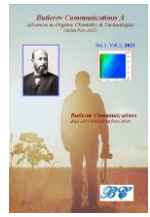
BUTLEROV HERITAGE

Butlerov Communications A
Advances in Organic Chemistry & Technologies
ISSN 2074-0948 (print)

2021. Vol.2, No.3, Id.3.
Journal Homepage: https://a-journal.butlerov.com/



Thematic section: Preparative Research.
Subsection: Technology of the Inorganic Substances.

Full Paper

The Reference Object Identifier – ROI-jbc-A/21-2-3-3
The Digital Object Identifier – DOI: 10.37952/ROI-jbc-A/21-2-3-3
Received 27 June 2021; Accepted 30 June 2021

Effect of temperature on the properties of chemical copper plating solutions and the quality of deposited copper

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Keywords: chemical deposition of copper, kinetic patterns, deposition rate of metal coatings, ductility of copper.

Abstract

Chemical copper plating solutions must be stable, operate at a sufficient copper plating rate, and, most importantly, the resulting copper coatings must have high physical and mechanical properties. This is because PCBs can get very hot during operation, resulting in thermal expansion of both the PCB material and the copper plating. Due to the difference in the linear expansion of the substrate material and the deposited copper, significant stresses can be generated in the copper layer deposited on the walls of the holes in the PCB. If the deposited copper plating is not plastic, then it can crack and the entire board is damaged.

This work is devoted to the study of the effect of temperature on the properties of chemical copper plating solutions (deposition rate of coatings and solution stability) and on the quality of deposited copper (elongation, tensile strength).

It is shown that an increase in the temperature of a chemical copper plating solution containing, mol·l^{-1}: $CuSO_4$ – 0.05; Trilon B – 0.18; NaOH – 0.17; CH_2O – 0.13; 2,2'-dipyridyl – 0.02 g/l; Surfactant-2K – 0.2 g·l^{-1}; $K_3[Fe(CN)_6]$ – 0.001 g·l^{-1}: leads to an increase in the deposition rate with a high quality of the resulting copper coating. It is shown that the decrease in plasticity observed at high temperatures is associated with the accumulation of ballast salts in the solution and the possible inclusion of copper oxide or cuprous hydroxide particles in the coating.

It has been established that the particular order of the reaction with respect to bivalent copper depends on the concentration range: it is equal to 0.99 at a copper sulfate concentration of 0.05-0.08 mol·l^{-1}: and 0.11 at lower concentrations of $CuSO_4$ in a chemical copper plating solution. It has been confirmed that the process of reduction of bivalent copper with formaldehyde is catalytic in nature. The activation energy of the copper plating process in the trilonate solution is 57.4 kJ·mol^{-1}. When determining the

partial orders of the reaction by the components of the chemical copper plating solution, it was found that the alkali has the most significant effect on the rate of copper plating; the partial order of this component is 0.69. It has been established that a change in the ratio of the rates of chemical copper plating and the rate of the Cannizzaro reaction in favor of a relative increase in the rate of chemical copper plating compared to the rate of the Cannizzaro reaction can be achieved by increasing the concentration of bivalent copper, alkali and a decrease in the concentration of formaldehyde and a decrease in temperature.

For citation: Ludmila A. Brusnitsina, Elena I. Stepanovskih, Tatiana A. Alekseeva. Effect of temperature on the properties of chemical copper plating solutions and the quality of deposited copper. *Butlerov Communications A.* **2021**. Vol.2. No.3. Id.3. DOI: 10.37952/ROI-jbc-A/21-2-3-3

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