Conducting PEDOT and Polyaniline Based Metal Oxide Nanocomposites as Efficient Supercapacitor

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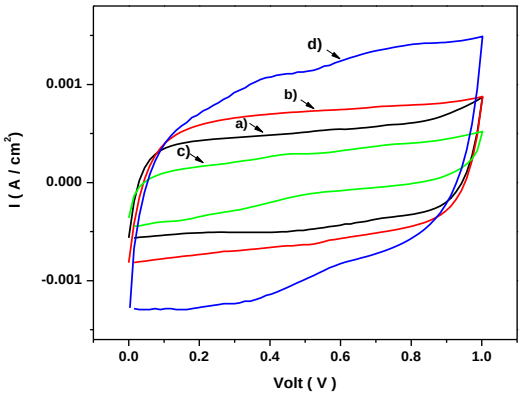
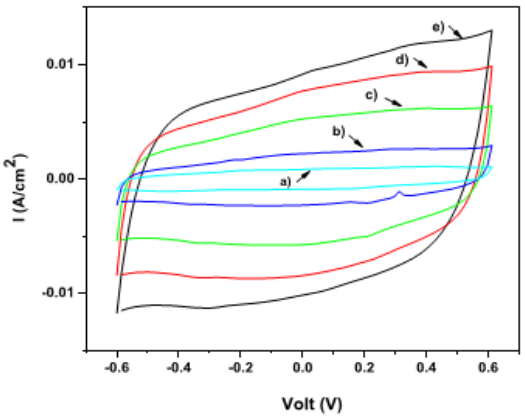
A nanocomposite material comprising of nanaoparticles of inorganic transition metal oxides and conducting polymer like poly 3,4-ethylenedioxythiophene (PEDOT) and Polyaniline (PANI) can act as very efficient supercapacitor with enhanced specific capacitance value due to synergistic effect. Here we used nanaoparticles of two different metal oxides i.e. nickel ferrite ($NiFe_2O_4$) and manganese dioxide (MnO_2) to combine separately with PEDOT or PANI to form nanocomposite electrodes to investigate their electrochemical behavior as supercapacitor. Nanocrystalline nickel ferrite was synthesized by sol-gel method from stoichiometric amount of their nitrates and α- MnO_2 nanorod by redox reaction between stoichiometric quantities of $MnSO_4$ and $KMnO_4$ in aqueous medium. Reverse micro emulsion polymerization in n-hexane medium was adopted for PEDOT nanotube formation using different surfactants. The PANI–MnO_2 nanocomposite was chemically synthesized by oxidative polymerization of aniline using $FeCl_3$ under controlled conditions in presence MnO_2 nanorod. Structural morphology and characterization for the nanocomposites were studied using XRD, SEM, TEM, IR and XPS. Their electrochemical performances were tested using cyclic voltammetry at different scan rates (2-20mV/s) and galvanostatic charge-discharge at different constant current densities in acetonitrile containing 1M $LiClO_4$ electrolyte. Both the Nanocomposite electrodes showed higher specific capacitances; for PEDOT-$NiFe_2O_4$ (251 F/g) in comparison to $NiFe_2O_4$ (127 F/g) and PEDOT (156 F/g) and for PEDOT-MnO_2 (315 F/g) and PANI-MnO_2 (221 F/g) respectively compared to MnO_2 (158 F/g) where morphology of the pore structure plays a significant role over the total surface area. AC impedance measurements were done to ascertain contribution of pseudocapacitance in the frequency range 10 kHz to 10 mHz with a potential amplitude of 5mV.





Cyclic voltammogram of PEDOT–MnO_2 composite in acetonitrile containing 1M $LiClO_4$ electrolyte at a scan rate (a) 2mV/s, (b) 5mV/s, (c) 10 mV/s (d) 15 mV/s and (e) 20 mV/s in a potential range between 0.6 and –0.6 V.

Typical cyclic voltammogram of (a) PEDOT-Aq (b) PEDOT-Org (c) Nano $NiFe_2O_4$ and (d) PEDOT-$NiFe_2O_4$ composite electrodes in acetonitrile containing 1 M $LiClO_4$ electrolyte at a scan rate 2mV/s in a potential range between 0 to 1V.