

# Advanced Energy Materials and Research

## Electrochemical Synthesis of NiCo<sub>2</sub>O<sub>4</sub>/Carbon Fiber Paper Composites

Tae-Hoon Ko<sup>1</sup>, Rai Min-Kang Seo<sup>2</sup>, Hak-Yong Kim<sup>3</sup> and Byoung-Suhk Kim<sup>4</sup>

<sup>1,3,4</sup>Chonbuk National University, Republic of Korea

<sup>2</sup>Korea Institute of Carbon Convergence Technology, Republic of Korea

Recently, electrochemical capacitors have been carried out with emphasis on the development of hybrid electroactive electrode materials, based on metal oxide, carbon materials and conducting polymers. The hybrid NiCo<sub>2</sub>O<sub>4</sub> modified carbon fiber paper (NiCo<sub>2</sub>O<sub>4</sub>/CFP) composites with different electrodeposited times of polypyrrole (PPy) layers were prepared by two-step process. At first, NiCo<sub>2</sub>O<sub>4</sub> was prepared by low temperature hydrothermal method. Secondly, PPy layer were coated onto the NiCo<sub>2</sub>O<sub>4</sub>/CFP composites by using electrochemical deposition method. The potential sweeping between -0.2 to 1.0 V at a scan rate of 50 mV/s was performed for various potential sweeping cycles (0, 5, 10, 15 and 20) in 0.5 M KCl solution in the presence of pyrrole monomer. SEM images clearly indicated that the NiCo<sub>2</sub>O<sub>4</sub> nanoneedles were uniformly grown over the CFP. Further, PPy layer was uniformly deposited over the NiCo<sub>2</sub>O<sub>4</sub>/CFP composites. In the present work, we have fabricated various hybrid NiCo<sub>2</sub>O<sub>4</sub>/CFP composite electrodes with different electrodeposited PPy layers, and the effects of electrodeposited PPy layer were investigated. The as-prepared NiCo<sub>2</sub>O<sub>4</sub>/CFP composite electrodes with PPy layer electrodeposited for 15 cycles (NiCo<sub>2</sub>O<sub>4</sub>-PPy15/CFP) showed good electrochemical performance. Further, NiCo<sub>2</sub>O<sub>4</sub>-PPy/CFP composite electrode was successfully utilized for solid-state high performance supercapacitor applications. It showed high capacitance value with high energy and power density as well as high rate capability, which were evaluated from galvanostatic charge-discharge and electrochemical impedance spectroscopy.

Taehoon222@naver.com