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Designing high-power graphite-based dual-ion batteries

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Abstract

Dual-ion battery with the use of both cations and anions as means of energy storage promises high power, as the ions do not have to travel from one electrode to another during charge and discharge. Though, actual rate performance of an electrode is highly dependent on material, electrode configuration and electrolyte. Here, we have identified the key parameters governing the rate performance of PF_6^- intercalation into graphite. Capacity is increased by increasing the surface area of the graphite material. Electrical conductivity and stability are enhanced with carbon addition in the electrode with reduced cut-off voltage. Operating voltage is reduced by increasing the salt concentration, and ionic conductivity is improved with the use of carboxymethyl cellulose as binder. Optimized graphite electrode delivers a capacity of about 90 mAh g^{-1} at 10 mA g^{-1}, and 90% of it can still be accessible at a rate of 500 mA g^{-1}, with excellent cycle stability for at least 200 cycles. The dual-ion battery is demonstrated to give power density superior to that of lithium-ion battery, and energy density superior to that of supercapacitor.

Keywords: dual-ion battery; graphite; cathode; anion intercalation; PF_6^-