Electrodeposition of Nanocrystalline Aluminium from 1-Ethyl-3-methylimidazolium Chloroaluminate with Niacinamide as an Efficient Additive

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Nanocrystalline aluminium has been used as a promising energetic material due to its unique properties. However, the traditional methods for nanocrystalline aluminium production suffer from many inherent problems, which restrict the large-scale industrial application. In this paper, a systematic study was carried out on the nucleation mechanism and electrodeposition behaviour of nanocrystalline aluminium in Lewis acidic 1-ethyl-3-methylimidazolium chloroaluminate ionic liquid. It was found that niacinamide could be used as an effective additive in the preparation of nanocrystalline aluminium. According to electrochemical measurements and computational calculations, niacinamide was highly electroactive and polarized, which is probably attributed to non-uniform distributions of positive and negative charges on niacinamide. Its strong interaction with the electrode and subsequent adsorption onto the surface of aluminium nuclei prevented the further growth of crystals. Consequently, nanocrystalline aluminium was obtained at 313.2–333.2 K and 3–6 mA/cm² from 1-ethyl-3-methylimidazolium chloroaluminate that contained 8–12 mmol/kg niacinamide. Smooth and compact aluminium crystals with a minimum grain size of 20–30 nm could be electrodeposited at 313.2 K and 6 mA/cm² with 8–12 mmol/kg niacinamide. The molar concentration of additive, temperature and current density were confirmed as the major influencing factors in the electrodeposition of nanocrystalline aluminium from the chloroaluminate ionic liquid. It is expected that this work may be useful for the future preparation and application of nanocrystalline aluminium.

Keywords: nanocrystalline aluminium; ionic liquid; electrodeposition; niacinamide

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