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Evaluation of stress build-up and its relaxation properties due to Electromigration in metallic single crystalline interconnects

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In order to understand electromigration induced stress build-up due to electronic current stress, we used single crystalline aluminum interconnection that was formed on Si(111) substrate. Prior to pursue current stressing test, we measured thin film stress-relaxation behaviors during thermal cycling test. For sample preparation, pure aluminum film with 0.9 μm thickness were grown on on Si(111) substrate by CVD method. Then Al film was patterned by wet chemical etching to 20 μm x 2000 μm line pattern, and covered with SOG (spin coated silicate glass). For SOR X-ray measurement, we used wavelength of 0.996 angstrom. We measured 2θ peak of Al (111) during a temperature cycling test for two Ψ angles of Ψ=0, and Ψ=70.5. Change of lattice spacing of Al (111) during thermal cycling test between RT and 300 °C is shown in Fig.1. We estimated Z-component stress from this measurement, and the result is shown in Fig.2. An almost linear stress-temperature relationship was obtained at temperature below 150 °C. Meanwhile, compressive stress did not increase when temperature was higher than 200 oC, and a large hysteresis loop that suggested a large plastic deformation was observed. We also carried out experiment to observe a change in Al (111) lattice spacing due to electromigration. However, there was no significant change through the experiments. Longer experiment would be needed further.

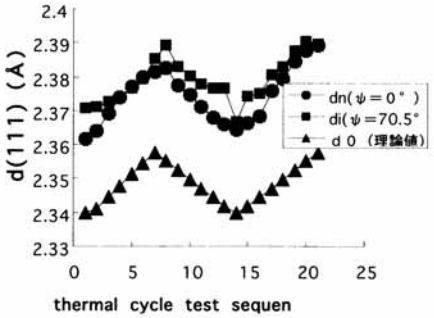

Fig. 1. Change of lattice spacing of Al (111) during thermal cycle test.

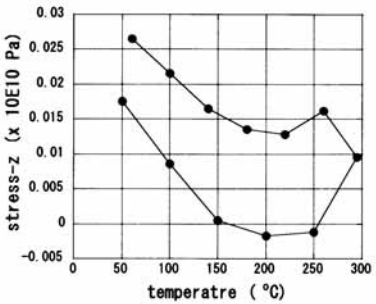

Fig.2 Change of the z-component of the stress in Single crystalline Al film on Si(111) during thermal cycle test.

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Surface X-ray structure analysis of new water structure formed on Cu(111) electrode

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Water is an important molecule for life science. The structures of water in gas phase and solid/solution phases are not clear. Especially, the structure of water in solid solution interfaces is really mysterious. In our previous study for Cu upd on Au(111) electrode surface, we found water molecules form closed packed planar structure in which hydrogen bonding network extends over on an substrate surface. The similar structure is also seen on ice-like bilayer on M(111)(M=Pt, Au, Ru(100)) under UHV conditions. In order to understand double layer structure and chemical properties at metal/solution interfaces, the surface structure of Cu(111) electrode in sulfuric acid solution at very negative electrode potentials where water molecules show 4x4 and 5x5 super lattice ordered structrures on the surface.

Experiments were carried out at the BL13XU beamline at SPring-8. The wavelength of the X-ray beam was 1.23 Å (10.08keV). The X-ray diffraction measurements were carried out by a grazing-angle (Z sample geometry) method. Figure 1 plots the typical result of non-integer reflection profile for Cu(111) surface at -0.45V. The copper surface was likely to be oxidized in spite of strict nitrogen purge during the whole measurements. It was quite difficult to collect many reflection sets. We need to change electrochemical cell for obtaining intensity data set

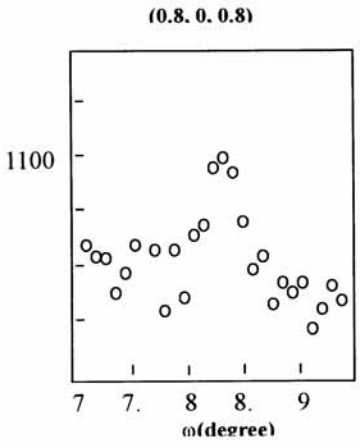

Figure 1