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Electrochemical Deposition of Aluminium on Aluminium from Urea-based Electrolyte

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Electrochemical deposition/dissolution of aluminium to/from aluminium in deep eutectic solvent (DES), made of the $AlCl_3$+urea, at temperatures of 25 to 60°C have been investigated. The depositions were performed in potentiostatic modes. The morphology of the obtained deposits was characterized using scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS).

Critical overpotential of aluminium deposition increased from around – 0.120 V at 25°C to around – 0.050 V at 50°C. All recorded currents were generally speaking small, but would substantially increase with increasing working temperature (from 0.01 mA cm^{-2} up to 0.25 mA cm^{-2}). Current/time transients recorded at overpotentials over – 0.100 V vs. Al indicate continuous three-dimensional nucleation and growth. Epitaxial growth over aluminium substrate was not observed under applied experimental conditions.

Electrodeposition/dissolution processes of aluminium under chosen conditions were reversible, reproducible and slow (relatively small current densities, bellow 0.3 mA cm^{-2}). Polarization curves recorded noticeable dependence of aluminium deposition/dissolution reversible potential on temperature applied.

The deposits obtained showed variety of morphological shapes (needles, rods, flakes, Fig.1) depending on the working temperature and potential applied. All the deposits were made of crystallites grouped randomly into more or less separate agglomerates which were positioned over lower layer of densely populated much smaller crystallites. Lower layer showed good adherence to the substrate and exhibited high surface area. Density of the crystallites distribution over the substrate and complicity of the crystal forms increased with the potentials applied.

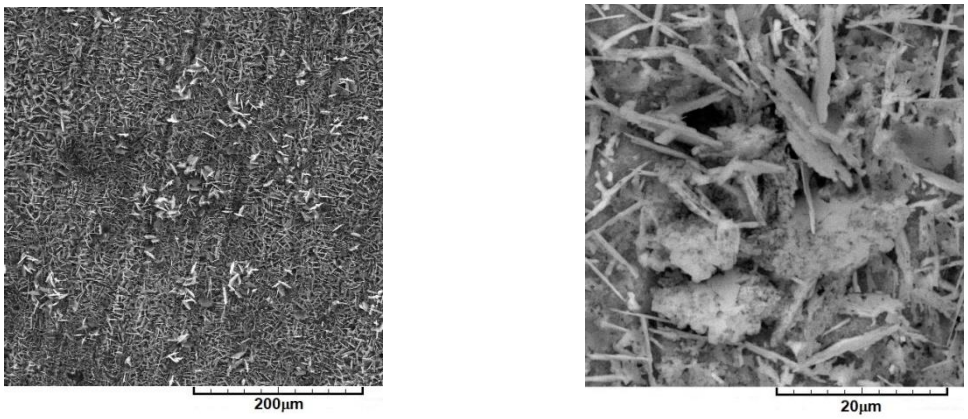

Figure 1: SEM photographs of electrodeposited aluminium onto aluminium substrate from DES obtained in a potentiostatic mode