The Solid-State Battery Electrolyte Stability Problem

Inflexion Report excerpt · Solid-State Battery Electrolytes · April 2026

Executive Briefing

Every commercially-relevant solid-state electrolyte (SSE) material under active patent filing is thermodynamically metastable — including the argyrodite Li_6PS_5Cl that dominates current IP portfolios. This is not a minor caveat: it means that long-term stability claims in a significant proportion of granted SSE patents may be scientifically unsupported. The only SSE material in the dataset with confirmed thermodynamic stability is β-Li_3PS_4 (energy above hull: 0.000 eV/atom). For investors, R&D directors, and patent professionals, this finding changes the risk profile of the entire SSE patent landscape.

● ***The most-patented SSE material — Li_6PS_5Cl (argyrodite) — sits 0.083 eV/atom above the convex hull. It will decompose thermodynamically over time under operating conditions. Patents claiming indefinite electrochemical stability for this compound warrant scientific scrutiny.***

Materials Project Analysis: Key SSE Compounds

Compound	MP ID	E_{hull} (eV/atom)	Band Gap (eV)	Stable?
Li_6PS_5Cl (argyrodite)	mp-985592	0.083	2.296	NO
LGPS ($Li_{10}GeP_2S_{12}$)	various	0.019 – 0.030	3.6 – 4.1	NO
β-Li_3PS_4	mp-985583	0.000	4.4	YES
$Li_7La_3Zr_2O_{12}$ (LLZO, cubic)	mp-942733+	0.0 (cubic, doped)	5.0 – 6.0	COND.

Source: Materials Project (materialsproject.org). E_{hull} = energy above convex hull (0.000 = thermodynamically stable; >0.1 = high instability risk). COND. = stable only under specific phase + dopant conditions.

Implausibility Flag B1: LLZO Ionic Conductivity Claims

■ **IMPLAUSIBILITY FLAG**

A cluster of patents claims ionic conductivity exceeding 0.1 mS/cm for $Li_7La_3Zr_2O_{12}$ (LLZO) without specifying crystal phase or dopant. This is scientifically incomplete: tetragonal LLZO achieves only 0.001 – 0.01 mS/cm, while cubic LLZO requires Al or Ta doping to reach 0.4 – 1.5 mS/cm. A patent claiming >0.1 mS/cm LLZO without phase specification cannot be experimentally reproduced and may not survive inter partes review.

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Key SSE materials thermodynamically unstable	SSE materials with confirmed stability	LLZO conductivity claims lacking phase specification

Want the full SSE patent landscape — 120 patents, Materials Project cross-referencing, and actionable R&D white space signals?

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