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An Alternative Polymer Material to PVDF Binder and Carbon Additive in Li-Ion Battery Positive Electrode

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Abstract

Li-ion battery performance relies fundamentally on modulation at the microstructure and interface levels of the composite electrodes. Correspondingly, the binder is a crucial component for mechanical integrity of the electrode, serving to interconnect the active material and conductive additive and to firmly attach this composite to the current collector. However, the commonly used poly(vinylidene fluoride) (PVDF) binder presents several limitations, including the use of toxic solvent during processing, a low electrical conductivity which for compensation requires the addition of carbon black, and weak interactions with active materials and collectors. This study investigates Poly(3,4-ethylenedioxythiophene):poly[(4-styrenesulfonyl) (trifluoromethylsulfonyl) imide] (PEDOT:PSSTFSI) as an alternative binder and conductive additive, in replacement of both PVDF and carbon black, in Li-ion batteries with $\text{LiFe}_{0.4}\text{Mn}_{0.6}\text{PO}_4$ at the positive electrode. Complex PEDOT:PSSTFSI significantly improves the electronic conductivity and lithium diffusion coefficient within the electrode, in comparison to standard PVDF binder and carbon black. This enhances significantly the electrochemical performance at high C-rates and for high active mass loading electrodes. Furthermore, an excellent long-range cyclability is achieved.