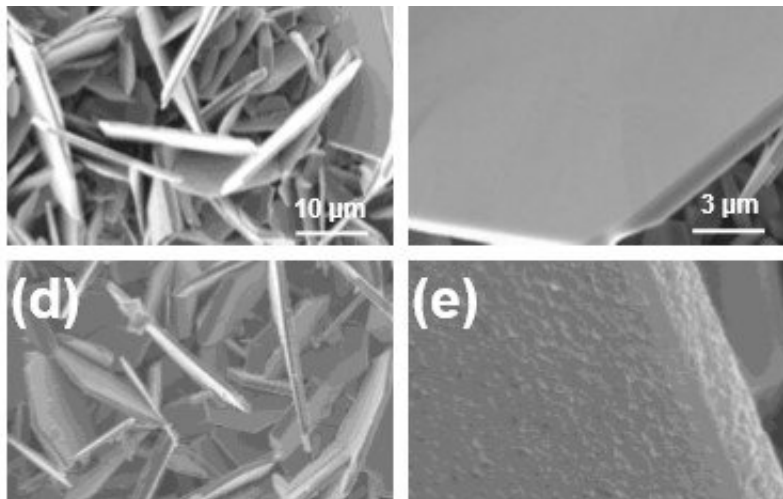


New discovery makes fast-charging, better performing lithium-ion batteries possible

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Materials research -- published in *Nature Communications* -- makes possible lithium-ion batteries that can charge in a matter of minutes but still operate at a high capacity. Credit: Rensselaer Polytechnic Institute

Creating a lithium-ion battery that can charge in a matter of minutes but still operate at a high capacity is possible, according to research from Rensselaer Polytechnic Institute just published in *Nature Communications*. This development has the potential to improve battery performance for consumer electronics, solar grid storage, and electric vehicles.

A lithium-ion battery charges and discharges as lithium ions move between two electrodes, called an anode and a cathode. In a traditional

lithium-ion battery, the anode is made of graphite, while the cathode is composed of lithium cobalt oxide.

These materials perform well together, which is why [lithium-ion batteries](#) have become increasingly popular, but researchers at Rensselaer believe the function can be enhanced further.

"The way to make batteries better is to improve the [materials](#) used for the electrodes," said Nikhil Koratkar, professor of mechanical, aerospace, and [nuclear engineering](#) at Rensselaer, and corresponding author of the paper. "What we are trying to do is make lithium-ion technology even better in performance."

Koratkar's extensive research into nanotechnology and energy storage has placed him among the most highly cited researchers in the world. In this most recent work, Koratkar and his team improved performance by substituting cobalt oxide with vanadium disulfide (VS_2).

"It gives you higher energy density, because it's light. And it gives you faster charging capability, because it's highly conductive. From those points of view, we were attracted to this material," said Koratkar, who is also a professor in the Department of Materials Science and Engineering.

Excitement surrounding the potential of VS_2 has been growing in recent years, but until now, Koratkar said, researchers had been challenged by its instability—a characteristic that would lead to short battery life. The Rensselaer researchers not only established why that instability was happening, but also developed a way to combat it.

The team, which also included Vincent Meunier, head of the Department of Physics, Applied Physics, and Astronomy, and others, determined that lithium insertion caused an asymmetry in the spacing between vanadium

atoms, known as Peierls distortion, which was responsible for the breakup of the VS_2 flakes. They discovered that covering the flakes with a nanolayered coating of titanium disulfide (TiS_2)—a material that does not Peierls distort—would stabilize the VS_2 flakes and improve their performance within the battery.

"This was new. People hadn't realized this was the underlying cause," Koratkar said. "The TiS_2 coating acts as a buffer layer. It holds the VS_2 material together, providing mechanical support."

Once that problem was solved, the team found that the VS_2 - TiS_2 electrodes could operate at a high specific capacity, or store a lot of charge per unit mass. Koratkar said that vanadium and sulfur's small size and weight allow them to deliver a high capacity and energy density. Their [small size](#) would also contribute to a compact [battery](#).

When charging was done more quickly, Koratkar said, the capacity didn't dip as significantly as it often does with other electrodes. The electrodes were able to maintain a reasonable capacity because, unlike cobalt oxide, the VS_2 - TiS_2 material is electrically conductive.

Koratkar sees multiple applications for this discovery in improving car batteries, power for portable electronics, and solar energy storage where high [capacity](#) is important, but increased charging speed would also be attractive.

Provided by Rensselaer Polytechnic Institute

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