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Synthesis and characterization of hydrothermally prepared molybdenum disulfide for supercapacitor application

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ABSTRACT

A simple and facile hydrothermal method has been used for synthesis of molybdenum disulfide (MoS_2). The structural and morphological properties of as-prepared MoS_2 were characterized by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy and scanning electron microscopy (SEM) techniques respectively. The XRD results indicate that the as-prepared MoS_2 material shows polycrystalline nature. The optical properties of MoS_2 were investigated by UV–Vis absorption spectroscopic technique. The UV–Vis absorption spectra show absorption of light in visible region. The supercapacitor behavior of MoS_2 was studied by cyclic voltammetry (CV). These results indicate that MoS_2 is promising material for supercapacitor application.

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1. Introduction

The globalization and digitalization of the human race has paved a way for power hungry world. With the depleting non-renewable resources, global community is already looking for a high energy density centric and fast charging power device [1]. Supercapacitors are the heart of this research field. Size, energy density, morphology and porosity are the building blocks of research in this field [2]. Basically, there are two types of capacitors based on their charge storage mechanisms (i) Electrical double layer capacitors, commonly known as EDLCs and (ii) Pseudocapacitors. EDLCs use carbon as an active material and is preferred for consumer electronic items, military equipments that require robust mechanism as well as electrical vehicles [3]. Pseudocapacitors are advanced as compared to EDLC and use polymers and metal oxides and have higher capacitance than EDLCs. High theoretical specific capacitance and low cost are the strong headpoints for the transition metal sulfide based supercapacitors [4].

Molybdenum disulfide has attracted worldwide attention in various applications such as Li-ion batteries [5], hydrogen evolution [6], counter electrode for dye sensitized solar cells (DSSCs) [7], sensors [8], supercapacitors [9,10] etc. due to its unique sheet like structure and higher conductivity. Due to layered structure MoS_2 can provide large surface area which enhances the capacitance of supercapacitor [11].

Numerous methods have been reported for the synthesis of MoS_2 such as chemical vapor deposition (CVD) [12], DC sputtering [13], electrodeposition [14], SILAR [15], chemical bath deposition (CBD) [16] etc.

The present research work is focuses on preparation of MoS_2 material via simple and cost effective hydrothermal method for supercapacitance application. For MoS_2 material synthesis, there were no major limitations as compared with other materials. As-synthesized MoS_2 material was characterized via various characterization techniques. The electrochemical performance of MoS_2 were examined through cyclic voltammetry and electrochemical impedance measurements. This work shows the role of scan rate on specific capacitance of MoS_2 material.

2. Experimental

2.1. Preparation of MoS_2 material

All chemicals used for MoS_2 preparation were analytical reagent (A. R.) grade. 0.01 M sodium molybdate and 0.2 M thiourea were dissolved in 100 ml of double distilled water (DDW). The pH value

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