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Solvothermal Synthesis and Characterization Studies of ZnO Nano-Rods for Supercapacitor Applications

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Well crystalline ZnO nanorods as electrode material for electrochemical capacitors were prepared by a facile, green and efficient solvothermal approach consisted of a novel liquid phase exfoliation synthesis route. A new method of synthesis has been adopted for the synthesis of rod like ZnO nanostructures based on double hydroxide performance. Structural, morphological features of the prepared material were studied by X-ray diffraction (XRD) and scanning electron microscopy (SEM) respectively. Electrochemical supercapacitive performances of the modified electrode material were also analyzed by electrochemical workstation in three-electrode system. This material found to exhibit pseudocapacitive behavior with high capacitance of 135.23 F/g at the current density of 1 A/g in 1 M Na_2SO_4 electrolyte solution, proving a suitable candidate electrode material for supercapacitor applications.

Keywords: Metal Oxides, Morphology, Electrochemical Properties, ZnO Nanorod.

1. INTRODUCTION

The power requirements for a number of portable electronic devices have increased rapidly in recent years and have exceeded the capability of conventional batteries to such an extent that great attention is being focused on supercapacitors are as energy storage systems.[1–3] Supercapacitors also known as electrochemical capacitors have been a subject of interest to many applications in research and development, due to its high power density, environmental friendliness, long shelf life and retentive life cycle, bridges the energy gap between capacitors (high power output) and fuel cells/batteries (high energy storage).[4,5] The performance of an electrochemical supercapacitor based on energy and power densities is governed, mainly by the specific capacitance of the active electrode materials and cell voltage. Obviously, the approach to improve the performance of a supercapacitor is to maximize both the capacitance and the cell voltage.[6]

The supercapacitor is mainly based on electrochemical double-layer capacitance (EDLC) and psudocapacitor capacitance. The EDLCs are electrical energy storage devices that store and release energy by charge separation at the interface between electrode and electrolyte. The charge storage mechanism of EDLCs is mainly based on the interfacial double-layer of high specific area (carbon based materials).[7] Carbon materials such as activated carbon, carbon arogels, and carbon nanotubes (CNTs) are usually utilized as electrodes in supercapacitors, and exhibit good electrical double-layer capacitive performance, because of their excellent conductivity, high surface area and stable chemical property.[8] Another class of supercapacitor is based on pseudocapacitance that stores and releases energy by electrosorption and surface redox processes at high surface area electrode materials such as metal oxides and conducting polymers.[9]

In recent years, metal oxides (RuO_2, IrO_2, MnO_2, NiO_2 and ZnO) activated carbon composite materials have been prepared as potential electrode materials as they can improve the capacitance of carbon-based supercapacitors, as they can contribute pseudo-capacitance to the total capacitance apart from the double layer capacitance from carbon materials.[10] Among the many metal oxides available, zinc oxide (ZnO) has attracted much attention as a promising electrode material for supercapacitors owing to its low cost, abundant availability, environmental friendly nature and electrochemical activity.[10–12] ZnO

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