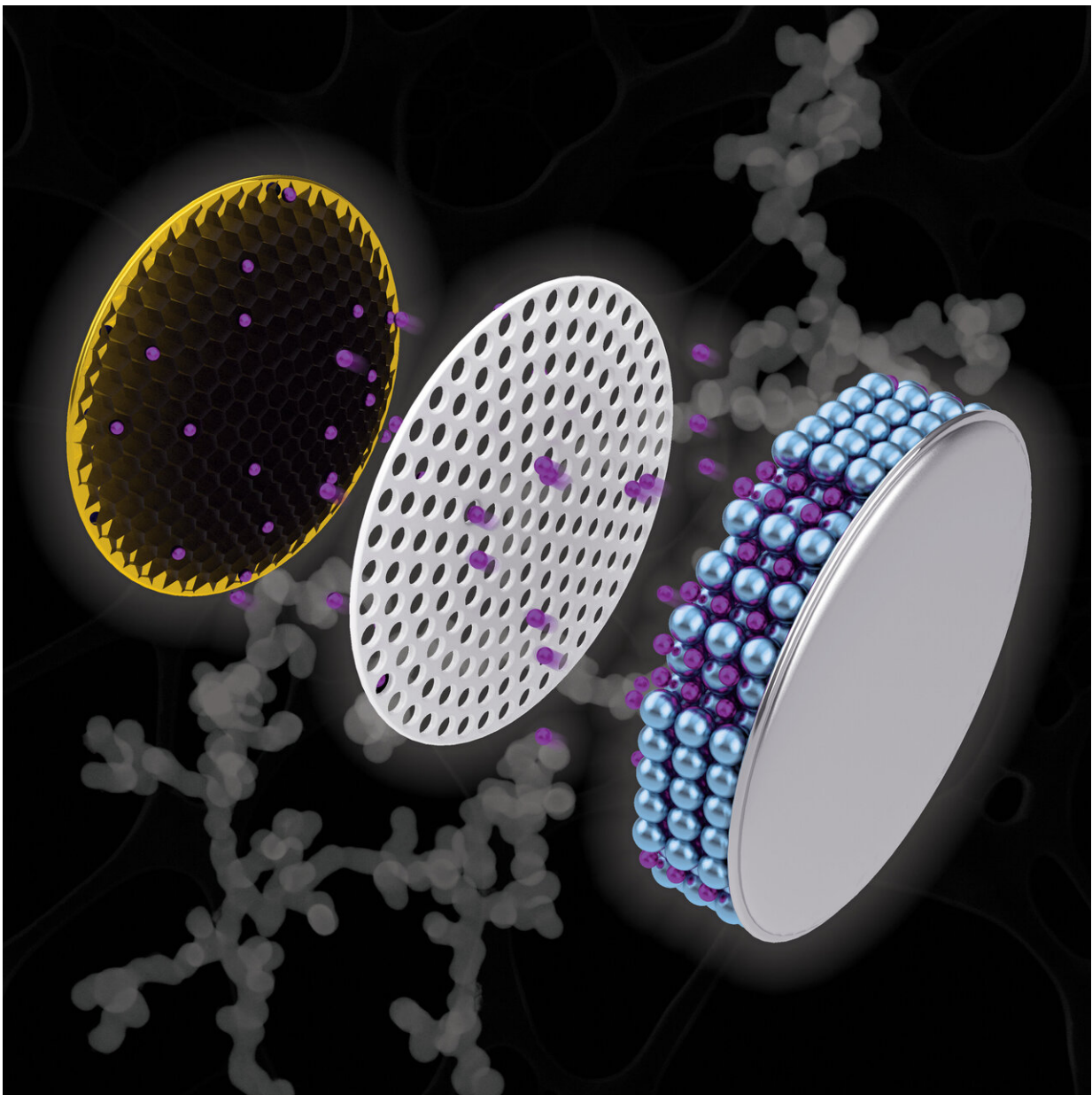


# 'Nanochains' could increase battery capacity, cut charging time

September 19 2019, by Kayla Wiles



Artistic depiction of a coin cell battery with a copper electrode (left) containing a black nanochain structure, which researchers have discovered could increase the capacity of a battery and cut charging time. Credit: Purdue University illustration/Henry Hamann

How long the battery of your phone or computer lasts depends on how many lithium ions can be stored in the battery's negative electrode material. If the battery runs out of these ions, it can't generate an electrical current to run a device and ultimately fails.

Materials with a higher [lithium ion](#) storage capacity are either too heavy or the wrong shape to replace graphite, the [electrode material](#) currently used in today's batteries.

Purdue University scientists and engineers have introduced a potential way that these materials could be restructured into a new electrode design that would allow them to increase a battery's lifespan, make it more stable and shorten its charging time.

The study, appearing as the cover of the September issue of *Applied Nano Materials*, created a net-like structure, called a "nanochain," of antimony, a metalloid known to enhance lithium ion charge capacity in batteries.

The researchers compared the nanochain electrodes to graphite electrodes, finding that when coin cell batteries with the nanochain electrode were only charged for 30 minutes, they achieved double the lithium-ion capacity for 100 [charge-discharge cycles](#).

Some types of commercial batteries already use carbon-metal composites similar to antimony metal negative electrodes, but the

material tends to expand up to three times as it takes in lithium ions, causing it to become a safety hazard as the battery charges.



A new method could allow better materials to make up battery electrodes by converting them into a nanochain structure, the black material on this copper electrode of a coin cell. Credit: Purdue University /Kayla Wiles

"You want to accommodate that type of expansion in your smartphone batteries. That way you're not carrying around something unsafe," said Vilas Pol, a Purdue associate professor of chemical engineering.

Through applying [chemical compounds](#)—a reducing agent and a

nucleating agent—Purdue scientists connected the tiny antimony particles into a nanochain shape that would accommodate the required expansion. The particular reducing agent the team used, ammonia-borane, is responsible for creating the empty spaces—the pores inside the nanochain—that accommodate expansion and suppress electrode failure.

The team applied ammonia-borane to several different compounds of antimony, finding that only antimony-chloride produced the nanochain structure.

"Our procedure to make the nanoparticles consistently provides the chain structures," said P. V. Ramachandran, a professor of organic chemistry at Purdue.

The nanochain also keeps lithium ion capacity stable for at least 100 charging-discharging cycles. "There's essentially no change from cycle 1 to cycle 100, so we have no reason to think that cycle 102 won't be the same," Pol said.

Henry Hamann, a chemistry graduate student at Purdue, synthesized the antimony nanochain structure and Jassiel Rodriguez, a Purdue chemical engineering postdoctoral candidate, tested the electrochemical battery performance.

The [electrode](#) design has the potential to be scalable for larger batteries, the researchers say. The team plans to test the design in pouch cell batteries next.

**More information:** Jassiel R. Rodriguez et al, Three-Dimensional Antimony Nanochains for Lithium-Ion Storage, *ACS Applied Nano Materials* (2019). [DOI: 10.1021/acsnm.9b01316](https://doi.org/10.1021/acsnm.9b01316)

Provided by Purdue University

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