ELECTRODEPOSITION OF TIN FROM A LACTATE ELECTROLYTE

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Electrochemical coatings are widely used in electroplating. One of the most in-demand is tin coating, which adheres well to the base metal, is flexible, withstands bending and stamping, and remains stable during screwing.

Tin deposition is typically performed using acidic or alkaline (stannate) electrolytes. The main advantages of these electrolytes include high coating quality, high cathodic current efficiency, and good throwing power [1]. However, they contain toxic anions from complexing acids and surface-active organic substances, which complicates the disposal of used solutions and wastewater treatment. One solution to this problem is to improve existing tin-plating electrolytes by replacing tin(II) with tin(IV) and toxic complexing agents with lactic acid, which is environmentally safe. It has been proven that lactate electrolytes offer advantages not only over standard acidic and stannate electrolytes but also over EDTA-based and pyrophosphate electrolytes due to their lower toxicity.

The research was conducted using a solution containing 50 to 150 ml/dm³ of lactic acid. The tin ion concentration in the electrolyte was 14 – 16 g/dm³ (in terms of metal).

Changes in the electrolyte's pH from 0.6 and temperature from 18 – 25 °C in either direction significantly reduced the cathodic current efficiency (CCE) and deteriorated coating quality. At pH 4.5, $Sn(OH)_4$ precipitate forms in the electrolyte.

As the cathodic current density increased from 0.3 to 3 A/dm², the CCE of tin decreased from 95 % to 57 %, and coating quality worsened.

Within the working current density range, increasing the concentration of tin ions in the electrolyte from 5 to 10 g/dm³ increased the tin CCE from 79 % to 95 % and improved coating quality.

Based on the conducted research, for electrochemical deposition of fine-crystalline, smooth, semi-bright coatings, the following electrolyte composition can be recommended: lactic acid – 100–150 ml/dm³, $SnCl_4$ (in terms of metal) – 15 g/dm³. At j = 1.0 A/dm² and t = 20 – 25 °C, pH = 0.6, the cathodic current efficiency is 95 – 98.6 %.

References:

1. Yakymenko H.Ya., V.M. Artemenko. Technical Electrochemistry. Part 3. Electroplating Production: Textbook edited by B.I. Bairachnyi. – Kharkiv: NTU "KhPI", 2006, – 272 p.