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Thermal Stability and Adhesion of Low-Emissivity Electroplated Au Coatings

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We are developing a thermal management coating system to minimize radiative heat losses under a high-vacuum environment. A material system of an electroplated Au coating with a porous Wood's Ni strike on a 304L structure support was selected for low emissivity (Table 1). The electroplating process uses a Au-cyanide bath that produces a Au coating with relatively good adhesion and a thermally stable grain structure, both of which are essential for the system performance (Fig 1-2).

In order to ensure longevity and long-term system reliability and performance, we have conducted an extensive thermal aging study to determine the evolution of physical and chemical properties at ≤ 500°C for ≤10 hours. These properties were characterized using advanced electron microscopy imaging as well as Auger and X-ray spectroscopy.

The results show that upon thermal aging, the grain structure is relatively stable and the interface bonding is strong, as expected. The as-plated Au and Ni contain submicron columnar grains and nanopore stringers, which often follow column grain boundaries. The strong interface bonding is attributed to the good mechanical locking from the porous Woods Ni strike. One of the most significant findings is the thermal instability of the nanopores in the Wood's Ni strike. Upon thermal aging at ≥250°C pore coalescence is clearly evident, especially along the grain boundaries. It is believed that the pore coarsening or thermal instability is derived from the combination of highly mobile vacancies and/or electroplating-induced gaseous phase(s) and/or inter-elemental diffusion between Ni and Au. The extent of pore coalescence and coarsening and their implication to the system performance is still being investigated. In this presentation, we will present and discuss the thermal evolution of microstructure, nanopores and Au-Ni inter-diffusion as well as their potential effect on system performance.

Table 1: Thermal emissivity of different metals

Metal	Exp. ε	Ideal ε
Stainless Steels	0.12 (SNL)	0.098
Nickel	0.04	0.033
Aluminum	0.02	0.019
Silver	0.015	0.016
Copper	0.027	0.015
Gold	0.02 (SNL)	0.007

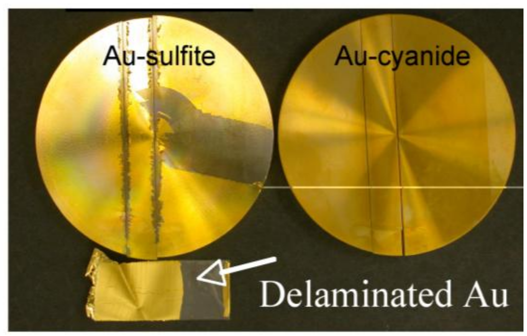

Figure 1: Scotch tape test show a good adhesion using Au-cyanide bath

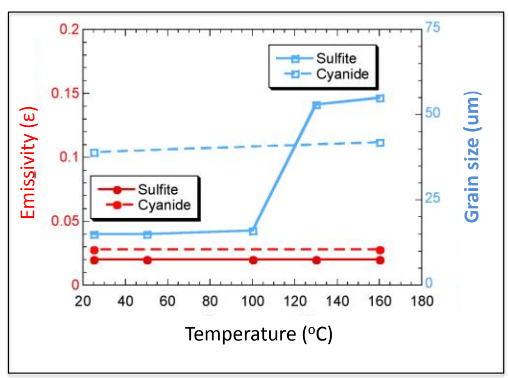

Figure 2: Shows low emissivity and stable grain structure of AU-cyanide system.

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