

## New generation battery technology

In the switch to "greener" energy sources, the demand for rechargeable lithium-ion batteries is surging. However, their cathodes typically contain cobalt -- a metal whose extraction has high environmental and societal costs. Now, researchers in ACS Central Science report evaluating an earth-abundant, carbon-based cathode material that could replace cobalt and other scarce and toxic metals without sacrificing lithium-ion battery performance.

So, Mircea Dinc<sup>?</sup> and his colleagues wanted to see if other carbon-based cathode materials could be more successful. They may have found a worthy candidate in bis-tetraaminobenzoquinone (TAQ). TAQ molecules form layered solid-state structures than can potentially compete with traditional cobalt-based cathode performance.

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MIT researchers have now designed a battery material that could offer a more sustainable way to power electric cars. The new lithium-ion battery includes a cathode based on organic materials, instead of cobalt or nickel (another metal often used in lithium-ion batteries).

In a new study, the researchers showed that this material, which could be produced at much lower cost than cobalt-containing batteries, can conduct electricity at similar rates as cobalt batteries. The new battery also has comparable storage capacity and can be charged up faster than cobalt batteries, the researchers report.

"I think this material could have a big impact because it works really well," says Mircea Dinc<sup>?</sup>, the W.M. Keck Professor of Energy at MIT. "It is already competitive with incumbent technologies, and it can save a lot of the cost and pain and environmental issues related to mining the metals that currently go into batteries."

Dinc<sup>?</sup> is the senior author of the study, which appears today in the journal ACS Central Science. Tianyang Chen PhD '23 and Harish Banda, a former MIT postdoc, are the lead authors of the paper. Other authors include Jiande Wang, an MIT postdoc; Julius Oppenheim, an MIT graduate student; and Alessandro Franceschi, a research fellow at the University of Bologna.

Most electric cars are powered by lithium-ion batteries, a type of battery that is recharged when lithium ions flow from a positively charged electrode, called a cathode, to a negatively electrode, called an anode. In most lithium-ion batteries, the cathode contains cobalt, a metal that offers high stability and energy density.

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However, cobalt has significant downsides. A scarce metal, its price can fluctuate dramatically, and much of the world's cobalt deposits are located in politically unstable countries. Cobalt extraction creates hazardous working conditions and generates toxic waste that contaminates land, air, and water surrounding the mines.

"Cobalt batteries can store a lot of energy, and they have all of features that people care about in terms of performance, but they have the issue of not being widely available, and the cost fluctuates broadly with commodity prices. And, as you transition to a much higher proportion of electrified vehicles in the consumer market, it's certainly going to get more expensive," Dinc? says.

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