Reduced graphene oxide decorated with V_2O_5 nanowires as an efficient electrode material for supercapacitor applications

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Super capacitors play vital role as an energy storage device due to their higher power densities than the standard batteries and higher energy densities than that of the conventional capacitors. The high energy density of supercapacitor is due to the pseudocapacitance behavior of redox active transition metal oxides. In this work we have synthesized reduced graphene oxide decorated with vanadium pentoxide nanowire (VN-rGO) electrodes using one step hydrothermal method, whereas V_2O_5 particles are converted into uniformly distributed nanowires with the simultaneous reduction of graphene oxide into rGO. VN shows higher surface area than the V_2O_5 raw particles which facilitates higher diffusion rate and mobility of cations (Na+, K+) during the charge discharge process. The V_2O_5 alone has a low electronic conductivity; hence the rGO enhances the electronic conductivity of VN-rGO hybrid material and also provides the enhanced electrochemical double layer capacitance (EDLC) to the system.

The degree of reduction of GO into rGO is confirmed using X-ray photoelectron spectroscopy (XPS) and laser Raman spectroscopy. The surface morphology of VN decorated rGO is examined using field emission scanning electron microscopy (FE-SEM), and transmission electron microscopy (TEM). The crystallinity and composition of the materials is analyzed using X-ray diffraction (XRD) and energy dispersive spectroscopy (EDS) respectively. The electrochemical performance of VN-rGO is analyzed using the cyclic voltammetry. The specific capacitance of the material is estimated using the constant current (galvanostatic) charge discharge method. The charge transfer resistance of the as prepared material is characterized using the electrochemical impedance spectroscopy (EIS). As expected, the rGO decorated with vanadium nanowire shows higher specific capacitance than the bulk V_2O_5 particles and bare rGO materials.

Keywords: Graphene, Vanadium pentoxide, supercapacitor, reduced graphene oxide, V_2O_5 nanowire

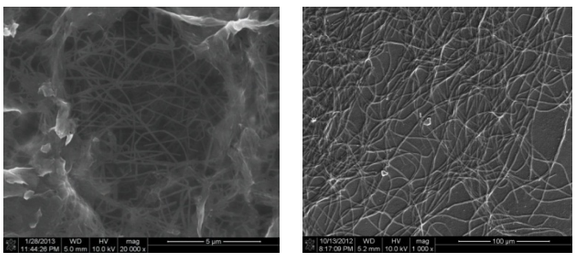

Fig. 1 FE-SEM images of surface morphology of VN-rGO material.