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Investigation of Supercapacitor Properties of Nanocomposites Obtained from Acid and Base-functionalized multi-walled carbon nanotube (MWCNT) and Polypyrrole (PPy)

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Abstract : Polymers are versatile materials with many unique properties, such as low density, reasonable strength, flexibility, and easy processability. However, the mechanical properties of these materials are insufficient for many engineering applications. Therefore, there is a continuous search for new polymeric materials with improved properties. Polymeric nanocomposites are an advanced class of composite materials that have attracted great attention in both academic and industrial fields. Since nano-reinforcement materials are very small in size, they provide ultra-large interfacial area per volume between the nano-element and the polymer matrix. This allows the nano-reinforcement composites to exhibit enhanced toughness without compromising hardness or optical clarity. PPy and MWCNT/PPy nanocomposites were synthesized by the chemical oxidative polymerization method and the supercapacitor properties of the obtained nanocomposites were investigated. In addition, pure MWCNT was functionalized with acid (H_2SO_4/H_2O_2) and base (NH_4OH/H_2O_2) solutions at a ratio of 3:1 and a-MWCNT/d-PPy, and b-MWCNT/d-PPy nanocomposites were obtained. The homogeneous distribution of MWCNTs in the polypyrrole matrix and shell-core type morphological structures of the nanocomposites was observed with SEM images. It was observed with SEM, FTIR and XRD analyses that the functional groups formed by the functionalization of MWCNTs caused the MWCNTs to come together and partially agglomerate. It was found that the conductivity of the nanocomposites consisting of MWCNT and d-PPy was higher than that of pure d-PPy. CV, GCD and EIS results show that the use of a-MWCNT and b-MWCNTs in nanocomposites with low particle content positively affects the supercapacitor properties of the materials but negatively at high particle content. It was revealed that the functional MWCNT particles combined in nanocomposites with high particle content cause a decrease in the conductivity and distribution of ions in the electrodes and, thus, a decrease in their energy storage capacity.

Keywords : polypyrrole, multi-walled carbon nanotube (MWCNT), conducting polymer, chemical oxidative polymerization, nanocomposite, supercapacitor
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