S/PAN/C flexible composite cathode made of nanofibers formed by electrospinning

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As one of the most promising energy storage devices, lithium-ion batteries (LIBs) have attracted tremendous attention due to their high volumetric and gravimetric energy density, no memory effect, good shape versatility, and relatively slow self-discharge rates. Conventional LIBs based on intercalation cathodes, have limited energy densities. Lithium/sulfur (Li/S) batteries are considered as an attractive and promising candidate to overcome these disadvantages due to their high theoretical specific capacity of 1672 mAh g^{-1} and energy density of 2600 Wh kg^{-1} [1,2]. However, practical application of Li/S batteries is hindered by several drawbacks. Among them electrical-insulating nature of sulfur resulting in its low utilization, and soluble intermediate products of electrochemical process, lithium polysulfides, in organic electrolytes, leading to severe capacity fading and low coulombic efficiency.

In this work, porous nanofibers were prepared by electrospinning using polyacrilonitrile (PAN) and carbon nanotube (CNT). Homogenous solution of PAN and PAN/CNT in DMF were used for electrospinning. Further, the nanofibers covered with sulfur powder were transferred to a tube furnace and stabilized at 300 ^{o}C for 1, 2 and 3 hours in argon. In this step, the thermoplastic PAN was converted to a non-plastic cyclic compound, which interacted with sulfur. Partially pyrolyzed and cyclized PAN is conductive and able to stabilize sulfur and suppress its dissolution into the electrolyte solution through forming chemical bonds with sulfur because of polarized C-N chemical bonds. The sulfur content in the composite varied from 30 to 70 wt%. The composite can be detached from current collector and used as a free-standing electrode.

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

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References:

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