



Chemical and structural stability of porous thin film NiO nanowire based electrodes for supercapacitors[☆]

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HIGHLIGHTS

- NiO nanowires of average diameter ~65 nm were synthesized by hydrothermal method.
- Porosity of NiO thin film was found to be greater than 50%.
- NiO nanowire electrodes showed specific mass capacitance of 750 F/g.

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ABSTRACT

Nanowires of NiO were successfully synthesized using a simple hydrothermal route. The nanowires were characterized for phase composition and morphology by X-ray diffraction (XRD) and transmission electron microscopy (TEM) techniques, respectively. XRD analysis showed that the powders produced were of high purity cubic NiO phase. Selected area electron diffraction (SAED) analysis during TEM showed the growth direction of NiO nanowires in (100), while exhibiting an average diameter of ~65 nm. BET analysis showed these nanowires exhibiting a surface area of 153.2 m²/g. These nanowires were electrophoretically deposited on titanium foils as thin layer (~5 μm thickness) and were studied for their capacitive behavior as electrodes for supercapacitor applications. Image analysis and atomic force microscopy (AFM) studies revealed the thin film coating to be highly porous (>50%). Cyclic voltammetry (CV) studies on these electrodes exhibited a specific mass capacitance of 750 F/g with 12% capacitance fade at the end of 1000 cycles. The present study elucidates how NiO surface morphology and OH⁻ adsorption/desorption behaviors underlying these electrodes impact the chemical and structural stability performance.

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1. Introduction

The unique properties like high cycling ability, low cost and extraordinarily high power density make supercapacitors highly desirable in a wide range of electronic and automotive applications [1–3]. Supercapacitors store charges based on one or both of these two mechanisms i.e. electric double-layer and pseudocapacitance [4,5]. In the former mechanism, charge builds up at the electrode and electrolyte interfaces with reversible ion movement and adsorption–desorption resulting to the capacitance. The charge storage mechanism based on pseudocapacitance arises from the

reversible redox reactions taking place on the surface of the electrode material which possess various valence/oxidation states. Transition metal compounds including oxides, nitrides as well as conducting polymers are good candidates for pseudocapacitors. Among these, rare earths like ruthenium and iridium related compounds show exceptional good capacitor performance due to their good electrical conductance [6]. But the high cost nature of these rare earth oxides has shifted the focus for alternative inexpensive oxides with similar performance. Nickel oxides possessing a theoretical capacitance of 2573 F/g [7] have attracted great interest due to their easy availability, low cost, eco-friendliness and well-defined oxidation/reduction activity. In order to develop a high performance supercapacitor, it is generally desirable to design the geometry and morphology of supercapacitor electrode with fully utilized surface area and well-defined pore structures, which can lead to faster ion movement contacting the electro-active materials and promote faradic redox reactions. Many synthesis and deposition techniques such as electrospinning [8], template assisted syn-

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