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Flower-like $NiCo_2S_4$/rGO composites directly grown on Ni foam as highly efficient electrode for long cycling stability supercapacitor

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$NiCo_2S_4$ and reduced graphene oxide(rGO) have been directly grown on Ni foam by a two-step hydrothermal method to form $NiCo_2S_4$/rGO composite material with hierarchical structures. The resulting samples display flower-like $NiCo_2S_4$ particles formed by interconnected $NiCo_2S_4$ nanosheets with the conductive rGO sheets interspersing among them. This unique structure can provide a much rougher surface, rich two-phase interface, and porous channels exposed to electrolytes with fast ion diffusions and electron transmissions, as well as effectively relieve the expansion/contractions during charging and discharging. The electrochemical test results show that $NiCo_2S_4$/rGO composite prepared at 120°C with 8.1 mg mass loading on Ni foam exhibits a specific capacitance (1974.7 $F \cdot g^{-1}$) at a current density of 10 $mA \cdot cm^{-2}$. An asymmetric supercapacitor device assembled by $NiCo_2S_4$/rGO and activated carbon can provide an energy density high up to 46.8 $Wh \cdot kg^{-1}$ at a power density of 219.5 $W \cdot kg^{-1}$. Even if the power density is increased up to 731.6 W kg^{-1}, it still can achieve the energy density superior to 31.8 Wh kg^{-1}. Moreover, the asymmetric supercapacitor device exhibits an outstanding cycling stability with 87.8% capacitance retention after 5000 cycles, which confirms its potential application in the energy storage.

Keywords: Flower-like composite, RGO, $NiCo_2S_4$/rGO composite, Asymmetric supercapacitor