Effects of Electrodeposition Mode and Deposition Cycle on the Electrochemical Performance of MnO$_2$-NiO Composite Electrodes for High-Energy-Density Supercapacitors

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Abstract

Non-interconnected network-like MnO$_2$-NiO composite electrodes were electrodeposited onto stainless steel substrates using different electrodeposition routes, such as chemical bath deposition, electrochemical deposition, and cyclic voltammetry, and then subjected to heat treatment at 150°C for 1 h in a vacuum chamber. Raman spectroscopy, X-ray diffraction, scanning electron microscopy, and transmission electron microscopy were used to study the crystallographic nature and morphology of the deposited films. The electrochemical properties were investigated using cyclic voltammetry and impedance spectroscopy. The results revealed that the electrochemical performance of the as-obtained composite electrodes depended on the electrodeposition mode. The electrochemical properties of MnO$_2$-NiO composite electrodes prepared using cyclic voltammetry exhibited the highest capacitance values and were most influenced by the deposition cycle number. The optimum specific capacitance was 500 F g$^{-1}$ with energy and power densities of 186.7 W kg$^{-1}$ and 143.2 W kg$^{-1}$, respectively, at a current density of 20 A kg$^{-1}$, in a solution of KOH 0.5 M and 0.5 M.