

Fatigue of Li metal anode in solid-state batteries





Overview

Why do solid-state lithium batteries fail over time?

Credit: Science (2025). DOI: 10.1126/science.adq6807 A team of materials scientists and engineers affiliated with several institutions in China has found that one of the major reasons solid-state lithium batteries fail over time is metal fatigue in the anode, which contributes to interface degradation and dendrite growth.

What causes a lithium ion battery to fail?

In so doing, they found that metal fatigue occurring in the anode (due to the expansion and contraction of lithium during charging and recharging) was the main reason for battery failure. Such fatigue, it was found, promoted the growth of dendrites.

Can a lithium battery cause a short circuit?

Cause a short circuit, rendering the battery unsafe and unusable. Even at low current densities, dendrites can form due to cyclic mechanical fatigue of the lithium metal anode. The Coffin-Manson law of material fatigue, a well-known principle in materials science, was found applicable to lithium metal degradation.

What is a solid-state lithium battery (SSB)?

Solid-state Li metal batteries (SSBs), which integrate a high-capacity Li metal anode (LMA) with a nonflammable inorganic solid-state electrolyte (SSE) and a high-voltage cathode, have emerged as a promising choice to simultaneously offer both high energy density and high safety (1 - 4).

Why is Li 4 Mg alloy anode kinetically ultrasluggish?

A kinetically ultrasluggish Li 4 Mg alloy anode can also verify the essential role of high fatigue resistance. The Li + diffusion coefficient of Li 4 Mg ($0.17 \times 10^{-11} \text{ cm}^2/\text{s}$) is only ~7.8% of that of pristine Li ($2.2 \times 10^{-11} \text{ cm}^2/\text{s}$),



whereas its mechanical strength is 25.4 times higher than pristine Li (fig. S38) (40).

Are solid-state lithium metal batteries good for electric vehicles?

Marc S. Lavine Solid-state lithium metal batteries (SSBs) are promising for electric vehicles because of their potential to provide high energy density and enhanced safety. However, these batteries face short-circuit challenges caused by uncontrolled lithium dendrite growth during cycling.



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Fatigue of Li Metal Anode in Solid-State Batteries

A recent study identifies mechanical fatigue of the lithium metal anode, rather than current density alone, as the key cause behind dendrite-induced short circuits and failure of Solid-State Batteries (SSBs).



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Lithium Alloy Anodes for All-Solid-State Lithium Batteries: From

Abstract All-solid-state lithium metal batteries (ASSLMBs) are poised to surpass conventional graphite-anode lithium-ion batteries due to their enhanced safety and high energy density.





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