IMPROVED PERFORMANCES OF GRAPHENE/NICKEL COMPOSITE PREPARED VIA BALL-MILLING AND HYDROTHERMAL METHODS AS AN ELECTRODE IN SUPERCAPACITOR

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ABSTRACT

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Supercapacitor has been highlighted and pointed as the most selectable energy storage devices due to its capability and potentiality to charge and recharge in few seconds. Graphene/nickel (graphene/Ni) is the new innovation of hybrid materials for supercapacitor which has the potential to improve the performance of the commercial supercapacitor. In this research, graphene/Ni composite has been prepared via two methods; ball-milling and hydrothermal, and subjected to structural, morphology and electrochemical characterizations. The grapheme and graphene/Ni composite were successfully synthesized without any impurity. The as-received Ni nanoparticle from Sigma Aldrich contained NiO, whereas pure phase of Ni nanoparticle was obtained when prepared via hydrothermal method. The Ni nanoparticle loadings in the graphene/Ni composite prepared via ball-milling method were estimated to be 27, 34 and 48 wt.%, whereas for hydrothermal method, the graphene/Ni composite was found to be approximately 9, 23 and 38 wt.%. The Ni nanoparticles with particle size of approximately 2 μm, were well dispersed on the graphene layers without any agglomerations. Electrochemical results showed that the

specific capacitance exhibited by the graphene/Ni 34 wt.% composite prepared via ball-milling was 275 F g^{-1} at a current density of 2 A g^{-1}, which is higher than the specific capacitance of bare graphene (145 F g^{-1}) and bare Ni (3 F g^{-1}). Graphene/Ni 34 wt.% electrode also showed superior performance at a high current density, exhibiting a capacitance of 190 F g^{-1} at a current density of 5 A g^{-1} and a capacitance of 144 F g^{-1} at a current density of 10 A g^{-1}. For hydrothermal method, the specific capacitance ofis 203, 150 and 102 F g^{-1} at 2, 5 and 10 A g^{-1}, respectively, was obtained by graphene/Ni 9 wt.% composite. Graphene/Ni 34 wt.% and graphene/Ni 9 wt.% synthesized from the respective methods, retains ~91% and ~85% of its initial capacitance value after 1000 cycles compares to other electrodes with low equivalent series resistance. The enhanced performance of these hybrid materials is best described by the synergistic effect, i.e. dual charge-storage mechanism, which is demonstrated by electrical double layer and pseudocapacitance materials. These results indicate that ball-milling and hydrothermal methods are effective to produce industry scalable graphene/Ni composite for the supercapacitor.