers have created a zinc battery with a biodegradable electrolyte from an unexpected source—crab shells. The discovery was presented in a paper this month in the journal *Matter*.

"Vast quantities of batteries are being produced and consumed, raising the possibility of environmental problems," said the lead author and materials science and engineering Professor Liangbing Hu, director of UMD's Center for Materials Innovation. The study's other authors are affiliated with the University of Houston and UMD's Department of Materials Science and Engineering. For example, he said, polypropylene and polycarbonate separators, which are widely used in lithium-ion batteries, will take hundreds or thousands of years to degrade.

Current batteries use an often-flammable or corrosive electrolyte to shuttle ions back and forth between positively and negatively charged terminals within the battery, providing current. The new battery, which could be used to store renewable power from large-scale wind and solar sources, uses a gel electrolyte made from a biological material with many natural sources called chitosan.

"The most abundant source of chitosan is the exoskeletons of crustaceans, including crabs, shrimps, and lobsters, which can be easily obtained from seafood waste," Hu said. "You can find it on your table."

A biodegradable electrolyte means that about two-thirds of the battery could be broken down by microbes, with the chitosan electrolyte decomposed completely within five months. This leaves behind the metal component, in this case zinc, rather lead or lithium. "Zinc is more abundant in earth's crust than lithium," said Hu. "Generally speaking, well-developed zinc batteries are cheaper and safer."

For the full story, click here
Additional related stories:

- Converting Biowaste into Hydroxide Exchange Membrane

Prof. Ichiro Takeuchi research graced the cover of *Nature Reviews Materials*

As we see the effect of climate change before our eyes, calls to minimize greenhouse gas emissions and demands for higher energy efficiency continue to drive research into green cooling and refrigeration technologies, which do away with ubiquitous vapor compression where refrigerants are hydroflourocarbons (HFCs) with high global warming potentials. Among the alternative cooling technologies are caloric cooling based on field-induced solid-state phase transitions. The field of caloric cooling has undergone a series of changes over the past 50 years, bolstered by the advent of new materials and devices, and these developments have led to the emergence of the concept of multicaloric cooling in the past decade.

Ichiro Takeuchi, a professor in the University of Maryland (UMD) Department of Materials Science and Engineering (MSE), together with his colleagues Huilong Hou (Beihang Univ.) and Suxin Qian (Xian Jiaotong Univ.) have published a major perspective article in this burgeoning field of multicaloric cooling as a new direction in environmentally friendly refrigeration technology. The article discusses new materials and their physics involving coexisting ferroic order parameters which can lead to multicaloric cooling processes. The authors examine key factors that govern the overall system efficiency of potential multicaloric devices. The study was published in the August issue of *Nature Reviews Materials* as a cover article (https://www.nature.com/articles/s41578-022-00428-x).

For the full story, click here.

Additional news on Dr. Takeuchi's work:

International research team sheds light on inner workings of unconventional superconductors

Prof. Liangbing Hu's research has graced the cover of *Nature & Science 4* times

Dr. Hu's recent contributions include:

- Electrified Heating Towards Green Methane Conversion and Ammonia Synthesis
- Radical scavengers improve the durability of electrocatalysts
- UMD, Princeton, PPPL, and ANL receive $4.5M for Low Carbon Manufacturing
- Fast-Charging, Solid-State, Roll-to-Roll Processed Li Metal Batteries Enabled by Intercalated Ions in Cellulose Molecular Channels
- Engineering a Multi-Element Atomic Arrangement

UMD top ranked U.S. university of solid-state battery research publications

Solid-state batteries are considered the ultimate future of energy storage for electric vehicles and consumer electronics. This promise has resulted in recent multi-billion$ investments in solid-state battery company start-ups like QuantumScape and Solid Power. All these solid-state battery start-ups have one thing in common, they started from university research and the quality of university research is gauged primarily by the resulting publications in terms of both the number of peer reviewed papers published and how many times those papers are cited in the scientific literature.

A recent citation analysis from Elsevier, a leading scientific publishing company, showed that among solid-state battery publications those based on garnet-electrolytes are the fastest growing topic and moreover revealed the University of Maryland (UMD) is the top ranked U.S. university in terms of number of publications in this topic and globally in terms of citations of those papers. Results are from the Elsevier product SciVal, a data analysis and visualization tool based on the Scopus database, which indexes the abstracts and references of approximately 25,000 academic journals from 7,000 publishers.

Topics showing high momentum over the past 10 years were further analyzed. Research analysis identified solid-state batteries as a major topic of rapid growth between 2011 and 2020. In 2011, there were 66 publications on solid-state battery technology, but by 2020, 722 papers were published on the topic. In a study conducted for the period 2015-2019 (table below), UMD ranked #4 globally and top in the U.S. in terms of solid-state battery Scholarly Output (number of publications), while also having the highest citation impact globally of those publications, the field-weighted citation impact (FWCI).

For the complete story, click here.

STUDENT HONORS AND AWARDS

- Eleanor Grosvenor Receives NSF Graduate Research Fellowship
- Natalie Schwab Wins Outstanding Student Poster Presentation Award
- MSE Ph.D. Student Daniela Fontecha Receives NSF Fellowship Award
- Maryland undergraduate (now graduate) student Logan Saar played a key role in developing LEGO-based robots for teaching artificial intelligence
- An experiment by a team of Maryland Materials Science undergraduate student Vincent Lan and other Maryland Engineering students launched to space:
- MSE graduate student Joshua Levy is the lead author of a major publication in *Advanced Materials Technologies*.