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Analysis of corrosion on the Al(Cu 1%) surface using XPS

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As devices and features have become smaller and chips have become larger, aluminum has been used as the primary interconnecting materials. Dry etching in a Cl containing plasma has been a potentially important technique for patterning Al alloy films of VLSI circuits. However Al alloy lines formed by dry etching tend to corrode upon atmospheric exposure. Especially the inclusion of Cu in Al to inhibit electromigration offers a more difficult plasma etching challenge. One of the difficulties is that the concentration of Cu may result in accelerated corrosion of aluminum in the presence of chlorine and moisture. This is not only an in-process corrosion problem but is also a reliability issue for the metallization of the circuits. So the corrosion phenomenon has been studied intensively in the earlier works. The most of papers has described the effects of chlorine on the corrosion. The effects of grain boundary have been not considered although the grain boundary of Al(Cu 1%) has been formed during Al(Cu 1%) sputtering. Therefore, analysis of corrosion on the Al(Cu 1%) surface must be evaluated.

In this study, analysis of corrosion on the Al(Cu 1%) surface have been investigated using x-ray photoelectron spectroscopy(XPS), scanning electron microscopy(SEM) and ellipsometry. The role of SF_6 plasma was also evaluated after subsequent SF_6 plasma treatments for the reduction of Al(Cu 1%) corrosion.

The corrosion of Al(Cu 1%) etched using $SiCl_4/Cl_2/He/CHF_3$ gas plasma has been studied with XPS and SEM. It was found that the surface of Al(Cu 1%) mainly corroded at the grain boundary. This implies that chlorine mainly exists at the grain boundary of Al(Cu 1%) after etching. Then, chlorine incorporated to the grain boundary has not been significantly removed during Al(Cu 1%) etching and the subsequent exposure of the SF_6 plasma. This may have resulted from the imperfect crystalline structure of Al(Cu 1%) at the grain boundary. Although the exposure of SF_6 plasma did not have an effect on the removal of the chlorine on the Al(Cu 1%), the Al(Cu 1%) did not experience the corrosion with the SF_6 plasma at the pressure of 300 mTorr. Apparently, the chlorine on the Al(Cu 1%) was not substituted for F atoms but passivated by F atoms generated from SF_6 plasma at the pressure of 300 mTorr. This was confirmed with the change of Cl atomic percents.

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