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Hollow Ni/Co-S microspheres derived from spherical coordination polymers: Preparation, characterization and application in energy storage

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Abstract

Hollow Ni/Co-S microspheres prepared through a precursor sulfuration route were reported here. The precursor was first generated at 150 °C for 24 h by a solvothermal process, employing $Ni(NO_3)_2$, $Co(NO_3)_2$ and 1,3,5-Benzenetricarboxylic acid (BTC) as the original reactants, and ethylene glycol (EG) as the solvent. Then, the precursor was sulfurized in a water-EG mixed solvent at 180 °C for 18 h to form hollow Ni/Co-S microspheres. The as-obtained product was characterized by FESEM, TEM, XRD, IR, XPS, and EDS mapping. It was found that the electrochemical properties of hollow Ni/Co-S microspheres strongly depended on the original molar ratio of Ni^{2+}/Co^{2+}. The product prepared from the system with the Ni^{2+}/Co^{2+} molar ratio of 2:1 (labeled as 2Ni-Co-S) exhibited the best electrochemical performances. At a current density of 1 A g^{-1}, the specific capacitance of 2Ni-Co-S reached 1397 mAh g^{-1}; and even at a current density of 10 A g^{-1}, the specific capacitance still reached 908 mAh g^{-1}. After 2000 cycles, the specific capacitance still retained ~114% of the initial value and ~76.0% of the biggest capacitance, exhibiting excellent cycling stability. Also, a hybrid battery assembled with 2Ni-Co-S and activated carbon owned the energy density of 178.97 Wh kg^{-1} at a power density of 1.96 kW kg^{-1}; and even at a power density of 9.3 kW kg^{-1}, the energy density still achieved 148.4 Wh kg^{-1}, indicating that the as-obtained hollow Ni/Co-S microspheres have potential applications for energy storage as high performance electrode materials.

Keywords: Nickel cobalt sulfides; Hollow microspheres; Solvothermal synthesis; Electrochemical performances; Energy storage