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Layered Transition Metal Dichalcogenides and Reduced Graphene Oxide Hybrids for Supercapacitor Applications

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Atomically thin semiconducting transition metal dichalcogenides (TMDCs) layered materials have recently been emerged as an exciting area of research due to acesiblity for easy synthesis using various chemical and physical methods. These two-dimensional (2D) layered materials with single layer have direct and wide band gap due to which, they are more suitable for nanoelectronics and optoelectronics device applications. Here we report composites consisting of layered structured WS_2/reduced graphene oxide (RGO) and VS_4/RGO hybrids prepared by a facile hydrothermal method for its possible application as supercapacitor materials in energy storage devices. The uniformity of distribution of TMDCs over rGO layer and its detailed morphology were studied by the high resolution FESEM and TEM analysis. XRD, Raman and EDAX analysis confirmed formation of pure phase without any impurities. Supercapacitors were fabricated using a swage-lok type two electrode cell using 1M $Na_2SO_4.6H_2O$ aqueous solution as the electrolytic medium. Cycling voltammetry (CV), charge-discharge and long cycling measurements in the two electrode configuration were performed by a potentiostat/galvanostat with working potential window between −0.1 and 0.9 V. Three electrode measurements were carried out using an electrochemical cell with glassy carbon electrode (GCE) coated composite as the working electrode, Ag/AgCl as the reference electrode and platinum wire as the counter electrode. Three electrode measurements were performed to verify the pseudocapacitive behaviour of the composites. The WS_2/RGO hybrids exhibited enhanced supercapacitor performance with specific capacitance of 350 F/g at a scan rate of 2mV/s. The obtained capacitance values of WS_2/RGO hybrids are about 5 and 2.5 times higher than bare WS_2 and RGO sheets. The VS_4/RGO hybrid showed a specific capacitance of 845 F/g and this high value of specific capacitance can be attributed to both EDLC and pseudocapacitive contributions from the RGO layer and VS_4, respectively.

Keywords: Graphene, Metal dichalcogenides, Layered materials, Supercapacitors, WS_2