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EFFECT OF ADDITIVES ON THE CATHODIC ELECTRODEPOSITION OF MnO_2 FOR ELECTROCHEMICAL CAPACITOR APPLICATIONS

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Abstract

Manganese dioxide (MnO_2) is a promising electrode material for electrochemical capacitors due to its low cost, abundance, and pseudocapacitive properties. This study investigated the influence of sodium saccharin, boric acid, and ascorbic acid on the cathodic electrodeposition of MnO_2 films and their electrochemical performance. Deposits were obtained on AISI 304 stainless steel from an aqueous electrolyte containing $0.01 mol L^{-1}$ $KMnO_4$ and $0.1 mol L^{-1}$ Na_2SO_4 at pH 7. Additive concentrations ranged from 0.5 to $5 g L^{-1}$, and cathodic current densities from −2 to $-50 mA cm^{-2}$ were investigated. Electrochemical performance was evaluated by cyclic voltammetry and galvanostatic charge–discharge measurements, while surface morphology and elemental composition were examined by scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS). Sodium saccharin yielded a maximum specific capacitance of $474 F g^{-1}$ at $3 g L^{-1}$ and $-20 mA cm^{-2}$. However, higher concentrations compromised film integrity and reduced capacitive performance. Boric acid produced a maximum specific capacitance of $310 F g^{-1}$ at $3 g L^{-1}$ and -10 $mA cm^{-2}$, with comparatively stable deposits. SEM observations revealed dendritic and irregular agglomerates in the presence of sodium saccharin, whereas boric acid promoted granular morphologies. EDS mapping also indicated differences in manganese distribution between the deposits obtained with the two additives. The use of ascorbic acid was unsuccessful under the investigated conditions because a dark solid formed during electrolyte preparation. These findings demonstrate that electrolyte additives influence the morphology, integrity, and capacitive performance of electrodeposited MnO_2, highlighting sodium saccharin and boric acid as promising alternatives for tailoring electrodes for electrochemical energy storage.

Keywords: Manganese dioxide; cathodic electrodeposition; electrochemical capacitors; sodium saccharin; boric acid.

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