

### Synthesis and Electrochemical Investigations of Nanostructured Nickel Oxides for Supercapacitors

Kyung-Wan Nam and Kwang-Bum Kim

Department of Metallurgical Engineering,  
Yonsei University  
134 Sinchon-dong Seodamun-gu, Seoul, Korea

Nickel oxide ( $\text{NiO}_x$ ) 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.  $\text{NiO}_x$  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.<sup>1-4</sup> The specific capacitance of these  $\text{NiO}_x$  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 charge storage reaction confined mainly to the surface layer of  $\text{NiO}_x$  electrodes. In order to enhance the specific capacitance and rate capability, the surface area of the  $\text{NiO}_x$  material should be increased, while keeping the mass constant. Hence, mass-normalized energy and power density can be optimized when the  $\text{NiO}_x$  material is prepared in nanostructured, highly porous forms.

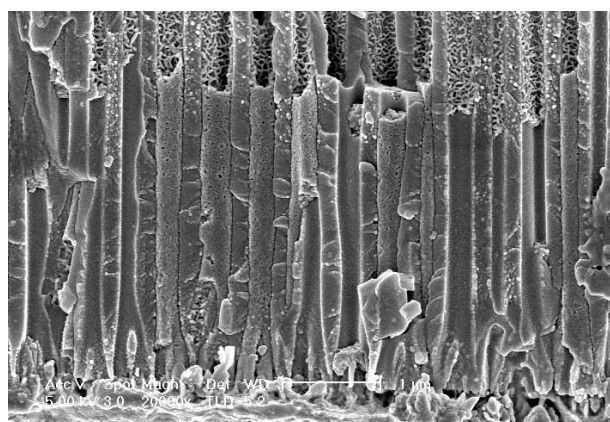
In this study, nanostructured  $\text{NiO}_x$  materials for supercapacitor were prepared by template synthesis method. Template synthesis is a general method for preparing nanomaterials and is described in detail elsewhere.<sup>5-6</sup> Two types of template membranes are used in this study: porous aluminum oxide and polycarbonate track-etch membranes with various pore diameters. Nanostructured  $\text{Ni}(\text{OH})_2$  was electrochemically precipitated and filled up the nano-sized cylindrical pores of membranes. Nanostructured  $\text{Ni}(\text{OH})_2$  in the pores with wire and tube types can be formed by controlling synthesis conditions. After removal of template membrane, nano-structured  $\text{NiO}_x$  was formed by heating the as-deposited  $\text{Ni}(\text{OH})_2$  materials in air at different temperatures.

Nanostructured  $\text{NiO}_x$  was characterized by SEM, XRD and thermogravimetric analysis. Electrochemical

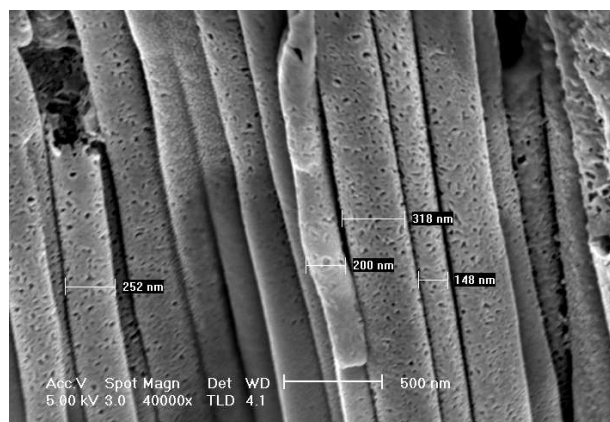
properties were also investigated. Detailed results and discussion will be presented in the meeting.

### References

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(a)



(b)

Fig. 1 SEM images of (a)  $\text{Ni}(\text{OH})_2$  nanowires in the anodic aluminum oxide membranes with  $\sim 200\text{nm}$  pore diameter and (b)  $\text{Ni}(\text{OH})_2$  nanowires after removing the anodic aluminum oxide membranes.