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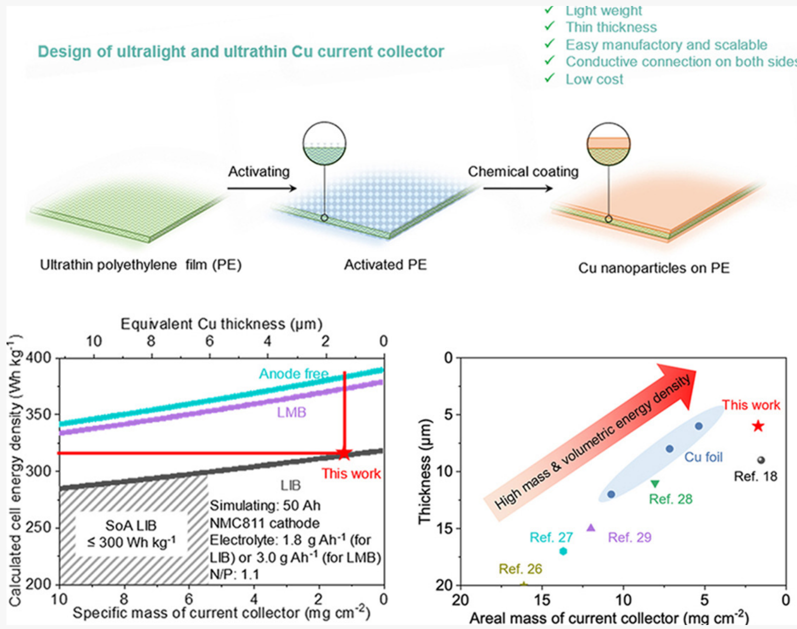
Lighting the future: ultrathin copper collectors for enhanced battery performance

GA, UNITED STATES, March 31, 2025 /EINPresswire.com/ -- Scientists have developed ultralight and ultrathin copper current collectors that could redefine lithium battery technology. These collectors, far lighter than traditional copper foils, significantly enhance cell-level energy density. This leap forward in efficiency and weight reduction is poised to transform the performance of portable electronics and electric vehicles, where lightweight, high-capacity batteries are crucial for progress.



Design and Impact of Ultralight Copper Current Collectors. A schematic of the fabrication process for ultralight and ultrathin copper current collectors using a polyethylene (PE) scaffold and electroless plating.

As electric vehicles, portable devices, and smart grids continue to expand, the demand for high-energy-density batteries has never been greater. Copper current collectors, although critical for battery function, contribute heavily to the overall weight and cost of these systems, limiting advancements in energy storage technology. Current approaches to reduce their weight often result in compromised mechanical strength or poor scalability. This underscores the urgent need for innovative, scalable solutions to create lightweight, high-performance current collectors.

A research team from Michigan State University has made a significant breakthrough, as detailed in their April 26, 2024 publication in eScience. Using an advanced electroless plating method, they fabricated ultralight copper current collectors on a polymer scaffold, reducing their weight by 70% compared to conventional copper foils. The new design retains exceptional mechanical strength and electrochemical performance, providing a cost-effective and scalable way to increase energy density in lithium-ion batteries without requiring changes to existing battery chemistries.

The innovative technique involves coating copper onto a 5 μm polyethylene scaffold, creating a current collector with an areal mass of just 1.72 mg/cm² — a 68% reduction compared to standard options. This ultrathin, ultralight design boosts cell-level energy density by 5 – 10% while maintaining volumetric energy density. Additional tests showed the collectors exhibit excellent thermal stability and tensile strength comparable to traditional foils. Batteries equipped with these collectors demonstrated improved cycling performance and higher energy efficiency, underscoring the material's readiness for industrial deployment. The simplicity and scalability of this method offer a practical path for integration into existing production processes.

"Reducing the weight and thickness of current collectors has long been a bottleneck in advancing battery technology," explained Dr. Chengcheng Fang, lead researcher of the study. "This solution not only addresses these challenges but also offers a scalable and cost-efficient pathway to elevate energy storage systems to new heights."

The ultralight current collectors have far-reaching implications for energy storage technologies. In electric vehicles, they could enable longer ranges and reduce costs, while in portable devices, they could lead to lighter, more efficient designs. The collectors' seamless compatibility with existing battery architectures ensures they can be swiftly adopted into manufacturing pipelines, accelerating the transition toward more sustainable and efficient energy solutions. This innovation marks a pivotal step in reimagining the future of batteries, laying the groundwork for lightweight, high-capacity systems that meet the growing demands of a rapidly electrifying world.

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