EPFL-TTO

EPFL Innovation Park J
CH-1015 Lausanne
Switzerland
+41 21 693 70 23
http://tto.epfl.ch/

Research Contact

Nicola Marzari
+41 21 693 11 29
nicola.marzari@epfl.ch

TTO Contact

Mauro Lattuada
+41 21 693 35 63
mauro.lattuada@epfl.ch

Solid-State Electrolytes for High-Performance Lithium Batteries

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Description

Conventional lithium-ion batteries rely on liquid or gel electrolytes, which offer high ionic conductivity but suffer from leakage, flammability, and limited thermal stability. Solid-state batteries (ASSLBs) emerged as a safer alternative, enabling higher energy densities and improved safety. However, current solid-state electrolytes often fail to meet all performance criteria, particularly achieving high ionic conductivity at room temperature and maintaining electrochemical stability.

This invention introduces a new class of inorganic lithium-based solid-state electrolytes that overcome the limitations of existing materials. Through high-throughput computational screening and molecular dynamics simulations, several compounds were identified that exhibit exceptional lithium-ion conductivity at room temperature (up to >20 mS/cm), low activation energy (<0.2 eV), enabling fast ion transport and robust electrochemical stability and compatibility with lithium metal anodes

These electrolytes enable safer, higher-capacity solid-state batteries suitable for next-generation energy storage solutions.

Advantages

- High ionic conductivity at room temperature (>20 mS/cm for top candidates)
- Low activation barrier (as low as 0.10 eV)
- Non-flammable and thermally stable
- Compatible with lithium metal anodes for increased energy density
- Reduced interfacial resistance with electrodes
- Potential for miniaturization and lightweight designs

Applications

- Electric Vehicles (EVs) – safer, high-energy batteries for long-range performance
- Consumer Electronics – compact, high-capacity batteries for smartphones and laptops
- Grid Energy Storage – reliable, high-efficiency storage for renewable energy
- Aerospace and Defense – robust batteries for extreme environments

Medical Devices – safe, long-lasting power sources for implants and portable equipment