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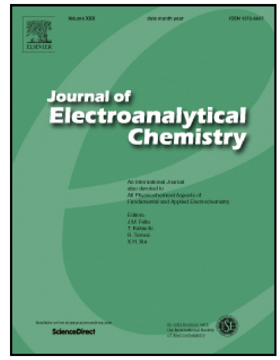

Comparative study of metal-doped carbon aerogel: Physical properties and electrochemical performance

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Comparative study of metal-doped carbon aerogel: physical properties and electrochemical performance

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Abstract The influence of metals on the structure and performance of carbon aerogels is presented here. Metal-doped carbon aerogels (M-CA) were obtained by a simple in situ method without any catalyst. The physical properties were characterized by SEM, XRD, Raman spectroscopy, XPS, and N_2 adsorption-desorption. The results show that the addition of metal particles did not destroy the original 3D structure of carbon aerogels, and Ni-CA displayed excellent pore size distribution and a high degree of graphitization. The results of the electrochemical performance revealed nickel doped carbon aerogel (Ni-CA) gave the highest specific capacitance (126.6 F g^{-1}) at 1 A g^{-1} because of the suitable pore size distribution and high conductivity. A cycling performance test showed good cycle stability of all the M-CA in this study, and the attenuation of Ni-CA after 1000 cycles was the lowest recorded, at only 0.6%.

Keyword carbon aerogel; metal; physical property; electrochemical

1. Introduction

With increasing energy demands, the development of more sustainable energy resources is becoming the focus of numerous studies. A supercapacitor is a renewable energy storage device that fulfills the energy requirements of the future, and it has attracted growing attention [1-2]. A supercapacitor combines the advantages of batteries and conventional dielectric capacitors, such as long cycle-life, low cost, rapid charge-discharge processes, and high power density. It has broad applications in telecommunication devices, uninterruptible power supplies, stand-by power systems, and hybrid electrical vehicle systems [3-5]. Capacitance of a supercapacitor includes double-layer capacitance and pseudocapacitance. The double-layer capacitance arises from the accumulation of ions on the double-layer at the electrode/electrolyte interface, and it is dependent on the surface area and electrode porosity. Pseudocapacitance arises from reversible faradaic reactions at the electrode-electrolyte interface due to the presence of transition metallic oxide or surface functionalities in the carbon electrodes [6-9]. The carbon materials used for double-layer capacitance usually exhibit good stability but suffer from a low specific capacitance. Unlike carbon materials, transition metal-based materials have substantially higher specific capacitance and are widely used for pseudocapacitors, which store charges through Faradic reactions, but their stability is poor [10-12]. Therefore, pure carbon materials or transition metal-based materials cannot effectively meet the practical requirement for large-scale application of