IAEA-CN-332/654

Gamma Irradiation Synthesis of rGO-Ni/NiO Nanocomposites with Supercapacities Properties

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Introduction

Reduced graphene oxide/nickel (rGO-Ni) nanocomposites possess remarkable electronic characteristics, and exhibit promises for diverse applications, notably in the domain of supercapacitors. As a result, in the last few years, several works regarding the synthesis of rGO-Ni nanocomposites, such as chemical reduction or thermal reduction, have been reported in the literature. However, these traditional methods usually comprise toxic chemical reducing reagents or require high temperatures and pressure. In the present study, we describe an attractive and green process for obtaining rGO-Ni nanocomposites using gamma radiation, without the use or generation of toxic residues and undesirable products.

Methodology

The GO dispersion in the presence of $Ni[(NH_3)_6]\ Cl_2$ was subjected to gamma radiation, in an alkaline solution of deionized water/isopropanol (1:1), at doses of 80 kGy and a dose rate of 8,. kGy/h , in a N_2 media to obtain rGO-Ni. XRD results confirmed that the Ni_2^+ and GO were simultaneously reduced by the gamma irradiation process. X-ray photoelectron spectroscopy (XPS) revealed the oxidation of the metal Ni on the GO surface. The morphology of the rGO-Ni was evaluated by TEM, and it was observed nickel nanoparticles evenly distributed over the rGO sheets. To study electrochemical behavior, screen-printed electrodes (SPE) were modified with the rGO and rGO-Ni and the cyclic voltammograms (CV) showed reversible behavior for all samples in the presence of $K_3[Fe\ (CN)_6]$. All rGO-Ni/SPE showed a remarkable enhancement in the anodic peak currents (Ipa) and electroactive area in comparison with the bare SPE. Moreover, it was observed that a directly proportional relationship between Ipa value and the radiation dose applied on nanocomposite synthesis. The CV curves of rGO-Ni prepared at 80 kGy exhibited better pseudocapacitive behavior compared with the rGO in same condition. The maximum specific capacitance of rGO-Ni was ~85 $F{\cdot}g^{-1}$ which is higher than that of rGO (~8 $F{\cdot}g^{-1}$) at the same scan rate.

Conclusion

These findings point out the potential applications of rGO-Ni nanocomposites in devices such as supercapacitors.