Electrosynthesis of Cu₅Zn₈ Alloy in Zinc Oxide-urea/ 1-ethyl-3-methylimidazolium Fluoride System at 353 K

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To solve problems of conventional methods in which the high temperatures, extreme pressures and huge currents are used in preparation process of Cu₅Zn₈ alloy, it's necessary to develop low-temperature and low-energy technology. In this study, a low temperature (353 K) electrodeposition method for preparation of Cu₅Zn₈ alloy was proposed. A new electrolyte used in this study, urea/ 1-ethyl-3-methylimidazolium fluoride, can surprisingly dissolve zinc oxides. ZnO was chosen as a zinc source instead of ZnCl₂ used in the conventional method. A Cu cathode was employed as the copper source in situ operation instead of the conventional method that copper source is introduced by adding copper salts. The electrochemical behavior of zinc in the system was investigated using linear sweep voltammograms and cyclic voltammetric techniques. The results illustrated that the zinc reduction is a diffusion-controlled irreversible process via a single-step two-electron transfer procedure. The diffusion coefficient was $1.8 \times 10^{-8} \text{ cm}^2 \text{ s}^{-1}$. Electrode reaction becomes more reversible and equal potentials shift toward the positive direction as temperature increases from 333 to 373 K. Electrodeposition experiments are performed on a Cu cathode and electrodeposits are identified as Cu₅Zn₈ alloy via XRD and EDS. The cross-sectional SEM showed that a distinguishable layer of Cu₅Zn₈ alloy was discovered on the surface of the Cu cathode and the thickness of this Cu₅Zn₈ layer was approximately 2 μm . An EDS linear scanning analysis for this layer showed that a high concentration of zinc atoms was distributed on the surface and the copper atoms were mainly concentrated at the bottom of the Cu cathode. A possible formation mechanism for Cu₅Zn₈ alloy was proposed.

Keywords: Cu₅Zn₈; 1-ethyl-3-methylimidazolium fluoride; zinc oxide; γ -brass; Ionic liquid

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