Characterisation and electrochemical behaviour of electrodeposited Cu-Fe metallic oxide nanofoams applied as redox supercapacitor electrodes

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Abstract

Cu-Fe 3D porous nanofoams for supercapacitor electrodes were electrodeposited in the cathodic regime, on stainless steel current collectors, using hydrogen bubbling dynamic template. The nanofoams were prepared at different current densities, for different times. The nanofoams were submitted to thermal conditioning at temperatures of 150 and 250ºC. The morphology, composition and structure of the formed films were studied by SEM, EDS and XRD, respectively. The electrochemical behaviour was studied by cyclic voltammetry, electrochemical impedance spectroscopy and chronopotentiometry.

The morphology of the 3D Cu-Fe nanofoams is sensitive to the electrodeposition current and time. The increase of the current density produces a denser, larger and more ramified dendritic structure. Thermal conditioning at high temperature induces a coarser grain structure and the formation of copper oxides, which affect the electrochemical behaviour.

The electrochemical response reveals the presence of various redox peaks assigned to the oxidation and reduction of Cu and Fe oxides and hydroxides in the nanofoams. The specific capacitance of the 3D Cu-Fe nanofoams was significantly enhanced by thermal conditioning at 150ºC. The highest specific capacitance values attained 297 Fg^{-1} which are much above the ones typically observed for single Cu or Fe oxides and hydroxides. These values highlight a synergistic behaviour resulting from the combination of Cu and Fe in the form of metallic nanofoams. Moreover, the capacitance retention observed in 8000 charge/discharge cycling test was above 66%, stating the good performance of these materials and its enhanced electrochemical response as supercapacitor negative electrodes.