Synthesis and Characterization of Cobalt Oxide Decorated Molybdenum Disulfide Nanomaterials for Energy Storage Applications

Abstract

In this study, a novel, Co_3O_4 nanoparticle decorated MoS_2 nanoflower (MoS_2/Co_3O_4) has been fabricated via a facile hydrothermal method by taking different concentration of Co_3O_4 (0%, 1%, 2%, 4%, and 6%). The FESEM images show three-dimensional flower-like structure for MoS_2 and MoS_2/Co_3O_4. The different structural parameters of the nanoflowers were estimated from the XRD analysis followed by the corresponding Rietveld refinement pattern which confirms the phase purity of MoS_2/Co_3O_4. TEM analysis revealed the inter-planar spacing of the nanostructure varied with the concentration of the Co_3O_4 nanoparticles. The Raman spectroscopy of MoS_2/Co_3O_4 nanoflower showed a distinct low-shift of the first-order Raman peaks suggesting a n-type doping due to the incorporation of Co_3O_4. The UV-Vis spectroscopy revealed a variation of the optical band gap between 1.44 eV - 1.20 eV due to the decoration of nanoparticles. The specific capacitance as high as 220.72 $mFcm^{-2}$ at 0.14$mAcm^{-2}$ together with high energy density and superior cycling stability (93% capacitance retention after 6000 charge/discharge cycles) were obtained for the MoS_2/Co_3O_4 (4%) from the electrochemical analysis. This improved specific capacitance of MoS_2/Co_3O_4 can be attributed to the higher surface area, defect-rich structure, and lower charge transfer resistance of the prepared sample. The MoS_2/Co_3O_4 nanostructure with improved specific capacitance and higher stability synthesized from a simple, low-cost process will pave a way to the production of efficient and economic energy storage devices.