Abstract

Pure and nickel doped (5 and 10 wt%) vanadium oxide nanoparticles were synthesized by the cost effective hydrothermal technique for the potential application in energy storage devices and for photocatalysis. All three samples were characterized by X-ray diffraction (XRD), Scanning electron microscopy (SEM), Energy-dispersive X-ray spectroscopy (EDX), UV-vis absorption spectroscopy, Fourier transformed infrared spectroscopy (FTIR), Raman spectroscopy, Photoluminescence (PL), Cyclic Voltammetry (CV) and Photocatalysis. XRD confirmed that most of the major diffraction peaks are according to the standard orthorhombic pattern of V_2O_5 phase. By increasing the Ni doping concentration the crystallinity also improved. SEM images reveal that as we increase the doping concentration the morphology of the pure sample changed to nanorods with improved crystallinity. EDX graphs represent the existence of Ni, V and O elements. UV-Vis spectroscopy revealed that the absorption intensity of the doped sample is less due to higher crystallinity. The optical band gap for the pure sample is calculated around 3.4 eV which increased to 4.5 and 4.6 eV for the 5% and 10% Ni doped sample respectively. The absorption peaks also shifts towards the lower wavelength resulting in blue shift as we increase the Ni doping concentration. FTIR graph exhibits the band vibration of different V-O vibrator below 1100 cm^{-1}. Raman Spectroscopy reveals the series of bands in the range of 200-1100 cm^{-1} because of the different vibration groups of V-O type. PL spectra demonstrated the highest intensity for the 10% Ni doped sample. CV graph exhibited that the Ni incorporation in V_2O_5 increases the current density upto 5 wt.% which is possibly due to the rearrangement of structure of V_2O_5 caused by the substitution of Ni^{2+} ions and the formation of nanorods. Moreover 5% Ni-V_2O_5 electrode showed broad oxidation redox peak, high capacitance and high peak current. Photocatalytic activity was assessed under the Uv irradiation by analyzing the degradation of methylene blue (MB) organic dye. 5% Ni doped sample exhibited lowest photocatalytic response in degradation of MB dye, however 10% Ni doped sample enhanced the degradation process and showed higher percentage degradation of MB dye in less time as compare to the undoped sample.