

Few-layer mixed 1T-2H phase MoS₂ as electrode material in supercapacitor and catalyst for hydrogen evolution reaction

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Molybdenum disulfide (MoS₂) is a layered transition-metal dichalcogenide which has attracted great interest as material for energy conversion and storage. MoS₂ exists in three different polymorphs that are the stable 2H, the meta-stable 1T and 3R with the possibility of obtaining 2D nanostructures. Herein, we report the synthesis and characterization of a few-layer hybrid material containing both metallic 1T and semiconducting 2H phases (1T-2H MoS₂ nanoflakes) obtained with phosphomolybdic acid and L-cysteine in one-pot hydrothermal synthesis. Morphological and structural characterizations are presented and compared to commercially available 2H-MoS₂ powders. The thermal conversion of the 1T-2H MoS₂ on fully 2H MoS₂ is studied by means of X-ray Photoelectron Spectroscopy due to the possibility to quantify the relative amount of 1T and 2H phase and maintaining the same morphology. This conversion allows to appreciate the superior properties of the 1T-2H mixed phases as catalyst for hydrogen evolution reaction (HER) and as electrode material in both aqueous and Li ion supercapacitors. In order to enhance the capacitive proprieties of the mixed phases, the 1T-2H nanoflakes were finely alternated to reduced graphene oxide (rGO) sheets by obtaining a tridimensional matrix of rGO-MoS₂. This co-synthesis allowed to increase the cycling life and stability of aqueous supercapacitors.