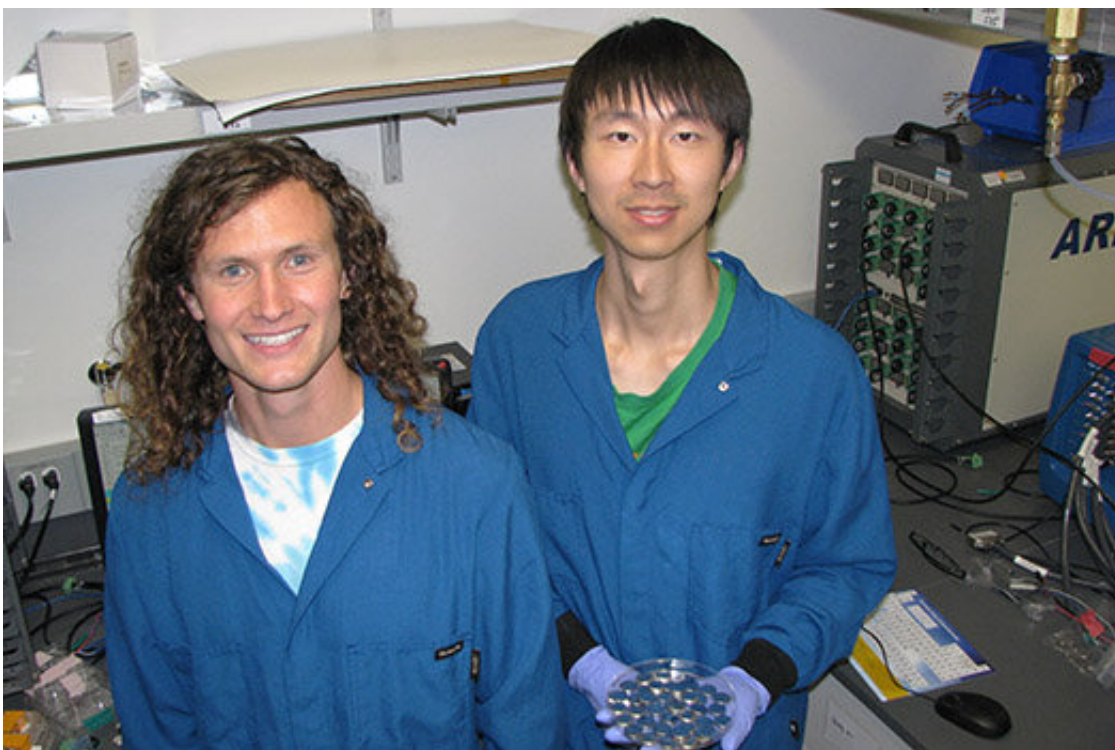


## New coating brings lithium metal battery closer to reality

August 26 2019, by Mark Golden

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Lead authors and Ph.D. students David Mackanic, left, and Zhiao Yu with their battery tester at right. Yu holds a dish of already tested cells that they call "the battery graveyard." Credit: Mark Golden

Hope has been restored for the rechargeable lithium metal battery—a potential battery powerhouse relegated for decades to the laboratory by its short life expectancy and occasional fiery demise while its rechargeable sibling, the lithium-ion battery, now rakes in more than \$30

billion a year.

A new [coating](#) could make lightweight [lithium metal](#) batteries safe and long lasting, a boon for development of next-generation electric vehicles. (Image credit: Shutterstock)

A team of researchers at Stanford University and SLAC National Accelerator Laboratory has invented a coating that overcomes some of the battery's defects, described in a paper published Aug. 26 in *Joule*.

In laboratory tests, the coating significantly extended the battery's life. It also dealt with the combustion issue by greatly limiting the tiny needlelike structures—or dendrites—that pierce the separator between the battery's positive and negative sides. In addition to ruining the battery, dendrites can create a short circuit within the battery's flammable liquid. Lithium-ion batteries occasionally have the same problem, but dendrites have been a non-starter for lithium metal [rechargeable batteries](#) to date.

"We're addressing the holy grail of lithium metal batteries," said Zhenan Bao, a professor of chemical engineering, who is senior author of the paper along with Yi Cui, professor of materials science and engineering and of photon science at SLAC. Bao added that dendrites had prevented lithium metal batteries from being used in what may be the next generation of electric vehicles.

## The promise

Lithium metal batteries can hold at least a third more power per pound as lithium-ion batteries do and are significantly lighter because they use lightweight lithium for the positively charged end rather than heavier graphite. If they were more reliable, these batteries could benefit portable electronics from notebook computers to cell phones, but the

real pay dirt, Cui said, would be for cars. The biggest drag on electric vehicles is that their batteries spend about a fourth of their energy carrying themselves around. That gets to the heart of EV range and cost.

"The capacity of conventional [lithium-ion batteries](#) has been developed almost as far as it can go," said Stanford Ph.D. student David Mackanic, co-lead author of the study. "So, it's crucial to develop new kinds of batteries to fulfill the aggressive energy density requirements of modern electronic devices."

The team from Stanford and SLAC tested their coating on the positively charged end—called the anode—of a standard lithium metal battery, which is where dendrites typically form. Ultimately, they combined their specially coated anodes with other commercially available components to create a fully operational battery. After 160 cycles, their lithium metal cells still delivered 85 percent of the power that they did in their first cycle. Regular lithium metal cells deliver about 30 percent after that many cycles, rendering them nearly useless even if they don't explode.

The new coating prevents dendrites from forming by creating a network of molecules that deliver charged lithium ions to the electrode uniformly. It prevents unwanted chemical reactions typical for these batteries and also reduces a chemical buildup on the anode, which quickly devastates the battery's ability to deliver power.

"Our new coating design makes [lithium metal](#) batteries stable and promising for further development," said the other co-lead author, Stanford Ph.D. student Zhiao Yu.

The group is now refining their coating design to increase capacity retention and testing cells over more cycles.

"While use in electric vehicles may be the ultimate goal," said Cui,

"commercialization would likely start with consumer electronics to demonstrate the battery's safety first."

**More information:** Zhiao Yu et al, A Dynamic, Electrolyte-Blocking, and Single-Ion-Conductive Network for Stable Lithium-Metal Anodes, *Joule* (2019). [DOI: 10.1016/j.joule.2019.07.025](https://doi.org/10.1016/j.joule.2019.07.025)

Provided by Stanford University

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