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Electrodeposition of tin coatings from ethylene glycol and propylene glycol electrolytes

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Abstract

Stable nonaqueous EG or PG electrolytes containing $SnCl_4 \cdot 5H_2O$ and boric acid have been developed for electrochemical plating of tin coatings at the rate of ~14 $\mu m \cdot h^{-1}$ and current yield 91–93 %. Owing to the absence of hydrogen evolution and whiskers formation typical to aqueous- electrolytes tin deposition the current yield is increased. The tin coatings obtained from glycolic electrolytes consist of compactly packed grains connected in a dense network. IR spectroscopy showed that dissolution of $SnCl_4 \cdot 5H_2O$ in glycol proceeds with the formation of bidentate complex ions $SnCl_2G(H_2O)_2^{2+}$ (G = EG or PG) and weakening of the intermolecular interaction in the solvent. Cyclic voltammetry demonstrated that Sn(IV) reduction is a single cathodic process in EG and PG electrolytes and anodic tin oxidation proceeds in two stages via Sn(II) compounds formation and their further oxidation to Sn(IV). When adding boric acid to EG and PG electrolytes the formation of whiskers is completely inhibited providing 2–7 fold increase in the rate of coatings growth. It also neutralizes the differences in the maximal values of the deposition rate in both electrolytes and promotes the current yield increase.

1. Introduction

Tin coatings due to their ability to soldering, eye appeal, and low toxicity are widely used in electrical engineering, electronics, for packing of food, perfumes, paints and