Facile template-free synthesis of 3D hierarchical ravine-like interconnected $MnCo_2S_4$ nanosheet arrays for hybrid energy storage device

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Abstract

Engineering of nanostructured electrodes for enhancing their electrochemical performance is a critical issue to further development in energy storage systems. In the present study, we have developed a facile template-free method to engineer 3D hierarchical ravine-like electrode based on $MnCo_2S_4$ nanosheet arrays as an efficient material for high-performance electrochemical capacitors. The physico-chemical characteristics of ravine-like structure of $MnCo_2S_4$ nanosheets are investigated by different techniques such as X-ray diffraction (XRD), transmission electron microscopy (TEM), field-emission scanning electron microscopy (FESEM) and X-ray photoelectron spectroscopy (XPS). The as-prepared $MnCo_2S_4$ electrode exhibits an ultrahigh specific capacity of 834 C g^{-1} (231 mAh g^{-1}) at the current density of 1 A g^{-1}, excellent rate capability and good cycle performance. Thiospinel nature of the $MnCo_2S_4$ electrode and its ravine-like nanosheet structure with effective spatial confinement for the electrolyte ions and charge transportation are responsible for this remarkable performance. Furthermore, the assembled $MnCo_2S_4$//AC asymmetric device shows the maximum energy density of 57 W h kg^{-1} and the highest power density of 20.8 kW kg^{-1}.

Keywords

Ravine-like
Nanosheets
$MnCo_2S_4$
Asymmetric electrochemical capacitors