Morphology-engineered, Bifunctional Electrodes Based on Ni-Doped Rouaite with Tunable 3D Nanostructures for Supercapacitor and Oxygen Evolution Reaction

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Abstract:

Precise morphological engineering is crucial for enhancing the intrinsic activity of electrochemical materials for efficient energy storage and conversion. We report a series of self-supported bimetallic copper–nickel composite materials featuring tunable morphologies for electrochemical and electrocatalytic applications. These materials were synthesized by modulating the NH_4F concentration during in situ hydrothermal precursor preparation, resulting in the flower-like microstructures. The optimized 0.4-Ni-doped rouaite electrode exhibited a 2.84-fold increase in specific capacitance compared with the undoped counterpart. Moreover, it demonstrated remarkable cycling stability, retaining 96% of its capacitance after 5,000 charge–discharge cycles in an asymmetric supercapacitor. The 0.4-Ni-doped rouaite//activated carbon asymmetric device achieved a high energy density of 25.37 Wh kg^{-1} and a power density of 307.52 W kg^{-1}. In addition, the 0.4-Ni-doped rouaite showed excellent oxygen evolution reaction performance, achieving an overpotential of 200 mV at 10 mA cm^{-2} with a Tafel slope of 163.09 mV dec^{-1}. These results highlight the potential of morphology-controlled rouaite as an efficient bifunctional electrode for advanced energy storage and electrocatalytic applications.