Electrochemical Study of Gold Cementation onto Copper in Thiosulfate Solution

Jaeheon Lee and J. Brent Hiskey

Department of Materials Science and Engineering
University of Arizona
Tucson, Arizona 85721

Introduction

The hydrometallurgical recovery of gold from thiosulfate solution by cementation onto copper has been previously investigated (1, 2). There are a number of complexities associated with this system. To begin with, cementation is performed in complex salt solutions and the complexing ligand is intrinsically unstable. The deposited layers have also been found to be a Au-Cu alloy instead of pure gold (2). To more fully understand the process, a detailed electrochemical investigation was carried out using a rotating disc electrode and an electrochemical quartz crystal nanobalance (EQCN).

Experimental

Polarization studies were carried out on pure copper and pure gold disk electrodes. Sodium thiosulfate was used as a source of thiosulfate at a standard concentration of 0.25 M and pH adjusted to 9.5 with the addition of NaOH. Initial gold concentration was varied between 10 - 100 ppm and dissolved copper changed from 0 to 30 ppm. Results were obtained with a PARC 273 potentiostat and an Elchema EQCN 700 system.

Results and Discussion

Polarization curves for copper oxidation and $Au(S_2O_3)_2^{3-}$ reduction were superimposed to generate Evans' diagram under selected conditions. The Evans' diagram shown in Figure 1 was constructed for different initial gold concentrations. The steady state mixed potential values differ by only 9 mV as the gold concentration increases from 30 to 90 ppm, whereas, the current density increased noticeably with increasing concentration. Similar behavior was observed with increasing disk rotation speed and thiosulfate concentration. These results suggest that gold cementation onto copper in thiosulfate solution is controlled by mass transfer.

Mixed potential was measured as a function of time under various experimental conditions. Variation of mixed potential with time for copper immersed in different concentrations of $Au(S_2O_3)_2^{3-}$ is depicted in Figure 2. Clearly, passivation of the electrode is shown to be sensitive to gold concentration. Dissolved oxygen was shown to have a pronounced effect on the mixed potential behavior.

Voltammetry was used in conjunction with an electrochemical quartz crystal nanobalance to further investigate the reduction of $Au(S_2O_3)_2^{3-}$ under typical cementation conditions.

References

1. E. Guerra, and D. Dreisinger, *Hydrometallurgy*, **51** (2), (1999) 155-172.

2. J. Lee, and J. B. Hiskey, *Hydrometallurgy*, (2003) in press.

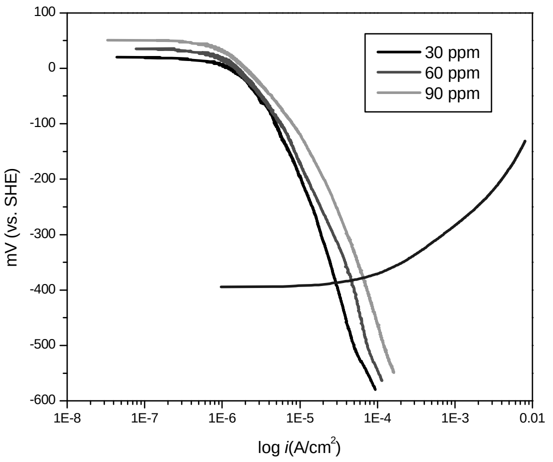

Figure 1 Evans' diagram for the $Au(S_2O_3)_2^{3-}$/Cu cementation system as a function of initial gold concentration.

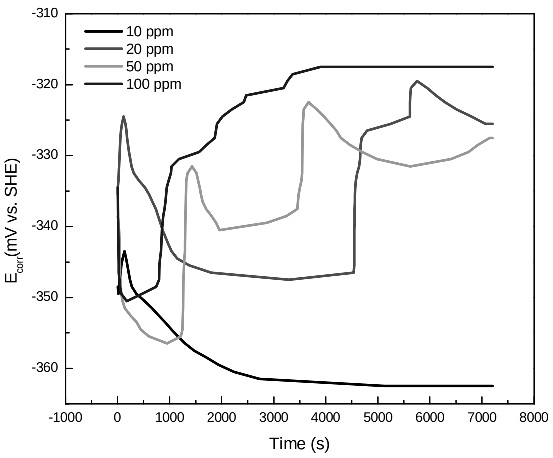

Figure 2 Variation of mixed potential as a function of time for the $Au(S_2O_3)_2^{3-}$/Cu cementation system as a function of initial gold concentration