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(57) Abstract :
. Title of Invention A Hierarchically Structured $NiFe_2O_4/MoS_2$/CNT Ternary Nanocomposite with Synergistic Redox and Conductive Network Engineering for High-Performance Supercapacitor and Energy Storage Applications 2. Abstract The current invention is connected to a hierarchical ternary nanocomposite of nickel ferrite (NiFe2O4), molybdenum disulfide (MoS2) and carbon nanotubes (CNTs) and to a method of their preparation to be used in the electrochemical energy storage devices, especially to the supercapacitors. The invention overcomes the weaknesses of traditional electrode materials such as low electrical conductivity, low electrochemical activity and low rate capability. As per the current invention, the NiFe2O4 constituent serves as a ferrite skeleton that offers structural stability with several redox-active sites by conducting reversible Ni2+/Ni3+ and Fe2+/Fe3+ redox reactions, which contributes to pseudocapacitive charge storage. The MoS2 element provides a high surface area, with a layered structure, which allows the diffusion of ions to proceed effectively, and it offers more sites that are electrochemically active. The carbon nanotubes create a three-dimensional conductive network which increases the speed of transfer of electrons, decreases the internal resistance and increases the mechanical strength of the electrode. The nanocomposite is prepared following a hierarchical structure in which the NiFe2O4 nanoparticles are deposited consistently on the carbon nanotubes surface and then the MoS2 are deposited in situ in the form of nanosheets or nanoflakes over the NiFe2O4/CNT system. This leads to an interconnected porous structure where there is an increased contact between the components and thus quick charge transfer and increased electrolyte accessibility. The steps to prepare the said nanocomposite include synthesis of NiFe2O4 nanoparticles by a hydrothermal, or solvothermal method, the dispersion and functionalization of carbon nanotubes to allow efficient anchoring of NiFe2O4, in situ growth of MoS2 using appropriate molybdenum and sulfur precursors under controlled temperature and reaction conditions and finally washing and drying. The resultant nanocomposite electrode has better electrochemical characteristics, such as high specific capacitance, high rate, and high cycling stability at long charge and discharge cycles. The synergistic action between ferrite, layered sulfide as well as the conductive carbon network offers an optimum balance of electrical conductivity, redox and structural strength. The invention is also associated with applying the said nanocomposite in supercapacitors and other electrochemical energy storage devices, such as hybrid capacitors and portable energy devices, thus providing them with a better energy density and power density than traditional electrode materials. Keywords $NiFe_2O_4$ nanocomposite, MoS_2 nanosheets, Carbon nanotubes (CNTs), Supercapacitor electrodes, Pseudocapacitive energy storage, Hierarchical nanostructures

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