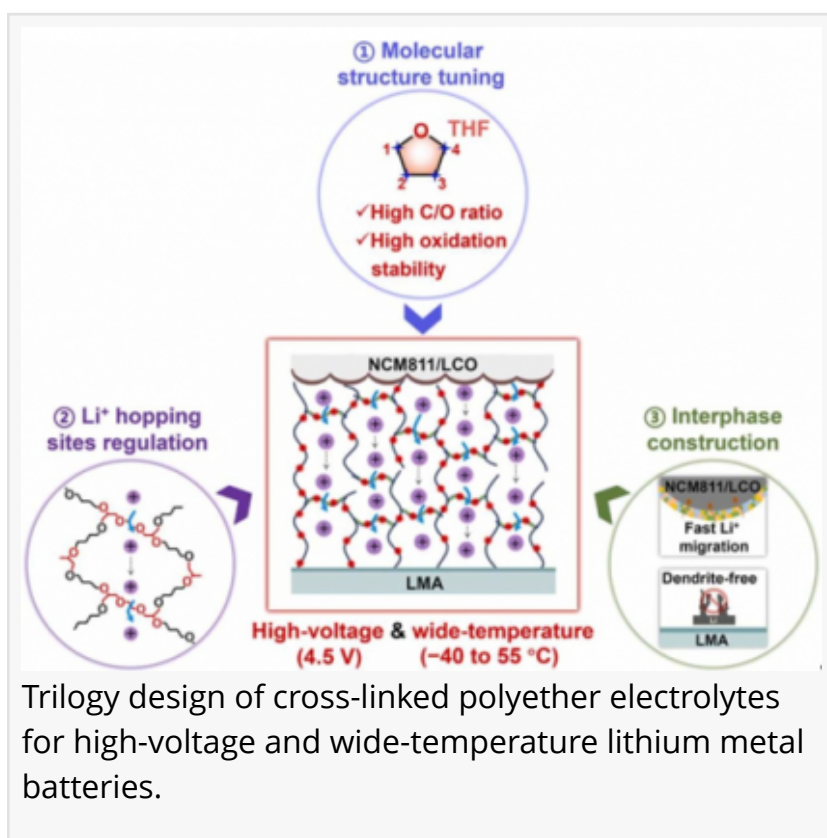


New polyether electrolyte paves the way for safer, high-energy batteries

FAYETTEVILLE, GA, UNITED STATES, June 12, 2026 /EINPresswire.com/ -- Researchers have developed a new polymer electrolyte that enables [lithium metal batteries](#) to operate safely at high voltages and across an extreme temperature range, from -40°C to 55°C. The material directly addresses two long-standing barriers to next-generation energy storage: poor oxidation stability and insufficient ionic conductivity. By tuning the molecular structure of the electrolyte and creating a cross-linked network, the team achieved exceptional electrochemical stability and rapid ion transport. This advance brings high-energy-density lithium metal batteries—promising longer-range electric vehicles and more reliable portable electronics—significantly closer to practical, real-world application.



Lithium metal batteries are a leading candidate for high-energy storage, but conventional liquid electrolytes are flammable and prone to parasitic reactions that shorten battery life. Solid-state polymer electrolytes offer improved safety, yet they typically suffer from poor interfacial contact with electrodes, low ionic conductivity, and an inability to withstand voltages above 4 volts. Existing in-situ polymerized polyether electrolytes, such as those based on 1,3-dioxolane, degrade rapidly when paired with high-voltage cathodes and perform poorly at low temperatures. Their molecular structure lacks sufficient oxidation stability, while their ion transport mechanism remains too slow for practical use. Due to these persistent challenges, a deeper investigation into molecular design strategies that simultaneously enhance oxidation stability, ion transport, and interfacial chemistry is urgently needed.

A team of researchers from South China Normal University reports a new cross-linked

poly(tetrahydrofuran) electrolyte. The findings, published (DOI: [10.1016/j.esen.2025.100025](https://doi.org/10.1016/j.esen.2025.100025)) in [eScience Energy](#), demonstrate an in-situ polymerization strategy that transforms liquid precursors into a solid-state electrolyte directly inside the battery, ensuring perfect electrode wetting and compatibility with existing lithium-ion battery manufacturing lines.

The team's "trilogy" design tackles three bottlenecks simultaneously. First, they replaced the conventional monomer 1,3-dioxolane (DOL) with tetrahydrofuran (THF), which has a higher carbon-to-oxygen ratio. This molecular adjustment raised the electrolyte's oxidation stability to 4.9 volts by lowering its highest occupied molecular orbital energy level. Second, they introduced ethylene glycol diglycidyl ether (GDE) as a cross-linker. The GDE creates a three-dimensional network containing abundant oxygen sites that serve as additional hopping points for lithium ions, dramatically boosting ionic conductivity to 3.3 mS/cm at room temperature—one of the highest values reported for such polymer systems. Third, they used lithium difluoro(oxalato)borate (LiDFOB) not merely as a salt but as a dual-function polymerization initiator. The LiDFOB decomposes preferentially to form a thin, inorganic-rich interphase on both electrodes, rich in lithium fluoride (LiF) and boron-oxygen-fluorine species. This protective layer effectively suppresses parasitic reactions and stabilizes the cathode structure during cycling. The resulting cross-linked poly(THF) electrolyte enabled lithium metal batteries with nickel-rich NCM811 ($\text{LiNi}_{0.8}\text{Co}_{0.1}\text{Mn}_{0.1}\text{O}_2$) and LCO (LiCoO_2) cathodes to cycle stably at an ultra-high cut-off voltage of 4.5 volts for hundreds of cycles, with minimal capacity loss.

"We realized that simply designing a polymer with high oxidation stability usually means sacrificing ionic conductivity," the authors said. "That's why we introduced the cross-linker—to add back the hopping sites for lithium ions without compromising voltage stability. The real surprise came from LiDFOB: it doesn't just start the polymerization, it builds a protective armor on both electrodes. This combined strategy finally breaks the trade-off between stability and conductivity. And because our process uses in-situ polymerization, battery manufacturers won't need to overhaul their production lines—it's a drop-in solution that works with existing equipment."

This work has immediate implications for electric vehicles, electric vertical take-off and landing (eVTOL) aircraft, and grid-scale energy storage—applications that demand both high energy density and extreme-temperature resilience. The ability to operate from -40°C to 55°C without external heating or cooling reduces system complexity and extends driving range in cold climates. Moreover, the compatibility of in-situ polymerization with existing lithium-ion battery manufacturing equipment promises a shorter path to commercialization. As the team continues to optimize the cross-linker chemistry and interphase composition, this design philosophy could extend to other solid-state battery systems, including sodium-based or lithium-sulfur chemistries, potentially broadening the impact beyond lithium metal technology.

References

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