Flexible Composite of S/PAN/C Nanofibers by Electrospinning as Binder–Free Cathodes for Li-S Batteries

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As one of the most promising energy storage devices, lithium-ion batteries (LIBs) have attracted tremendous attention for its high volumetric and gravimetric energy density, no memory effects, good shape versatility, and relatively slow self-discharge rates. Conventional LIBs based on intercalation cathodes, have limited energy densities. Therefore, lithium/sulfur (Li/S) battery is considered as an attractive and promising candidate to be utilized for the mentioned purposes, which is due to its high theoretical specific capacity of 1672 mAh g^{-1} and theoretical energy density of 2600 Wh kg^{-1} [1,2]. However, practical application of Li/S batteries is hindered by several drawbacks as: the electrical-insulating nature of sulfur results in its low utilization; lithium polysulfides intermediate products of electrochemical process are easily soluble into the organic electrolytes, which leads to severe capacity fading and low coulombic efficiency.

In current work, the porous nanofibers using polyacrilonitrile (PAN) and sulfur with carbon nanotube (CNT) were prepared by electrospinning, which is an effective method to prepare nanofibers. PAN/S/CNT/DMF dispersed solution was obtained and used for electrospinning. Furthermore, the nanofibers with sulfur nanoparticles were transferred to a tube furnace and stabilized at 300 ^{o}C for 1 hour in an inert atmosphere. In this step, the thermoplastic PAN was converted to a non-plastic cyclic compound and interacted with sulfur.

The partially pyrolyzed and cyclized PAN is conductive and able to stabilize sulfur and suppress its dissolution into electrolyte solution through forming chemical bonds between PAN and sulfur, because of polarized C-N chemical bonds.

Formation of a homogeneous hierarchical mesoporous structure was observed by SEM, EDS mapping and XRD techniques. The lithium cells with these ternary composites cathode were assembled and electrochemical performance was tested. The addition of CNT improves C rate performance of the cell.

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