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ScienceDirect
J. Mater. Sci. Technol., 2011, 27(10), 873-878.
www.JMST.org

Synthesis and Characterization of Magnetite/Carbon Nanocomposite Thin Films for Electrochemical Applications

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[Manuscript received January 18, 2011, in revised form July 12, 2011]

Stable colloidal suspension of magnetite/starch nanocomposite was prepared by a facile and aqueous-based chemical precipitation method. Magnetite/carbon nanocomposite thin films were subsequently formed upon carbonization of the starch component by heat treatment under controlled conditions. The initial content of native sago starch as the carbon source was found to affect the microstructure and electrochemical properties of the resulted magnetite/carbon nanocomposite thin films. A specific capacitance of 124 F/g was achieved for the magnetite/carbon nanocomposite thin films as compared to that of 82 F/g for pure magnetite thin films in Na_2SO_4 aqueous electrolyte.

KEY WORDS: Magnetite; Magnetite/carbon nanocomposite; Native sago starch; Specific capacitance

1. Introduction

Electrochemical capacitors are charge-storage devices that possess power capability and energy density that are several orders of magnitude higher than batteries and conventional capacitors, respectively. In addition, the energy storage mechanisms in electrochemical capacitors are simpler and highly reversible and thus ensure a very long cycle life (>100000)[1]. The combined effects of improved power density as well as energy density make the enhanced capability and performances of electrochemical capacitors very attractive. Electrochemical capacitors have therefore attracted much attention for potential applications in portable electric and electronic devices.

Many transition metal oxides have been shown to be excellent electrode materials for electrochemical capacitors[2,3] For instance, ruthenium-based oxides (RuO_2) were reported to exhibit specific capacitance value as high as 720 F/g. Although RuO_2 possesses high specific capacitance, it has inherent disadvantages of being both expensive and toxic in nature thereby limiting its commercial applications[4]. Hence substantial research efforts have been directed towards development of electrode materials which are cheaper and more environmentally benign in nature.

Due to its low cost, ease of preparation and non-toxic in nature, iron oxide such as magnetite (Fe_3O_4) nanoparticles have been widely investigated in biomedical applications[5]. Recently, magnetite has received much attention as electrode materials for lithium batteries and supercapacitors. Du *et al.*[6] recently reported a specific capacitance value of 37.9 F/g for magnetite/activated carbon as electrode materials for supercapacitors. The magnetite nanoparticles prepared by the microwave method were about 35 nm in mean diameter. As pure magnetite nanoparticles are low in electronic conductivity, addition of activated carbon to the magnetite films leads to improvement in their conductivity. Wang *et al.*[7] reported a similar specific capacitance value of 30 F/g for magnetite/carbon black nanocomposites. These studies focused mainly on the characterization of electrochemical properties of

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