Facile synthesis of common Sulphur cathode using crosslinked Chitosan-tripolyphosphate binder and Carbon nanofibers

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Lithium–Sulphur batteries with theoretical energy density of 2500 Wh/kg have attracted much attention in recent times. The high energy density of Li–S batteries originates from the Sulphur cathode having a high theoretical capacity of 1672 mA h/g and the Lithium-metal anode having a high capacity of 3860 mAh/g. In spite of this high capacity, Li-S batteries are not considered any close to commercial production because of a few inherent problems. The active material Sulphur has a low electrical conductivity and undergoes a series of complicated compositional and structural changes to form electrolyte soluble polysulfide intermediates which migrate towards the anode thus amounting to huge loss of active material. To tackle these problems, a highly conductive carbon matrix and a highly effective binder is paramount towards the fabrication of a high capacity stable cathode. In this work common Sulphur powder was used as the active material along with Carbon Super P and Carbon nanofiber (CNF) as conducting agents and a natural biopolymer Chitosan crosslinked with tripolyphosphate anion was used as binder. The binder helps in uniform distribution of the active material and conducting agents, binds the polysulphides through bonding with the abundantly present -OH and -NH_2 functional groups and mitigates the expansion of the active material. Carbon nanofibers, having almost four times conductivity as compared to Carbon Super P, can be used as a conducting agent for Sulphur cathodes, effectively increasing the Sulphur loading, conductivity and mechanical strength of the composite and absorbing the polysulphides onto its surface through formation of C-S bonds. Figure 1(a) shows that the produced Sulphur cathode had a 1st cycle gravimetric discharge capacity of 980 mAh/g at 0.05C rate. After 200 cycles the percentage capacity retention at the 0.1C, 0.5C and 1C rates were found to be about 90%. Rate performance of the cathode composite was evaluated, as shown in Figure 1(b). The capacity retention at 0.1C after charge-discharge at 5C was excellent with a discharge capacity of 820 mAh/g. This shows that the cathode is extremely stable under different charging and discharging conditions making it suitable for a wide range of applications.

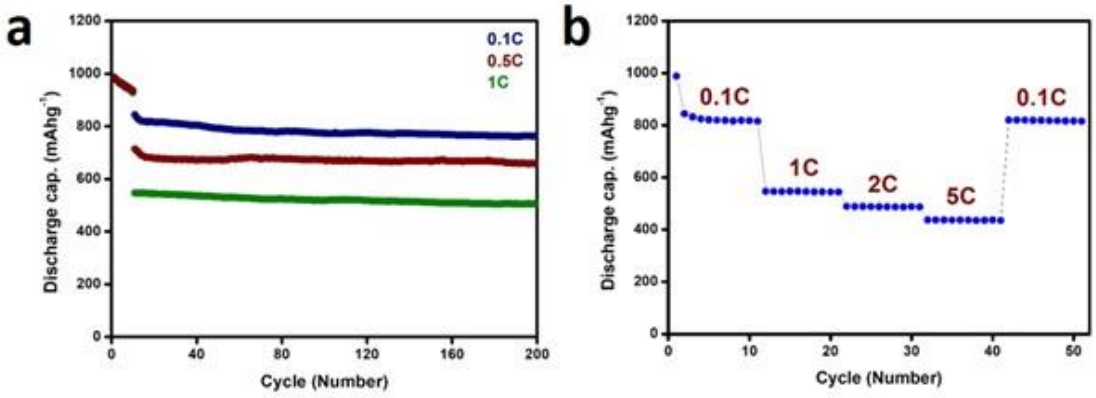

Figure 1: (a) Cycling performance at different C rates of 0.1C, 0.5C and 1C and (b) rate performance of the S-C-CNF-ChitosanTPP cathode composite.

References:

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