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Influence of Electrodeposited Polypyrrole Layer on the Capacitive Performance of Hybrid NiCo₂O₄/Carbon Fiber Paper Composites

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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 NiCo₂O₄ modified carbon fiber paper (NiCo₂O₄/CFP) composites with different electrodeposited times of polypyrrole (PPy) layers were prepared by two-step process. At first, NiCo₂O₄ was prepared by low temperature hydrothermal method. Secondly, PPy layer were coated onto the NiCo₂O₄/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 NiCo₂O₄ nanoneedles were uniformly grown over the CFP. Further, PPy layer was uniformly deposited over the NiCo₂O₄/CFP composites. In the present work, we have fabricated various hybrid NiCo₂O₄/CFP composite electrodes with different electrodeposited PPy layers, and the effects of electrodeposited PPy layer were investigated. The as-prepared NiCo₂O₄/CFP composite electrodes with PPy layer electrodeposited for 15 cycles (NiCo₂O₄-PPy15/CFP) showed good electrochemical performance. Further, NiCo₂O₄-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.

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