Electrodeposition of Cu from a water-containing deep eutectic solvent

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Ionic Liquids (ILs) have been proposed as alternatives electrolytes for metal electrodeposition. Deep Eutectic Solvents (DESs) are a novel type of ILs tolerant to water. Moreover, DESs formulated from quaternary ammonium salts and hydrogen bond donors are promising electrolytes since they are water tolerant and they are available at a reasonable cost. Although DESs are hygroscopic and absorb water from the atmosphere, earlier studies to plate Cu have concentrated on low-water containing DESs (<0.5 wt% H2O). However, for DESs to become exploitable, metal deposition from water-containing electrolytes requires to be investigated. In this work, we have endeavoured to establish a quantitative correlation that might explain the effect of water content on the electrolyte and on Cu deposition process. The intrinsic concentration of water in the electrolyte was measured using Karl Fischer titration. Thereafter, to quantify the electrolyte uptake of water a time-dependant test was conducted. After adding various concentration of water to the electrolyte determined from the time-dependant experiment (3 to 15 wt%), the influence of water content was examined with polarisation experiments collected using a rotating disc electrode. Finally, Cu deposition was carried on steel substrata from electrolytes containing different weight percentages of water. Cu deposits were characterised with Scanning Electron Microscopy (SEM) (Figure 1) and Energy Dispersive X-ray Spectroscopy (EDS).Different water contents in the electrolyte reduced the viscosity of the liquid which promotes the diffusivity of Cu2+ ions in the liquid. As a result, the limiting currents of the process increased. Higher water content changed the morphology of Cu films. Even at low water content (~3 wt%), the current distribution on the deposits is non-uniform. Furthermore, adding H2O worsens the already uneven current distribution leading to less uniform Cu deposits.

Keywords: electrodeposition; copper; deep eutectic solvents; water

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