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Development of Environmentally Friendly Silver–Tin Plating Bath Using Hydrate Melts

Atsushi Kitada

Department of Materials Science and Engineering, Kyoto University

Summary

Lead (Pb)-free solder such as silver-tin (Ag-Sn) alloy is highly demanded since the use of Pb is more and more limited nowadays due to the adoption of RoHS directive in EU. Ag-Sn solder for electric wiring/circuit board is electroplated in aqueous solutions. However, the use of cyanides as complexing agents in the electroplating baths has been an issue toward SDGs. The strong complexing agents also make it difficult to separate the metal elements from the waste baths.

$CaCl_2$ is a low-toxic, inexpensive reagent that dissolves in large amounts in water to form highly concentrated aqueous solutions, or hydrate melts electrolyte. In this work, the $CaCl_2$ hydrate melt was investigated as novel Ag-Sn electroplating baths. While AgCl is poorly soluble in water at room temperature, AgCl is soluble to the $CaCl_2$ hydrate melt (40 mmol dm^{-3}). Flat electroplating of Ag-Sn alloy was obtained between -0.4 V and -0.5 V vs. Ag/AgCl in 3.33 M KClaq. In addition, the metal separation between Ag and Sn was successful by the addition of NaOH (high pH). The dilution by pure water for efficient Ag-Sn separation was unsuccessful.

The $CaCl_2$ hydrate melt was also investigated for novel lead (Pb) electrolysis processes. While $PbCl_2$ is poorly soluble in water at room temperature as well as AgCl, $PbCl_2$ dissolved up to [Pb(II)] = 93.7 g kg^{-1} (0.452 mol kg^{-1}) in the $CaCl_2$ hydrate melt due to its high Cl^- activity. The $CaCl_2$ hydrate melt can be a potential candidate electrolyte for $PbCl_2$-based electrolytic processes, which include recycling of Pb batteries and Pb-containing old electric boards.