Hierarchical NiCo₂O₄@NiCo₂O₄ Nanoflake Arrays Supported on Ni Foam as High-performance Electrodes for Supercapacitors

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A facile strategy for the stepwise preparation of a NiCo₂O₄ nanosheet array on a nickel foam skeleton was developed by a hydrothermal-calcination method. Under optimum process conditions, the NiCo₂O₄@NiCo₂O₄ materials supported on NiCo₂O₄ nanoflakes displayed different performances than bare NiCo₂O₄ nanosheet arrays according to experimental characterization and electrochemical studies and were grown in situ on nickel foam. The NiCo₂O₄ nanoflake material, used as the electrode of the supercapacitor, exhibited a multilevel mesoporous nanostructure that had a narrow pore size (3.18 nm) and wide pore size (6.22 nm). In addition, the specific surface area (SSA, 1.84 m²g⁻¹) and average pore size (13 nm) were acquired by calculations, and this material showed a relatively high specific capacitance (C_s , 840 Fg⁻¹) when the current density was 1 Ag⁻¹, and a rate capability of 86.67% from 1 to 15 Ag⁻¹ and the capacitance could maintain 93% of the initial value after 5000 charge-discharge cycles. The NiCo₂O₄@NiCo₂O₄ nanostructures provided effective electron pathways and a relatively large electroactive surface area, and narrow pore sizes were observed at 2.46 nm and 3.48 nm, while a wide pore size was observed at 5.53 nm. The SSA was improved to 8.64 m²g⁻¹, and the average pore diameter was distributed at 11 nm. Accordingly, a remarkable electrochemical performance demonstrated that the C_s of 1036 Fg⁻¹ was obtained at a current density of 1 Ag⁻¹, and the rate capability reached 69.59% as the current density increased from 1 to 15 Ag⁻¹. Excellent capacitance retention was retained at 92.5% after 5000 cycles, while the coulombic efficiency was maintained at 100%.

Keywords: NiCo₂O₄, Hierarchical structure, Hydrothermal calcination method, Supercapacitors

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