

Title	Cyclic voltammetry growth and characterization of Sn–Ag alloys of different nanomorphologies and compositions for efficient hydrogen evolution in alkaline solutions
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Abstract

Electrodeposition of silver, tin and their alloys from different aqueous electrolytes suffer from various environmental issues and deposits are affected by H₂ evolution and metal oxide formation. In this work, these metals and their alloys are electrodeposited by cyclic voltammetry utilizing ionic liquids based on C₅H₁₄ClNO (choline chloride) that permits deposit properties control. Both Ag and Sn concentrations in the ionic liquid were varied from 0.01 to 0.15 mol L⁻¹. Methionine effect on the reduction potential of Sn and Ag was studied. Different techniques were applied to explore the structures, morphologies, and electrochemical (EC) activities of the deposits. A single Ag₃Sn phase with orthorhombic packed structure was observed for all alloys, whereas the preferred growth orientation was varied from (202) to (112) depending on Ag%. Also, the dislocation density is decreased by increasing Ag content. EDX spectra showed only Ag and Sn signals indicating the high purity of the Sn–Ag alloys. The deposit from Sn-rich liquid showed rougher and larger agglomerates at the surface than that formed from the Ag-rich liquids with or without methionine. The electrochemical activities of the deposits toward the H₂ evolution reaction (HER) were investigated through electrochemical polarization (ECP) measurements and EC impedance spectroscopies (EISs). The Sn–Ag alloys possess higher performance, as a catalyst for HER using alkaline solution, than Ag or Sn electrodes. The highest rate of HER was recorded for Sn–35% Ag and Sn–97% Ag deposits, which correlated strongly to the microstructure and surface morphology. The ECP results were confirmed by EIS investigations. The measured impedance values are close-fitting to a hypothetical model for the electrode/electrolyte interface.