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Kinetics and Mechanism of High-Temperature Oxidation in Air of Au - Cu Alloy

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Abstract

We have used thermogravimetry to study the kinetics of high-temperature (up to 800 °C) oxidation of the alloy 58.3 mass% Au - 41.7 mass% Cu with isothermal heating of the specimens. Using petrographic analysis of the oxide layers, we determined the reaction products. We have shown that up to 200 °C, the indicated alloy is not oxidized at all. More rapid oxidation of the alloy is observed at temperatures above 400 °C. Up to 500 °C, an inner layer consisting of Cu_2O predominates in the two-layer scale on the alloy, while the outer CuO layer has a significantly smaller thickness. At 600 °C, the upper layer of scale contains Cu_2O while the lower layer contains Cu_2O and gold. At higher temperatures, all the way up to 800 °C, the scale is two-layer as before but its upper layer contains CuO while its lower layer contains Cu_2O and small gold rods distributed in that oxide. Thus we have established three oxidation regions characterized by different scale phase compositions and different mechanisms for the process, mainly due to transition from an ordered state of the alloy (intermetallic $AuCu_3$) to a completely disordered solid solution of gold in copper. We used the Arrhenius equation to calculate the apparent activation energy for oxidation: E_1 = 20.4 kJ/mole for the temperature range 400–500 °C and E_2 = 9.5 kJ/mole for 600–800 °C.