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## **The influence of nickel salts on the properties of the chemical copper plating solution and quality of deposited coatings**

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### **Abstract**

The possibility of introducing divalent nickel salts additives into solutions of thick-layer chemical copper plating to obtain copper coatings with high values of elongation and tensile strength has been investigated.

The introduction of divalent nickel salts with anions: chloride, sulfate, nitrate, and acetate in the concentration range from 0.004 to 0.07 mol·l<sup>-1</sup> into two basic solutions was tested.

The trilonate solution of chemical copper plating contained, mol·l<sup>-1</sup>: Trilon B – 0.10; copper sulfate – 0.036; caustic soda – 0.20; formaldehyde – 0.13; Surfactant-2K – 0.05 g·l<sup>-1</sup>; potassium hexaferrocyanide – 0.06 g·l<sup>-1</sup>; 2,2'-dipyridyl – 0.06 g·l<sup>-1</sup>. The working temperature of the solution is 70 °C. Formaldehyde – 25 ml of a 40% solution per 1 liter.

The tartrate solution of chemical copper plating included, mol·l<sup>-1</sup>: CuSO<sub>4</sub> – 0.1; KNaTart – 0.21; NaOH – 0.375; Na<sub>2</sub>CO<sub>3</sub> – 0.028; K<sub>3</sub>Fe(CN)<sub>6</sub> – 3·10<sup>-5</sup>; Surfactant-2K – 0.1 g·l<sup>-1</sup>; formaldehyde – 25 ml of a 40% solution per 1 liter. The solution worked at 40 °C.

Studies have shown the inexpediency of introducing into a solution with Trilon B as a ligand of nickel salts. The range of concentrations of bivalent nickel for additions to a tartrate solution of thick-layer chemical copper plating to improve the quality of coatings without a significant decrease in the rate of the process and without disturbing the stability of the solution has been determined.

The effect of divalent nickel salts containing anions of different nature on the rate of copper plating and the quality of copper layers is considered. It is shown that the studied nickel salts reduce the rate of chemical copper plating.

The concentration range of the nickel chloride salt is determined, at which an increase in the plasticity of the deposited copper coatings is observed in a solution of chemical copper plating with a ligand in the form of potassium-sodium tartrate, and their appearance is improved. A real improvement in the properties of copper coatings is observed in the range of

concentrations of divalent nickel in a solution of chemical copper plating from 0.01 to 0.02 mol·l<sup>-1</sup>.

It was found that nickel is coprecipitated with copper in the copper coating in an amount from 0 to 1.2 wt.%, thus forming a continuous series of solid solutions. Analysis of diffraction patterns shows a decrease in the crystal lattice parameter from 3.615 Å to 3.610 Å with an increase in the concentration of divalent nickel in solution from 0.005 to 0.050 mol·l<sup>-1</sup>.

A change in the concentration of Ni<sup>2+</sup> in a solution of thick-layer chemical copper plating leads to a change in the texture of copper growth. When the content of the Ni<sup>2+</sup> ion is in the range from 0.013 to 0.021 mol·l<sup>-1</sup>, only the <111> texture is observed. Copper deposits with such a texture have the best plasticity and a sufficiently high tensile strength (600 MPa).

Plastic copper films are characterized by large crystallites and lower internal stresses than brittle coatings. It was found that plastic deformation is associated with sliding along the crystallographic axes. In this regard, better sliding and higher plasticity are provided by rather large crystals. It can be assumed that it was the introduction of the nickel salt that facilitated the coarsening of copper grains in thick copper films.

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