

Preparation of MoS₂/Curved Graphene Nanosheets based composite as a remarkable electrode material for high-performance supercapacitors

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Abstract

MoS₂ was prepared with flower like microspheres by hydrothermal method using ammonium molybdate and thiourea. Followed by curved graphene nanosheets (CGN) was synthesized from MWCNTs by a two-step process, including oxidation and reduction via modified Hummers method using sodium nitrate, sulfuric acid, and potassium permanganate and NaBH₄. After the reduction, the solid sample was collected and washed with ethanol and deionized water and vacuum-dried at 60 °C to obtain the CGN. XRD pattern of MoS₂ nanosheets showed diffraction peaks at 14.12, 33.57 and 58.79 corresponding to the planes of (002), (101) and (110). The intensity of diffraction peaks of hexagonal phase indicated the crystalline structure of flower-like MoS₂ nanosheets. Hummer's method of oxidation and following reduction process will lead to unzipping of MWCNT to curved graphene nanosheets (CGN). XRD pattern for MWCNT showed a plane (001), as evidenced by a peak at $2\theta = 26.05^\circ$. After reduction with NaBH₄, this peak completely disappeared, and a very broad peak appeared at around 23.2° which corresponds to an interlayer spacing of about 3.7 Å. First, 3 mg of prepared MoS₂ was dispersed in 2 ml DI water and sonicated for 5 min and 3 mg of CGN was dissolved in 2 ml DI water and sonicated. From these dispersions, we found that MoS₂ dispersion was not stable compared to CGN in DI water. Next, 3 mg of CGN and 3 mg of MoS₂ were mixed in 2 mL water and sonicated for 5 min. MoS₂/CGN dispersion was a stable dispersion in DI water. This composite was used to prepare anode material for supercapacitors. We have studied the electrochemical properties of MoS₂/CGN after coating on a glassy carbon electrode.

MoS₂/CGN loaded electrode showed better capacitive performance, a specific capacitance of (C_{sp}) of 621 F g⁻¹ at 1 A g⁻¹ with H₂SO₄ with good capability. MoS₂/CGN loaded electrode also showed extraordinary cycling stability with 86.1% capacitance maintenance after 1000 nonstop charge–discharge cycles at a current density of 1 A g⁻¹.

Keywords: Molybdenum disulfide (MoS₂), Curved graphene nanosheets (CGN), Heterostructure (MoS₂/CGN) and Specific capacitance.