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Energypolis, Rue de l'Industrie 17, CH-1950 Sion, Switzerland

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Electrochemical study of electrodeposition process

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1. Copper electroplating in aqueous solution

Although it is very detrimental to the operators and our environment, cyanide copper electroplating bath is still broadly used nowadays. In order to replace the cyanide bath, we developed and investigated an alkaline cyanide-free bath containing 5, 5'- dimethylhydantoin (DMH) and citrate as the complex agents for copper electrodeposition. Bright copper electrodeposits with good adhesion on steel substrates were obtained from the newly developed solution. Cyclic voltammetry(CV) study indicated that electrodeposition process was mainly controlled by DMH. Electrochemical kinetics parameters were obtained from sample current voltammetry method. Molecular dynamic (MD) simulation unveiled the adsorption of DMH on iron and copper surfaces. The morphology as the function of solution composition was revealed by scanning electron microscopy (SEM).

2. Electrodeposition of gallium, indium, and copper in ionic liquid

The electrodeposition process of gallium, copper, and indium in an ionic liquid solution was investigated to lay a foundation for the electrodeposition of CIGS alloy films, which is the key layer of one of the most promising types of solar cell, namely the CIGS solar cell. Results of CV displayed that both temperature and electrode material had a great influence on the electroreduction kinetics of Ga^{3+} ions in 1-Butyl-3-methylimidazolium trifluoromethanesulfonate ([BMIM][TfO]) ionic liquid. The diffusion coefficients of Ga^{3+} ions were obtained through three methods involving rotating disk electrode. Non-linear fitting theoretical function to the current transients from chronoamperometry, combined with SEM images of the initial deposition stage on GCE, unveiled the nucleation process. The effect of potential and temperature on the morphology of gallium deposits was revealed by SEM images. Similar methods were employed to investigate the electrodeposition process of indium and copper in the same ionic liquid. One interesting thing was that octahedral indium particles were obtained, which might be related to the interaction between [BMIM][TfO] and the different oriented surfaces of indium according to the results of MD simulation.

References:

[1] Zhang, J., et al. (2014). "Electrodeposit copper from alkaline cyanide-free baths containing 5,5[prime or minute]-dimethylhydantoin and citrate as complexing agents." RSC Advances **4**(72): 38012-38026.
[2] Zhang, J., et al. (2016). "Electrochemical Study of the Diffusion and Nucleation of Gallium(III) in [Bmim][TfO] Ionic Liquid." Electrochimica Acta **190**: 1066-1077.
[3] Zhang, J., et al. (2016). "Octahedral Indium Particles Synthesized by Electrodeposition from 1-Butyl-3-methylimidazolium Trifluoromethanesulfonate Ionic Liquid." Journal of the Electrochemical Society **163**(13): D707-D709.

CV: Jie Zhang

Jie Zhang was Born in 1989 in Hubei, China. He received both his Bachelor's and Master's degree in Chemical Engineering (Electrochemistry) from the Harbin Institute of Technology in 2013 and 2015, respectively. During that period, he worked as a research assistant in the field of electrodeposition of metal. After working for a year in a company, he has been working as a full-time research assistant in Southern University of Science and Technology of China. At the moment, his research focus is on developing platinum-free catalysts for fuel cell working at intermediate high temperature.