Preparation of nitrogen-doped and interconnected hollow carbon nanospheres for superior lithium-sulfur battery

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Sulfur is the promising cathode materials for rechargeable lithium batteries with high theoretical specific capacity and energy density. However, sulfur has poor cycling stability due to its low conductivity and polysulfide dissolution. Herein, nitrogen-doped and interconnected hollow carbon nanospheres with particle size of 50-80 nm via direct carbonization of Zn, Co-ZIF coated with resorcinol-melamine-formaldehyde resin have been reported as highly efficient sulfur host for high-performance lithium-sulfur batteries. The interconnected hollow nanospheres are derived from the different carbon yield and shrinkage between Zn, Co-ZIF core and RMFs shell and the as-prepared HPCNs have the specific surface area of 836-881 m^2/g, large pore volume up to 1.50 cm^3/g and high conductivity. Combining the high conductivity and chemical trapping of lithium polysulfides, the obtained S/HPCNs cathode of 70 wt.% sulfur content in the composite delivered a high specific capacity up to 1300 mAh/g at 0.2 C and 762 mAh/g at 8 C. Moreover, a stable capacity of 950 mAh/g could be maintained even after 200 cycles at 0.2 C. The nature of the interactions between N-doped carbons and lithium polysulfide species was investigated by X-ray photoelectron spectroscopy studies. The unique electrochemical behavior and superior performance of S/HPCN composites open possibilities for new class of cathode materials for high energy and high power density lithium rechargeable batteries.