

ELECTROCHEMISTRY OF INDIUM AND ELECTROCHEMICAL FORMATION OF Cu-In INTERMETALLIC COMPOUNDS IN CHOLINE CHLORIDE-ETHYLENE GLYCOL (1:2)

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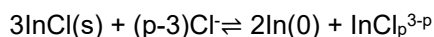
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Indium and its alloys are suitable materials for producing semiconductor compounds (e.g. InSb, InAs, GaInAs, CuInSe₂ and Cu(In,Ga)Se₂) which are widely used in electronic and optoelectronic technology. Polycrystalline thin films of the chalcopyrite materials CuInSe₂ and Cu(In,Ga)Se₂ are proposed as absorbent materials for photovoltaic solar cells, due to their high optical absorption coefficient and p-i-n-type electrical conductivity.

The processes to prepare chalcopyrite absorber layers involve electrodeposition of precursor films of Cu-In alloy, CuInSe₂, Cu(In,Ga)Se₂ followed by re-crystallization by thermal annealing at high temperature in selenium atmosphere. An alternative to aqueous electroplating solutions is to use as electrolytes low cost room temperature ionic liquids, as the deep eutectic solvents (DES) due to their important properties (i.e high conductivity, relatively wide potential range of electrochemical stability, low vapor pressure and the ability to solvate many metal salts).

As a part of a project to look into the possibilities offered by DES in the formation of semiconductor compounds, the present work is concerned with the electrochemical behaviour of indium in the eutectic mixture ChCl-EG (1:2). The study has been carried out using different substrates as working electrodes: i) W as an inert material and ii) Cu as a reactive electrode.

InCl₃, dissolved in the rich chloride media as InCl_p^{3-p}, is reduced on a tungsten electrode to indium metal via only one electrochemical step. Conversely, InCl undergoes the following disproportionation reaction when dissolved in the eutectic ChCl:2EG.



Transient electrochemical techniques were used in order to study the reaction mechanism and the transport parameters of the electroactive species at a tungsten electrode. The results showed that electrocrystallization of In plays an important role in the electrodeposition process. Experimental current-time transients have been compared with the theoretical models based on instantaneous and progressive nucleation.

Mass transport towards the electrode is a diffusion process, and the diffusion coefficient of In(III) and the activation energy for diffusion have been calculated.

The electro-reduction of In(III) solutions was also investigated at a copper substrate. The resulting cyclic voltammograms evidenced the formation of In-Cu intermetallic compounds. Hence, In-Cu alloy films were obtained by continuous potentiostatic electrolysis and intensiostatic pulse electrolysis. The obtained samples, characterized by XRD and SEM, revealed the formation of the metastable CuIn phase that could be transformed into Cu₁₁In₉ by thermal annealing.

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