

Laser micro- and nano-structuring of Copper Current Collectors for enhanced lithium metal battery performance

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Electric mobility, driven by battery-powered vehicles, offers a promising solution to reduce greenhouse gas emissions and improve air quality, contributing to climate change mitigation. However, the sustainability of battery production and disposal presents significant challenges, particularly regarding resource extraction and environmental impact. Advances in battery technology aim to enhance performance and extend lifespan, thereby reducing the need for raw materials.

Future developments focus on next-generation batteries, such as solid-state and anode-free designs, to improve energy density, safety, and cost-efficiency.

In this context, the proposed research investigates the use of ultrashort pulsed laser for micro- and nano-structuring copper current collectors to increase their lithium affinity. Copper foils of 100 μm and 10 μm thickness were textured and analyzed using SEM and XPS, then tested in anode-free lithium (AFLB) coin cells.

Electrochemical evaluations show that laser-textured surfaces enhance specific discharge capacity, maintain state of health over 50 cycles, and achieve high coulombic efficiency. These results demonstrate the effectiveness of laser-induced surface modification in improving lithium plating reversibility and overall battery performance, offering a scalable route toward safer and more efficient lithium-metal batteries. The same principle is also applied to zinc batteries, which are rechargeable, supporting a more sustainable energy model.
