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Short communication

Calcium-based nanosized mixed metal oxides for supercapacitor application

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Abstract

The nanosized mixed metal oxides ($Ca_3Co_2O_6$, $CaMnO_3$ and Ca_2CuO_3) have been synthesized and their electrochemical performance as supercapacitor electrodes have been evaluated. All of them show good pseudocapacitance in KOH electrolyte with specific capacitance of 563, 384 and 275 F g^{-1} for $Ca_3Co_2O_6$, $CaMnO_3$ and Ca_2CuO_3, respectively. The charge kinetics of $Ca_3Co_2O_6$ is further evaluated by electrochemical impedance spectroscopy and the results show the low resistivity of $Ca_3Co_2O_6$ and its charge kinetic shows little variation after long continuous cycling. The present study signifies the successful application of nanosized mixed metal oxides as supercapacitor electrode.

Keywords: C. Impedance; Calcium-based mixed metal oxides; Pseudocapacitance; Electrochemistry; Supercapacitor

1. Introduction

The development of high energy density supercapacitor is one of the critical requirements for high energy demanding devices such as electric vehicle. The most direct way of energy density improvement is achieved by maximizing the specific capacitance of a supercapacitor electrode. In this context, metal oxides with excellent pseudocapacitance could significantly improve the energy density. Hydrated ruthenium oxide is a remarkable metal oxide with very high specific capacitance of 1585 F g^{-1} [1]. However, the toxicity and high cost dampened the commercial application of the material. Research studies have been going on to find a cheap yet environmental friendly material to replace hydrated ruthenium oxide as supercapacitor electrode. Non-noble metal oxides such as, cobalt oxide, manganese oxide and copper oxide had been reported as the promising materials for supercapacitor electrode [2–8]. Apart from pure metal oxides, mixed metal oxides were reported to be the good supercapacitor electrode [9–11].

To the best of our knowledge, the application of calcium-based mixed metal oxides as supercapacitor electrode has not been reported. Our previous work reported the synthesis of calcium-metal oxides as heat and corrosion resistant pigments [12,13]. The current work is motivated by the presence of transition metals (Co, Mn and Cu) in our samples, which possess various oxidation states that contribute to pseudocapacitance.

2. Experimental procedures

2.1. Samples preparation and characterization

The nanosized mixed metals oxide $Ca_3Co_2O_6$, $CaMnO_3$ and Ca_2CuO_3 materials have been prepared by solid-state calcination and co-precipitation routes. Detailed preparation procedure had been reported in our previously published paper [12,13]. Phase compositions of the mixed metal oxides were obtained from the data of the X-ray diffractograms (XRD) using X-ray diffraction analysis (Bruker/D8). Cu Kα radiation target of wavelength

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