Selection of solvents for solution processing and compatibility with sulfide solid electrolytes

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Abstract

In recent years, all-solid-state battery (ASSB) has been recognized as a promising solution to further increase the battery energy density and mitigate the safety concern of the flammable liquid-state electrolytes (LSEs) in state-of-art lithium-ion batteries. Solid-state electrolytes (SSEs) with excellent mechanical properties and ionic conductivity comparable to LSEs make them technically viable to incorporate with lithium metal as the anode material within the battery to increase energy density. In general, pellet-type SSEs with thickness of several hundred μm are used in ASSBs, which are far thicker than the separator used in conventional LIBs. However, thick SSEs will decrease the energy density and cannot compete with liquid LIBs. In this work, a solution-casting process is developed to modify the SSE from pellet-type to sheet-type with thickness comparable to separator. In particular, the argyrodite sulfide-based solid electrolyte (Li_6PS_5Cl) is selected as the SSE candidate due to its significantly higher ionic conductivity among various SSEs. In order to use the solution-casting process for SSE manufacturing, a suitable solvent that is compatible with sulfide-based SSE is need. Hence, various nonpolar/polar solvents are chosen to study the compatibility with SSE. Synchrotron-based XRD and XPS are used to monitored the crystalline structure and chemical composition of SSE after mixing with different solvents. Finally, it is found that xylene and anisole are potentially the best solvents for solution-casting of SSE sheets.