Reversible Behavior of Copper Sulfide as Negative Electrode in Non-Flammable Trimethyl Phosphate Electrolytes for Safe Sodium-Ion Batteries

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ABSTRACT

Rechargeable sodium-ion batteries are considered as promising candidates for low-cost and large-scale energy storage systems. However, the limited energy density, cyclability and safety issues remain challenges for practical applications. Herein, we report our investigation of the $Cu_{1.8}S$/C composite material as the negative electrode active (conversion) material in combination with the concentrated electrolyte composed of 3.3 M solution of sodium bis(fluorosulfonyl)imide in trimethyl phosphate and fluoroethylene carbonate as additive. Such a combination enables the stable cycling of the conversion-type $Cu_{1.8}S$/C electrode material for hundreds of cycles with high capacity (380 mAh g^{-1}). Both the salt (NaFSI) and the additive (FEC) contribute to the formation of a stable NaF-rich solid electrolyte interphase (SEI) on the anode surface. Full cell employing the $Na_3V_2(PO4)_3$/C cathode also demonstrate stable cycling performance for 200 cycles with a promising coulombic efficiency (99.3%). These findings open new opportunities for the development of safer rechargeable sodium-ion batteries.

Keywords: Conversion, copper sulfide, metal-organic frameworks, phosphate electrolyte, safety, sodium-ion batteries

Submitted: 09.03.2021

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