

Tuning Wettability of Copper-Silver Coatings by Constant Magnetic Field During Electrodeposition

Anne-Lise Daltin ^{1*}, Sofya Effimova ¹, Florica Lazar¹, Jean-Paul Chopart¹, François Debray²

¹ MATIM Université de Reims Champagne-Ardenne, 51100 Reims, France

² LNCMI-EMFL, CNRS, univ. Grenoble Alpes, Univ. Toulouse, Univ. Toulouse 3, INSA-T, Grenoble and Toulouse, France

*corresponding author: anne-lise.daltin@univ-reims.fr

Magnetoelectrodeposition (MED), consisting in the superimposition of a magnetic field during electroplating, is a well-established method for enhancing coating properties of metallic alloys. This technique has proven effective in improving deposition rate, modulating composition, and tailoring surface properties due to magnetohydrodynamic (MHD) effects [1].

The electrodeposition of Cu–Ag alloys has received considerable attention due to their excellent mechanical and electrical properties [2]. In this study, the influence of a constant magnetic field (up to 1 Tesla) applied parallel to the electrode surface was investigated during the potentiostatic electrodeposition of Cu–Ag alloys on Ti6Al4V substrates. Electrodeposition was performed using ammonium hydroxide-based electrolytes with varying compositions. The application of a magnetic field significantly changed the alloy composition, as evidenced by Energy Dispersive X-ray Spectroscopy (EDS), showing an increase in silver content with rising field amplitude.

X-ray diffraction (XRD) analysis revealed changes in crystallographic texture. While one electrolyte composition showed an increased texture coefficient (TC) for the (200) peak, another indicated a decrease in the same orientation, suggesting that magnetic field effects depend on the bath chemistry. Morphological observations using scanning electron microscopy (SEM) highlighted a transition from octahedral to treelike crystal structures under magnetic influence.

A key finding of this study relates to the wettability of the electrodeposited Cu–Ag coatings. In the absence of a magnetic field, the surfaces exhibited hydrophilic behavior, with a water contact angle of approximately 63°. However, when a 1 T magnetic field was applied during electrodeposition the resulting surfaces displayed pseudo-superhydrophobic properties, with a contact angle reaching 156°. This behavior is reminiscent of the Rose petal effect, where water droplets adhere to the surface despite their high contact angle. These results highlight the capability of magnetoelectrodeposition (MED) to precisely tailor surface wettability, offering promising opportunities for applications in sensing, electrical interconnections, catalysis, and antimicrobial surfaces.

[1] A.L. Daltin, M. Benaissa, J.P. Chopart, IOP Conference Series: Materials Science and Engineering (2018) p. 012022.

[2] S. Efimova, F. S. Lazar, J. P., Chopart, F. Debray, A. L. Daltin (2024), Compounds, 4(3), 453-478.