Using Mechanical Relaxation to Stabilize Solid-State Lithium Batteries

Scientific Achievement

This work shows that carefully timed rest or low-current steps allow lithium metal and the Li_6PS_5Cl solid electrolyte to relax mechanically, closing interfacial voids and raising the critical current density of solid-state batteries by up to 2–3x.

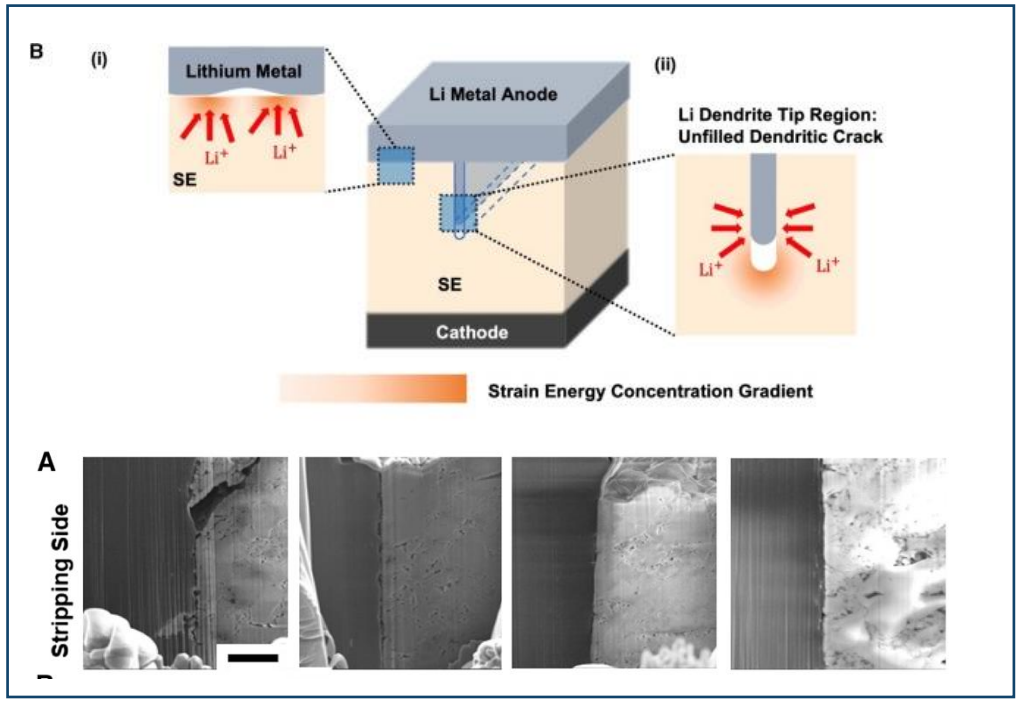

Figure: Mechanical relaxation improves contact at the lithium/solid-electrolyte interface. Schematic illustration of stress concentration at the lithium metal/Li_6PS_5Cl interface, paired with FIB-SEM images showing that tiny interfacial voids shrink after current-hold periods under stack pressure.

Significance and Impact

By treating stack pressure as a time-dependent mechanical tool rather than just a static load, this study introduces a practical, chemistry-free strategy for improving solid-state battery stability, lifetime, and resistance to dendrite-driven failure.

Research Details

- Zero-current holds under moderate stack pressure enabled slow viscoplastic creep at the lithium/Li_6PS_5Cl interface, shrinking micron-scale voids observed by FIB-SEM and reducing interfacial impedance.
- At 8 MPa stack pressure, a 5-hour hold increased the critical current density to 4.8 mA/cm², while quasi-sinusoidal cycling protocols more than doubled cell lifetime compared with conventional cycling.

Work was performed, in part, at the Center for Integrated Nanotechnologies.

Shi, C.; Wang, Y.; Liu, X.; López-Pernía, C.; Watt, J.; Gan, C.; Mijailovic, A.; Guduru, P. R.; Mitlin, D.; Sheldon, B. W. Stack Pressure Effects and Viscoplastic Deformation in Argyrodite Solid-State Electrolyte. *Matter*. 2026.