High performance sodium-ion rechargeable battery with 3V-120 Wh/kg

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Abstract

For several decades, lithium ion batteries (LIBs) have been used widely as main power sources for mobile devices. However, due to the explosively increasing demands such as electrical energy storage (ESS) and electric vehicle (EV) on LIB, the cost of lithium resources are expected to be correspondingly increasing. The several rechargeable batteries which can replace LIB have been introduced. Among them, recently sodium ion battery (SIB) has been regarded as the attractive alternative system to LIB considering that it has the electrochemical similarity to LIB and its cost is much cheaper than LIB due to the abundance of sodium source on the earth. Although SIB has the same operating principle as LIB, the development of SIB comparable to LIB performances has been recognized as a big challenge due to sodium's larger radius and higher redox potential compared with lithium.

To ensure the feasible competitiveness against LIB, we developed a sodium ion battery with a long life (300 cycles) of 3V-120 Wh kg-1 based on the total cell mass for practical application. Based on the computational materials' chemistry, the Fe-Mn layered cathode with high voltage/high capacity and hard carbon anode having a high reversible capacity (~310 mAh g-1) were developed and applied for full cell. In addition, to ensure long life and safety, we have developed the mixed salt electrolyte with high voltage stability and the high-heat resistant separator with high wettability. Furthermore, through improving the stacking-type SIB cell design and process technology considering the various process parameters during slurry mixing, electrode fabrication and cell assembly. Finally, through both materials design and process technological improvements, we succeeded in making high performance SIB with 3V-120 Wh/kg and verified the electrochemical performances such as long-term durability and safety tests.

Keywords: *Sodium-ion rechargeable battery, layered cathode material, carbonaceous anode material, electrolyte, process technology*

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