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Facile Hydrothermal Synthesis of Hierarchical NiO/$ZnCo_2O_4$ Nanocomposite for High-Energy Supercapacitor Applications

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Abstract : Currently, tremendous attention has been paid to the rational design and synthesis of core/shell heterostructures for high-performance supercapacitors. In this study, the hierarchical NiO/$ZnCo_2O_4$ Core-Shell Nanorods Arrays were successfully deposited onto ITO substrate via a two-step hydrothermal and electrodeposition methods. The effect of the thin carbon layer between NiO and $ZnCo_2O_4$ in this multi-scale hierarchical structure was investigated. The selection of this structure was based on: (i) a high specific area of pseudo-capacitive NiO to maximize specific capacitance; (ii) an effective NiO-electrolyte interface to facilitate fast charging/discharging; and (iii) conducting carbon layer between $ZnCo_2O_4$ and NiO enhance the electric conductivity which reduces energy loss, and the corrosion protection of $ZnCo_2O_4$ in alkaline electrolyte. The obtained results indicate that hierarchical NiO/$ZnCo_2O_4$ present a high specific capacitance of 63 $mF.cm^{-2}$ at a current density of 0.05 $mA.cm^{-2}$ higher than that of pristine NiO and $ZnCo_2O_4$ of 6 and 3 $mF.cm^{-2}$, respectively. The carbon layer improves the electrical conductivity among NiO and $ZnCo_2O_4$ in the hierarchical NiO/C/$ZnCo_2O_4$ electrode. As well, the specific capacitance drastically increased to reach 125 $mF.cm^{-2}$. Moreover, this multi-scale hierarchical structure exhibits superior cycling stability with ~ 95.7 % capacitance retention after 65k cycles. These results indicate that the NiO/C/$ZnCo_2O_4$ nanocomposite material is an outstanding electrode material for supercapacitors.

Keywords : NiO/C/$ZnCo_2O_4$, specific capacitance, hydrothermal, supercapacitors
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