# Polymer-based electrolytes for solid-state batteries, addressing energy density, safety and sustainability

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Adoption of all-solid-state designs by polymer materials, ceramics, low-volatility additives, and hybrids thereof represent a promising solution towards next-gen, advanced alkali metal (Li, Na)-ion secondary batteries; in addition to safety advantages, these offer higher energy density and longer runtime than traditional Li-ion batteries. However, low ionic conductivity, low cation transport properties and issues in sustainable and scalable manufacturing processes must be overcome for market deployment.
Herein, recent advancements in polymer-based electrolytes with high ionic mobility, designed for safe and efficient solid-state batteries, are highlighted. Polymer matrices include poly(ethylene oxide), poly(carbonates), poly(vinylidene fluoride), and various blends thereof. Sustainable techniques, including solvent-free extrusion and UV-induced photo-polymerization, are used for solid electrolyte production. Incorporating room-temperature ionic liquids, low-volatility additives, and biosourced materials further improves electrochemical performance, achieving near-theoretical capacities at high C-rates with stable cycling at ambient conditions, also in combination with high-energy 4V class cathodes. Single-ion conducting polyelectrolytes are also particularly promising as they feature immobilized anions and free-to-move lithium counterions, resulting in a lithium transference number close to unity and resistance towards dendrite growth. Eventually, in terms of sustainable development, the aim is at exploring alternative recycling pathways for materials holding potential for a second life within the energy storage domain, particularly as components in advanced solid-state batteries.

Acknowledgements
The PSIONIC (GA 101069703), SOLVE (GA 101147094), and BIOMAPS (GA 101177344) projects have received funding from the EU’s Horizon Europe R&I Program.