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Superhighway channels of nickel ferrite doped Polyaniline nanocomposites for a high-performance stable symmetric pseudo-supercapacitor

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Abstract

The electrochemical performance of Polyaniline (PANI) can be significantly improved due to the incorporation of spinel-type transition metal oxide, i.e., 1 wt. % of Nickel Ferrite ($NiFe_2O_4$) into the PANI matrix. In this report, we have synthesised $NiFe_2O_4$ (NF), PANI1:1 ratio, PANI1:2 ratio, and PANI/$NiFe_2O_4$ nanocomposites, i.e., PANI1:1/NF1 and PANI1:2/NF2 nanocomposites by in-situ oxidative polymerization method. The conducting network formed in the nanocomposite significantly increases the multiple valence states of the metal for the electrolytic ions. The PANI/$NiFe_2O_4$ nanocomposite shows good interaction and was confirmed by Fourier Transform Infra-red Spectroscopy (FTIR) and Raman analysis. The SEM analysis reveals a uniformly porous and agglomerated globular morphology of the nanocomposite. Also, the PANI/$NiFe_2O_4$ composite (PANI1:1/NF1) exhibits enhanced supercapacitive properties due to improve strong conducting path of PANI, which helps to provide the delocalization of the electrons in the polymeric chain. The highest specific capacitance ~ 758 Fg^{-1} is achieved for PANI 1:1/NF1 sample as compared to bare PANI1:1 (677 Fg^{-1}), PANI1:2 (500 Fg^{-1}), NF (253 Fg^{-1}) and other PANI1:2/NF2 (686 Fg^{-1}) samples at 10 mV/s scan rate in a two-electrode system due to NF nanoparticles filling the vacant places in the polymeric matrix. The energy density (54 $Whkg^{-1}$), power density (1705 Wkg^{-1}) and good cycling stability approx. 97 % after 10000 GCD cycles of the device is found for PANI1:1/NF1. The EIS studies further confirm that the PANI 1:1/NF1 device has a lower charge transfer resistance (R_{ct}) ~ 0.35 Ohm in comparison to other fabricated devices. It seems that $NiFe_2O_4$ acts as a "superhighway" for charge transportation between PANI which is beneficial for supercapacitors.

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