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Short communication

Small quaternary alkyl phosphonium bis(fluorosulfonyl)imide ionic liquid electrolytes for sodium-ion batteries with P2- and O3-$Na_{2/3}[Fe_{2/3}Mn_{1/3}]O_2$ cathode material

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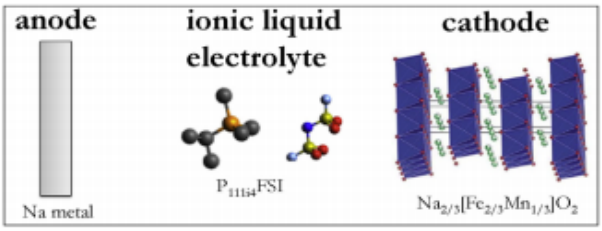
HIGHLIGHTS

- Phosphonium ionic liquid electrolyte was incorporated into a sodium battery device.
- Capacity is superior to conventional solvent electrolytes.
- Cycle stability is superior to conventional solvent electrolytes.
- Elevated temperature performance is superior to conventional solvent electrolytes.

GRAPHICAL ABSTRACT



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ABSTRACT

A saturated solution of 2.3 M sodium bis(fluorosulfonyl)imide in trimethyl *iso*-butyl phosphonium bis(fluorosulfonyl)imide ionic liquid shows a high conductivity (0.94 $mScm^{-1}$ at 50 °C), low ion association, and a wide operational temperature window (−71 °C–305 °C) making it a promising electrolyte for sodium battery applications. Cycling with P2- and O3-$Na_{2/3}[Fe_{2/3}Mn1/3]O_2$ cathode display excellent performance at 50 °C outperforming conventional organic solvent based electrolytes in terms of capacities (at C/10) and long term cycle stability (at C/2). Post analysis of the electrolyte shows no measurable changes while the sodium metal anode and the cathode surface shows the presence of electrolyte specific elements after cycling, suggesting the formation of a stabilizing solid electrolyte interface. Additionally, cycling changes the topography and particle morphology of the cathode. Thus, the electrolyte properties and cell performance match or outperform previously reported results with the additional benefit of replacing the hazardous and flammable organic solvent solutions commonly employed.

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