

Researchers establish new design rule for high-entropy superionic solid-state conductors

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Designing Superionic Conductors for All-Solid-State Lithium Batteries

All-solid-state lithium batteries (ASSLBs) use lithium superionic conductors as solid electrolytes, which can provide enhanced energy–power characteristics

However, there is a lack of design rules for fabricating these superionic crystals

A novel design strategy

Superionic crystals
Li₁₀GeP₂S₁₂ (LGPS)-type

● P (2b) ● GeP (4d) ● Li ● S

Increase in compositional complexity

Series of solid electrolytes

Li_{9.54}[Si_{1-δ}M_δ]_{1.74}P_{1.44}S_{11.1}Br_{0.3}O_{0.6}
(LSiM_δPSBrO: M = Ge, Sn; 0 ≤ δ ≤ 1)

LSiGePSBrO-based battery with millimeter-thick electrode showed larger area-specific capacity than state-of-the-art ASSLiBs

Study	Capacity (mAh cm ⁻²)	Improvement
Previous study	17.3	-
This study	26.4	x 1.53

Combined with Li metal anode

14 mA cm⁻² discharge current density at 60 °C

The new design strategy not only enhances the charge–discharge performance at room temperature but also opens new avenues for superionic conductor exploration

A lithium superionic conductor for millimeter-thick battery electrode
Li et al. (2023) | Science



Solid electrolytes with high lithium-ion conductivity can be designed for millimeter-thick battery electrodes by increasing the complexity of their composite superionic crystals, report researchers from Tokyo Tech. This new design rule enables the synthesis of high-entropy active materials while preserving their superionic conduction. Credit: Professor Ryoji Kanno, Tokyo Institute of Technology

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As the world transitions towards a greener and more sustainable energy economy, reliance on lithium (Li)-[ion batteries](#) is expected to rise. Scientists from across the globe are working towards designing smaller yet efficient batteries that can keep up with the ever-increasing demand for [energy storage](#).

In recent years, all-solid-state lithium batteries (ASSLBs) have captured research interest due to their unique use of solid electrolytes instead of conventional liquid ones. Solid electrolytes not only make the battery safer from leakage and fire-related hazards, but also provide superior energy and power characteristics.

However, their stiffness results in poor wetting of the [cathode](#) surface and a lack of homogenous supply of Li ions to the cathode. This, in turn, leads to a loss of capacity in the solid-state battery. The issue becomes more pronounced in thick battery cathode electrode such as millimeter-

thick one, which is a more advantageous electrode configuration for realizing inexpensive and high-energy-density [battery](#) package, compared to conventional [electrode](#) with typical thickness of

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