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Full Paper

Supercapacitive Properties of Europium Oxide Nanoparticles Decorated on Nitrogen Doped Graphene Nanosheets Hybridized with Lanthanum based Metal-Organic Frameworks

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Abstract- In this research, a new nanocomposite as supercapacitor based on the europium oxide (Eu_2O_3) nanoparticles decorated on the nitrogen doped graphene nanosheets (EuNs@NGNs) hybridized with the metal-organic framework of lanthanum and 1,5-naphthalene disulfonic acid ligand (La-MOF) were synthesized. The design of experiment (DOE) method and Design Expert software was used to study the influence and optimize the structural effects for the studied nanocomposite. The structural characteristics of the supercapacitive material were investigated with XRD, FTIR and Raman techniques. Also, morphology was evaluated through FESEM and TEM analyses. The electrochemical profile of these materials in a three-electrode setup was investigated using cyclic voltammetry (CV), galvanostatic charge-discharge (GCD) and electrochemical impedance spectroscopy (EIS) techniques. Also, continuous cyclic voltammetry method based on fast Fourier transform (FFTCCV) was used to evaluate the cyclic stability of the synthesized electrodes. The suitable electrolyte for this supercapacitor is 6.0 M sodium hydroxide solution. The specific capacitances of the EuNs@NGNs, La-MOFs and EuNs@NGNs /La-MOF electrodes were calculated to be 328, 505 and 920 and $F.g^{-1}$ at 2 mV/s. Moreover, EuNs@NGNs /La-MOF had a large energy density (59.62 Wh kg^{-1}) at 1511 W $kg^{-1}$and maintained its specific energy (37.09 Wh kg^{-1}) even when specific powers as high as (20000 W kg^{-1}) were applied. The material also enjoys unique cycling performance and its retention rate after 2500 charge-discharge cycles was determined to be 96.15%.

Keywords- Supercapacitive nanocomposite; Europium oxide nanoparticles; Nitrogen-doped graphene nanosheets; Lanthanium-based metal-organic frameworks; Continuous cyclic voltammetry