

Template-Based Synthesis and Electrochemical Investigations of Nanostructured Nickel Oxides for Supercapacitors

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Electrochemical capacitor has received considerable amount of attention over the last few years because of their use in high power energy storage devices. The capacitance in an electrochemical capacitor can arise from the charging or discharging of the electrical double layers (electrical double layer capacitance) or from Faradaic redox reactions (pseudocapacitance). Carbon materials with very high-surface area are widely used for double layer capacitors. Subsequently, conducting polymers and transition metal oxides with relatively high-surface-area, such as hydrous RuO_2 , NiO_x , CoO_x and MnO_x have been identified as possible electrode materials for supercapacitors.

Nickel oxide (NiO_x) is being considered as one of the promising potential electrode materials for supercapacitors as well as for many other applications such as catalyst, electrochromic films, fuel cell electrodes, and gas sensors. NiO_x materials for supercapacitors can be prepared by thermal treatment of electrodeposited $\text{Ni}(\text{OH})_2$ (electrochemical route), sol-gel method and electrostatic spray deposition technique.¹⁻⁴ The specific capacitance of these NiO_x materials ranges from 200 to 278 F/g (from a single electrode) in 1 M KOH within 0.5V potential window.

Our previous study revealed that the pseudo-capacitance of NiO_x films was due to H^+ and OH^- ion adsorption/desorption reactions at or near the electrode /electrolyte interface. In order to enhance the specific capacitance and rate capability the surface area of the NiO_x material should be increased, while keeping the mass constant. Hence, mass-normalized energy and power density can be optimized when the NiO_x material is prepared in nanostructured, highly porous forms.

In this study, nanostructured NiO_x materials for supercapacitor were prepared by template synthesis

method. Template synthesis is a general method for preparing nanomaterials and is described in detail elsewhere.⁵⁻⁶ The template membranes used for nanostructured NiO_x material synthesis is porous alumina membranes and they are prepared electrochemically from aluminum metal. Nanostructured $\text{Ni}(\text{OH})_2$ was electrochemically precipitated and filled up the nano-sized cylindrical pores of membrane. The alumina template membrane was then removed. Nanostructured NiO_x was formed by heating the as-deposited $\text{Ni}(\text{OH})_2$ materials in air at different temperatures.

Nanostructured NiO_x was characterized by SEM, XRD and thermogravimetric analysis. Electrochemical properties were also investigated. Detailed results and discussion will be presented in the meeting.

References

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