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Mesoporous spinel manganese zinc ferrite for high-performance supercapacitors

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Abstract

We report on the synthesis of manganese zinc ferrite ($MnZnFe_2O_4$) nanoneedles via a simple one-pot coprecipitation method and their characterization using energy-dispersive spectroscopy (EDS), X-ray diffraction (XRD), field emission scanning electron microscope (FESEM), high-resolution transmission electron microscope (HR-TEM) and N_2 adsorption/desorption techniques. The electrochemical performance of $MnZnFe_2O_4$ nanoneedles-based supercapacitors was investigated, showing superior specific capacitance of 783 F g^{-1}, which is significantly higher than that reported for any ferrite material. Also, the spinel $MnZnFe_2O_4$ exhibits very high columbic efficiency and an excellent long-term stability. The fabricated asymmetric supercapacitor based on $MnZnF_2O_4$ nanoneedles/activated carbon electrodes can deliver 15.8 Wh kg^{-1} energy density at a power density of 899.7 W kg^{-1}. The contribution of the double layer capacitance was found to be only 3.14% of the total specific capacitance and mainly based on psuedocapacitance faradaic mechanism. Therefore, the fabricated $MnZnFe_2O_4$ electrode is a promising candidate for supercapacitor applications.

1. Introduction

Owing to the rapidly increasing demand for energy conversion devices, energy storage platforms have become significantly attractive more than any instance in the past. Indeed, supercapacitors are considered one of the most promising energy storage devices, due to their excellent reversibility, rapid charge/discharge, high power density, in addition to long-life and cyclic stability compared to the analogous electrochemical energy storage devices.[1-5] Typically, supercapacitors can be classified into three basic categories, pseudocapacitors, battery-like, and electrochemical double layer capacitors (EDLC).[6-8] On one hand, both pseudo and Faradaic capacitors store energy via the reversible reactions at the electrode-active