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S-containing copolymer as cathode material in poly(ethylene oxide)-based all-solid-state Li-S batteries

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Highlights

- S copolymers as cathode materials for all-solid-state polymer Li-S battery.
- S copolymer materials effectively trap polysulfides leading to improved cycle life.
- Superior cell performance compared with elemental S cathode in PEO-based Li-S cells.

Abstract

Inverse vulcanization copolymers (p(S-DVB)) from the radical polymerization of elemental sulfur and divinylbenzene (DVB) have been studied as cathode active materials in poly(ethylene oxide) (PEO)-based all-solid-state Li-S cells. The Li-S cell comprising the optimized p(S-DVB) cathode (80:20 w/w S/DVB ratio) and lithium bis(fluorosulfonyl)imide/PEO (LiFSI/PEO) electrolyte shows high specific capacity (ca. 800 mAh g^{-1}) and high Coulombic efficiency for 50 cycles. Most importantly, polysulfide (PS) shuttle is highly mitigated due to the strong interactions of PS species with polymer backbone in p(S-DVB). This is demonstrated by the stable cycling of the p(S-DVB)-based cell using lithium bis(trifluoromethanesulfonyl)imide (LiTFSI)/PEO electrolyte, where successful charging cannot be achieved even at the first cycle with plain elemental S-based cathode material due to the severe PS shuttle phenomenon. These results suggest that inverse vulcanization copolymers are promising alternatives to elemental sulfur for enhancing the electrochemical performance of PEO-based all-solid-state Li-S cells.

Keywords

Li-S batteries; Cathode materials; Organosulfur; Inverse vulcanization; PEO-based all-solid-state lithium batteries