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Synthesis and characterization of NiO nanoparticles for electrochemical applications

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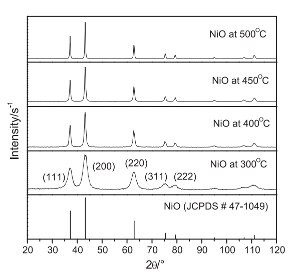
HIGHLIGHTS

- NiO was synthesized for electrochemical applications by pyrolysis of an oxalate precursor.
- The CV curves of NiO nanoparticles exhibit pseudocapacitive behavior.
- NiO at 400 °C shows higher capacity than the NiO at 500 °C due to higher porosity.

GRAPHICAL ABSTRACT

XRD patterns of NiO nanoparticles.



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ABSTRACT

Nanosized NiO anode material was synthesized for lithium ion batteries and supercapacitor applications using pyrolysis of an oxalate precursor, which was prepared by a rheological phase reaction from nickel carbonate hydrate and oxalic acid. The obtained material was characterized with X-ray diffraction (XRD), differential scanning calorimetry–thermogravimetric analysis (DSC–TGA), scanning electron microscopy (SEM) and transition electron microscopy (TEM). Cyclic voltammetry was conducted to examine the capacitive behavior of working electrodes made from these new NiO nanoparticles. X-ray diffraction results show that the particle size of the nanomaterials increases with increasing calcination temperature. The anode made from NiO at 400 °C shows a higher specific capacity (1188 mAh/g) than the anode made from NiO at 500 °C (1010 mAh/g). The better electrochemical behavior of the material prepared at 400 °C is attributed to higher porosity in the material.

1. Introduction

Rock salt structured MO-type (M = Co, Cu, Fe, Ni, etc.) transition metal oxides are promising candidates as anode materials (i.e. negative electrode) for lithium ion batteries due to higher specific capacity, long cycle life and high recharging rates because these oxides can react reversibly with lithium in a lithium cell below 1.5 V [1,2]. These materials exhibit capacities over 700 mAh/g, which is two times higher than that of the traditional carbon materials. On the other hand, for many unmodified rock salt structured MO-type transition metal oxides, the capacities often reduce very quickly during repeated charge–discharge process. In recent years, many researchers focused on improving their electrochemical performance by adopting different synthesis methods. Among the rock salt structured MO-type transition metal oxides, NiO is an attractive material with applications in various fields, such as catalysis, magnetic materials, fuel cell electrodes, electrochromic films, gas sensors, lithium-ion batteries and electrochemical capacitors [3–12] because of low cost of their raw materials and low toxicity.

Nanostructured materials play a significant role in electrochemical devices because they have high specific surface area and sustain fast redox reactions; capacitive electrochemical behavior is

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