Direct (Seedless) Cu Deposition on W: Implications for ULSI Processing

J. A. Kelber, J. Liu, C. Wang and S. Rudenja
Dept. of Chemistry, University of North Texas
PO Box 305070, Denton, TX 76203

Direct electrodeposition of Cu onto W without the use of a Cu seed layer is reported. The seedless electrodeposition of Cu on W or other reactive barrier metals is of considerable importance in ULSI processing, and has broader implications for control of metal nucleation and growth at the liquid/solid interface. Depositions were carried out in 0.05 M $CuSO_4$ in H_2SO_4 supporting electrolyte (deaerated) at pH 1 at cathodic potentials (< -0.2 V vs Ag/AgCl): conditions at which tungsten oxides are thermodynamically unstable with respect to clean W metal[1]. CV data (fig. 1) indicate a Cu deposition peak at ~ -0.24 mV/Ag/AgCl. Pulsed data (fig. 2), indicate a nucleation phase followed by diffusion-induced decrease in the cathodic current. Deposited films are shiny, and pass the "scotch tape" test. Preliminary XPS and EDX data indicate that films are pure Cu, without observable S or other contamination.

Under UHV conditions, the presence of a monolayer of oxide will prevent Cu from growing conformally ("wetting") the copper surface and induce poor adhesion[2]. It is not yet understood whether Cu nucleation will be governed in an analogous fashion in the more complex electrodeposition environment. In addition, the effects of specifically adsorbed anions and electrochemical potential on nucleation behavior remain to be explored.

This talk will discuss electrochemical, SEM and XPS data for electrodeposition on W in comparison with corresponding data on other barrier surfaces. Results will be discussed in light of expected differences for Cu electrodepositon on reactive vs unreactive substrates in aqueous environments.

Acknowledgements:
The authors wish to acknowledge support from the Semiconductor Research Corporation and the Welch Foundation for support of this work.

References:

1. M. Pourbaix, Atlas of Electrochemical Equilibria in Aqueous Solutions (Pergammon Press, London, UK (1966)

2. L. Chen, N. P. Magtoto, B. Ekstrom and J. A. Kelber, *Thin Solid Films* **376**, 115 (2000)

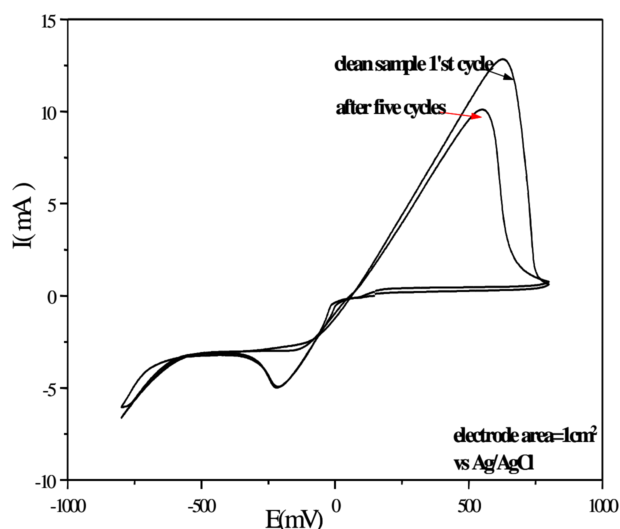

Figure 1; CV data for Cu electrodeposition on clean tungsten

Figure 1; CV data for Cu electrodeposition on clean tungsten

Fig. 2 W pulsed in CuSO4=0.05M/pH=1H2SO4 for 10s