In-situ Quick scanning X-ray absorption spectroscopy studies of binary transition metal sulfide $MnCo_2S_4$ as high-performance electrochemical supercapacitor electrode

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Abstract

A binary transition metal sulfide $MnCo_2S_4$ nanowire grown on Nickel foam, is synthesized though a facile two-step hydrothermal method for supercapacitor electrode. The $MnCo_2S_4$ electrode exhibit high specific capacitance of 2100 F g^{-1} and areal capacitance of 8.4 F cm^{-2} at current density of 1 A g^{-1} and 3 mA cm^{-2} also show as well as good rate capability and cycling stability in alkaline electrolyte. Moreover, we fabricate an asymmetric supercapacitor with active carbon as negative electrode and the full cell delivers a high energy density of 55.08 W h kg^{-1} at a power density of 0.85 kW kg^{-1}, and 22.43 W h kg^{-1} at a power density of 8.5 kW kg^{-1}. To elucidate the mechanism of the electrochemical reactions of electrode during the charge/discharge process, the in-situ X-ray absorption spectroscopy (XAS) of the Mn K-edge and Co K-edge was performed. From in-situ XAS results, the Mn and Co element increased average valence state from the Faradaic pseudocapacitance and the increase of average valence state in $MnCo_2S_4$ is higher than binary transition metal oxide electrode $MnCo_2O_4$, indicate that the binary transition metal sulfide greater electrochemical performance than binary transition metal oxide. These results could reveal sulfide material as supercapacitor electrode demonstrating extensive application prospects.

Keywords - Binary transition metal sulfide, $MnCo_2S_4$ nanowire, Supercapacitor, Quick scanning X-ray Absorption Spectroscopy