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A Facile Synthesis of a Palladium-Doped Polyaniline-Modified Carbon Nanotube Composites for Supercapacitors

SOUMEN GIRI,[1] DEBASIS GHOSH,[1] ASISH MALAS,[1] and CHAPAL KUMAR DAS[1,2]

1.—Materials Science Centre, Indian Institute of Technology, Kharagpur 721302, India.
2.—e-mail: chapal12@yahoo.co.in

Supercapacitors have evolved as the premier choice of the era for storing huge amounts of charge in the field of energy storage devices, but it is still necessary to enhance their performance to meet the increasing requirements of future systems. This could be achieved either through advancing the interfaces of the material at the nanoscale or by using novel material compositions. We report a high-performance material composition prepared by combining a transition metal (palladium)-doped conductive polymer with multiwalled carbon nanotubes (MWCNTs). MWCNTs/palladium-doped polyaniline (MWCNTs/Pd/PANI) composites and multiwalled carbon nanotube/polyaniline (MWCNTs/PANI) composites (for comparison) were prepared via *in situ* oxidative polymerization of aniline monomer. The reported composites were characterized by Fourier-transform infrared (FTIR), x-ray diffraction (XRD), field-emission scanning electron microscopy (FESEM), and transmission electron microscopy (TEM) studies. FESEM and TEM studies indicated the narrow size distribution of the π-conjugated polymer-protected palladium nanoparticles on the surface of the carbon nanotubes. All the electrochemical characterizations were executed using a three-electrode system in 1 M H_2SO_4 electrolyte. Cyclic voltammetry (CV) analysis was performed to observe the capacitive performance and redox behavior of the composites. The ion transfer behavior and cyclic stability of the composites were investigated by electrochemical impedance spectroscopy (EIS) analysis and cyclic charge–discharge (CCD) testing, respectively. The MWCNTs/Pd/PANI composite was found to exhibit an especially high specific capacitance value of 920 F/g at scan rate of 2 mV/s.

Key words: Nanocomposites, MWCNTs, polyaniline, palladium chloride, supercapacitor

INTRODUCTION

The need to develop improved sustainable electrical energy storage devices with enhanced performance is of eminent importance to meet increasing consumer demands. There is growing interest in the development of low-cost, high-power electrochemical energy storage devices with high electrochemical energy conversion efficiency and compatibility with power generation from solar, wind, and nuclear resources. Among all energy storage devices, supercapacitors have attracted major attention and are being utilized in various applications such as hybrid electric vehicles, electric vehicles, and portable electronic devices and for backup power. This is due to the fact that supercapacitors possess high power density (10 times that of generic batteries), high energy density (a few orders higher than conventional capacitors), fast charging (within seconds), excellent cyclic stability, small size, and light weight.[1,2] On the basis of the charge storage mechanism, supercapacitors can be categorized into two main streams: (i) electrical

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