Effect of cyanide inhibition and ultrasonic waves on the electrodeposition of pur Au-Cu alloys plated from an alkaline cyanide bath

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In order to study the laser-matter interactions, some targets for laser experiments require gold-copper alloys with drastic characteristics, particularly in mechanical properties. Although the electrochemical deposition technique is best suited to synthesize this type of alloy, studies were needed to master the plating process and understand the electrocrystallization of gold-copper alloy.

The electrodeposition of gold-copper alloys is realized in an alkaline cyanide bath at 70°C. Considering the equilibrium potentials, gold is the most easily reducible metal while copper reduction starts after exceeding the limiting diffusion current of gold. Under these conditions, an increase of potential at the working electrode increases the concentration of copper in the alloy. In fact, alloys containing up to 40%wt of copper were deposited. However, it was observed when the coating thickness increases, the microstructure becomes more dendritical and the concentration of copper in the alloy decreases. Moreover, beyond 10µm thickness, deposits are copper free and have a powdery microstructure.

Studies have shown that free cyanide was released at the electrode working during the reduction of gold with the effect to produce higher-order copper complexes which have lower diffusion coefficient and higher energy of activation. Consequently, for a given potential, copper is more difficult to reduce gradually as the concentration of free cyanide increases. On the other hand, the current density at the working electrode becomes too fast for a good reduction of gold that explains why above few micrometers thick deposits have rapidly dendritical or powdery microstructure.

In the goal to obtain thickness over 10µm with a mastered microstructure and a stoichiometry alloy, ultrasonic waves have been used during deposition. In these conditions, smoothes deposits about 30µm thick have been plated. The good stability of the current density at the working electrode under ultrasound, show that there is no degradation of the gold-copper microstructure. Moreover, the concentration of copper, for a given potential, is homogeneous in the wall thickness of the alloy.

These results show that ultrasonic waves can be used to limit inhibition effect of cyanide free on copper reduction. In these conditions, smoothes gold-copper alloys more than 30 µm thick can be plated with structure and stoichiometry mastered.

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