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Advanced Characterization of thermo-mechanical fatigue mechanisms of different copper film systems for wafer metallizations

Stephan Bigl[1], Stefan Wurster[1], Megan J. Cordill[2], Daniel Kiener[1]

[1] Department of Materials Physics, Montanuniversität Leoben, Jahnstrasse 12, 8700 Leoben, Austria

[2] Erich Schmid Institute of Materials Science, Austrian Academy of Sciences, Jahnstrasse 12, 8700 Leoben, Austria

Corresponding author: Dipl.-Ing. Stephan Bigl, B. Sc. Montanuniversität Leoben, Department of Materials Physics, Jahnstrasse 12, 8700 Leoben, Austria
+43(0)3842 804 422, stephan-paul.bigl@stud.unileoben.ac.at

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Abstract:

In this study, two different electrodeposited 5 µm thick copper films were subjected to thermal cycling. The microstructural evolution of both films was studied with a site specific tracking technique. It was observed that the initially similar microstructures develop differently upon cycling with respect to grain size and texture. In detail, a Cu film which contains residual inorganic species from the organic additives used during Cu plating, in the ppm regime, showed a constrained surface roughness evolution and marginal grain growth coupled with a stable twin boundary network. Furthermore, voiding in the film interior was observed. In comparison, a high-purity Cu film exhibited strong surface roughening in conjunction with pronounced grain growth promoted by twin boundary migration. Moreover, the film showed a (100) texture intensity increase as a result of strain energy minimization upon cycling and no void formation. These observations underline the influence of film processing related impurities on the thermo-mechanical behaviour of Cu thin films.

Keywords: copper metallization, thermo-mechanical fatigue, twin boundary migration, void formation, surface roughening, small angle grain boundary formation, inorganic impurities

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