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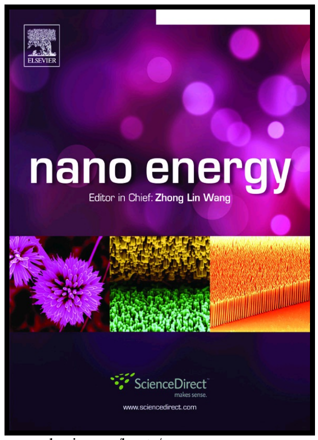

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Controlled synthesis of three-phase Ni_xS_y/rGO nanoflake electrodes for hybrid supercapacitors with high-energy and power density

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Abstract

Composition design and morphology control of electrode materials are effective strategies to enhance the specific capacity, rate capability, and cycling life of electrochemical energy storage devices. Here we report our findings in the design and synthesis of a three-phase nickel sulfide (NiS-Ni_3S_2-Ni_3S_4, denoted as TP-Ni_xS_y) with 3D flower-like architecture assembled from interconnected nanoflakes, which delivers a specific capacity of 724 C g^{-1} at a current density of 1 A g^{-1}. When integrated with reduced graphene oxide (rGO), a TP-Ni_xS_y/rGO composite nanoflake electrode, derived from a hydrothermal process, demonstrates not only higher specific capacity (807 C g^{-1} at 1 A g^{-1}) but also better rate capability (~72% capacity retention as the current density was increased from 1 to 20 A g^{-1}). Moreover, a hybrid energy storage device, constructed from a TP-Ni_xS_y/rGO positive electrode and a graphene-based negative electrode, shows a high energy density of 46 Wh kg^{-1} at a power density of 1.8 kW kg^{-1}. It retains an energy density of 32 Wh kg^{-1} at power density of 17.2 kW kg^{-1}, demonstrating its viability and potential for practical applications.