Transmission Electron Microscopy Study of Copper Exposed to an Environment Containing H_2S, SO_2, NO_2, and Cl_2

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This paper describes a Transmission Electron Microscopy (TEM) investigation on the surface of copper coupons exposed to a Class III Mixed Flowing Gas environment (MFG) following the guidelines given by Battelle and IEC for environmental testing[1-6]. A Focused ion beam (FIB) lift-out technique utilising a 30 kV Ga+ ion beam was used to extract electron transparent specimens with nanometer scale precision. Using this procedure, the thin corrosion film in the samples (exposed at different time intervals) were studied. The nature of the film as well as the structure will be identified for ach of the different samples exposed to the gaseous environment[7-10].

The image depicted in Figure 1 shows a dark-field TEM image of a FIB-milled corrosion product that developed after 7 days exposure. This investigation will focus on showing the structure and composition of the different corrosion products formed.

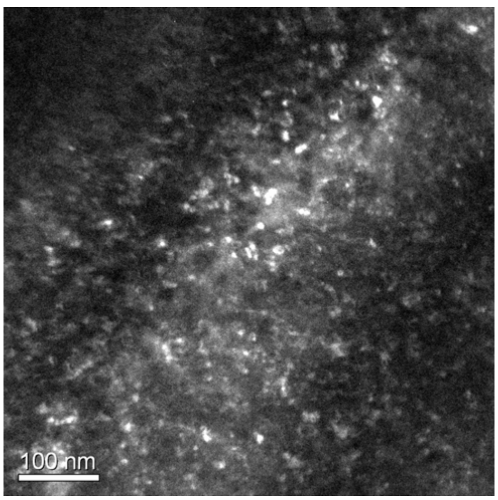

Figure 1. Dark-field TEM image of corrosion product that developed after 7 days exposure.

References

1. Abbott, W.H., The Development and Performance Characteristics of Mixed Flowing Gas Environment, IEEE Trans. Components, Hybrids, Manufacturing Technology, 1988. Vol. 11, pp. 22-35.

2. Abbott, W.H., The Corrosion Of Copper And Porous Gold In Flowing Mixed Gas Environments. Ieee Transactions On Components Hybrids And Manufacturing Technology, 1990. 13(1): p. 40-45.

3. ASTM International, Standard Guide for Mixed Flowing Gas Tests for Electrical Contacts, ASTM B 845-97. 2003

4. Telcordia Technologies, NEBSTM Requirements: Physical Protection, Generic Requirements GR-63-CORE, 2002. Method 5.5.2.

5. Geckle, R.J. and Mroczkowski, R.S., Corrosion Of Precious Metal Plated Copper-Alloys Due To Mixed Flowing Gas Exposure. IEEE Transactions On Components Hybrids And Manufacturing Technology, 1991. Vol. 14 pp. 162-169.

6. Zhao, P. and Pecht, M., Mixed flowing gas studies of creep corrosion on plastic encapsulated microcircuit packages with noble metal pre-plated leadframes. IEEE Transactions On Device And Materials Reliability, 2005. Vol. 5, pp. 268-276.

7. Tran, T.T.M., Fiaud C. and Sutter, E.M.M., Oxide and sulphide layers on copper exposed to H2S containing moist air. Corrosion Science, 2005. Vol. 47, pp. 1724-1737.

8. Reid, M., Punch, J., Ryan, C., Garfias, L. F., Belochapkine, S., Franey, J.P., Derkits, G.E. and Reents, W.D., The microstructural development of copper sulphide on copper exposed to humid H_2S. Journal of the Electrochemical Society, 2007. Vol. 154, pp. 209-214.

9. Watanabe, M., Higashi Y. and Ichino, T., Surface Observation and Depth Profiling Analysis Studies of Corrosion Products on Copper Exposed Outdoors. Journal of The Electrochemical Society, 2003. Vol. 150, pp. B37-B44.

10. Lenglet, M., Lopitaux, J., Leygraf, C., Odnevall, I., Carballeira, M., Noualhaguet, J.C., Guinement, J., Gautier, J. and Boissel, J., Analysis Of Corrosion Products Formed On Copper In $Cl^-_2/H_2S/N0_2$ Exposure. Journal Of The Electrochemical Society, 1995. Vol. 142. pp. 3690-3696.