Strategies for solid electrolyte and electrode/electrolyte interface in solid-state Li-battery

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Nowadays, the energy density of state-of-the-art lithium ion batteries (LIBs) will soon reach its limit, attributed to the use of organic liquid electrolytes, which is not stable toward high energy density electrode such as metallic lithium anode. Meanwhile, safety issues in those conventional LIBs still remain unresolved, mostly involved organic liquid electrolytes: leakage of flammable electrolyte; internal short circuits occur due to the lithium dendrites grow across a thin separator which formed during plating of metallic lithium in organic liquid electrolytes; combustible and flammable reactions or thermal runaways arise inevitably. Therefore, research interests have been stimulated for a durable solid-state lithium battery (SLB) with nonflammable solid electrolyte (SE, based on polymer and/or ceramics) instead of liquid ones, which is more stable toward high energy density electrode, flame resistant and flexible geometry.

Nevertheless, there are many challenges remain in both manufacturing and fundamental understanding of SLB technology. The research interest of our group has been focused on the exploration of high ionic conductivity SEs and fast kinetics electrode/electrolyte interface. A combination of inorganic ceramic and polymeric electrolytes may integrate the benefits from both of them and address the problems of each. The as-obtained LAGP ceramic/PPC-based polymer composite electrolyte shows an ionic conductivity with the order of 10^{-4} S cm^{-1} at ambient temperature and can be a promising and reliable candidate for ambient temperature SSBs. PEO (LiTFSI)-modified Li anode/composite solid electrolyte interface has been applied to inhibit the formation of lithium dendrites. The coating layer of PEO (LiTFSI) can form a bridge connecting the ceramic solid electrolyte with Li anode but preventing the direct contact and side reaction between them. Besides, succinonitrile (SN) with high polarity and good interfacial wettability has been performed for cathode modification via in-situ thermo-polymerization method. The introduction of SN into cathode increases the interfacial contact and ion transmission ability, resulted in a better electrochemical performance of SLBs. A cross-linking SN-based composite polymer electrolyte has been successfully prepared and used as a soft interphase for SLBs. These improvements in key material and interfacial behavior will be benefit for the large-scale manufacture of solid-state batteries.

References:

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