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A comparative study of Zn-Mn electrodeposition from deep eutectic solvents and aqueous electrolytes

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The production of Zn-Mn coatings with high Mn and low oxygen content from additive free choline chloride/urea deep eutectic solvent (DES) is reported in this work. Alloy coatings containing high Mn contents (~30 at.% Mn) show the highest corrosion resistance amongst zinc alloys [1]. However, in order to obtain Mn-rich deposits on steel from a simple aqueous bath, a significant cathodic polarization or high deposition current density is necessary. Under such conditions, the Zn^{2+} reduction reaction is under diffusion control, leading to the formation and growth of dendrites. In addition intensive hydrogen evolution significantly reduces the current efficiency, often leading to the formation of porous coatings containing large amounts of oxygen [2]. It has been shown that a dendritic deposit formation and hydrogen reduction during Zn-Mn electrodeposition at high current densities could be prevented through use of plating additives [3].

By utilising DES instead of an aqueous electrolyte Zn-Mn codeposition was successfully achieved, with deposits containing high amounts of Mn at high current efficiencies. The amount of oxygen present in the alloy deposits obtained from DES was significantly reduced in comparison to those prepared from a normal water based electrolyte. Microstructural features and corrosion stability of the DES Zn-Mn deposits are compared with the coatings deposited from a conventional water-based electrolyte. The quantity of water absorbed from the atmosphere in the DES during both the electroplating procedure and throughout the DES storage period is also reported.

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