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Jeffamine® based polymers as highly conductive polymer electrolytes and cathode binder materials for battery application

Itziar Aldalur, Heng Zhang, Michał Piszcz*, Uxue Oteo, Lide M. Rodriguez-Martinez, Devaraj Shanmukaraj, Teofilo Rojo, Michel Armand

CIC Energigune, Parque Tecnológico de Álava, Albert Einstein, 48, ED.CIC, 01510 Miñano, Álava, Spain

HIGHLIGHTS

- New comb polymer electrolytes synthesized by imide ring formation.
- Novel polymer electrolytes with EO/PO based chain structure (Jeffamine®).
- High ionic conductivity in fully amorphous solid polymer electrolytes.
- High cycle-ability of $LiFePO_4$ and sulphur cells based on these new polymer electrolytes.
- Jeffamine based polymers as alternative binders for Li based batteries.

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ABSTRACT

We report a simple synthesis route towards a new type of comb polymer material based on polyether amines oligomer side chains (i.e., Jeffamine® compounds) and a poly(ethylene-*alt*-maleic anhydride) backbone. Reaction proceeds by imide ring formation through the NH_2 group allowing for attachment of side chains. By taking advantage of the high configurational freedoms and flexibility of propylene oxide/ethylene oxide units (PO/EO) in Jeffamine® compounds, novel polymer matrices were obtained with good elastomeric properties. Fully amorphous solid polymer electrolytes (SPEs) based on lithium bis(-trifluoromethanesulfonyl)imide (LiTFSI) and Jeffamine®-based polymer matrices show low glass transition temperatures around −40 °C, high ionic conductivities and good electrochemical stabilities. The ionic conductivities of Jeffamine-based SPEs (5.3×10^{-4} S cm^{-1} at 70 °C and 4.5×10^{-5} S cm^{-1} at room temperature) are higher than those of the conventional SPEs comprising of LiTFSI and linear poly(-ethylene oxide) (PEO), due to the amorphous nature and the high concentration of mobile end-groups of the Jeffamine-based polymer matrices rather than the semi-crystalline PEO The feasibility of Jeffamine-based compounds in lithium metal batteries is further demonstrated by the implementation of Jeffamine®-based polymer as a binder for cathode materials, and the stable cycling of Li|SPE|$LiFePO_4$ and Li|SPE|S cells using Jeffamine-based SPEs.

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