

# Electrochemical Study of the Anodic Dissolution of Copper with Electrochemical Quartz Crystal Microbalance(EQCM) in Alkaline Solution

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Because of its low resistivity and high electromigration resistance, copper has been studied as a candidate for the interconnect material. Recently, it has been presented that the integration of copper interconnection, damascene and dual damascene, may resolve the patterning problem of copper layers. In damascene and dual damascene process, chemical mechanical polishing (CMP) is used to remove overburden material and planarize the surface roughness for multilevel interconnection. The CMP slurry chemistries of copper in various media have been studied by many research groups. Particularly,  $\text{NH}_4\text{OH}$ -based slurry chemistry has been investigated by Steigerwald [1] and Luo [2-3]. Steigerwald et. al. presented a two-step process of mechanical abrasion of the copper surface followed by removal of the abraded material from the vicinity of the surface. Luo et. al. supposed that the reaction of recessed region is different from that of protruded region and is similar to reaction in aqueous solution. In our work, we concentrated on recessed surface reaction mechanism in  $\text{NH}_4\text{OH}$  media by using voltammetry and EQCM. In addition, we investigated the effect of additives used in copper electroplating on copper dissolution.

## Results and discussions

Figure 1 shows that, when potential is anodically scanned at a rate of 20mV/s from 0.75V to 1.7V, two distinct anodic current peaks appear and, mass decrease rates are varied with potential. Current peaks are ascribed to the formation of  $\text{Cu}_2\text{O}$  and  $\text{CuO}$  respectively[2-3] and electrode mass is expected to be increased. However, electrode mass decreases slowly to the peak potential and the rapid mass decrease is followed above the peak potential. XRD results indicate that copper oxide are not identified when anodic scan is terminated at the peak potential. The dissolution behavior of Cu in  $\text{NH}_4\text{OH}$  is investigated with the constant anodic current of  $100\mu\text{A}/\text{cm}^2$ .

With the increase of  $\text{NH}_4\text{OH}$  concentration, peak potential in the LSV shifted to the cathodic direction and the second peak current diminishes. These results support the two-step Cu dissolution in alkaline solution. It was supported that copper oxide formed during Cu dissolution is chemically dissolved at faster rates. In addition, when additives such as BTA, PEG,  $\text{Cl}^-$  were added in electroplating bath, the effects on copper CMP was investigated. Additives during electroplating do not affect the anodic dissolution mechanism.

## Reference

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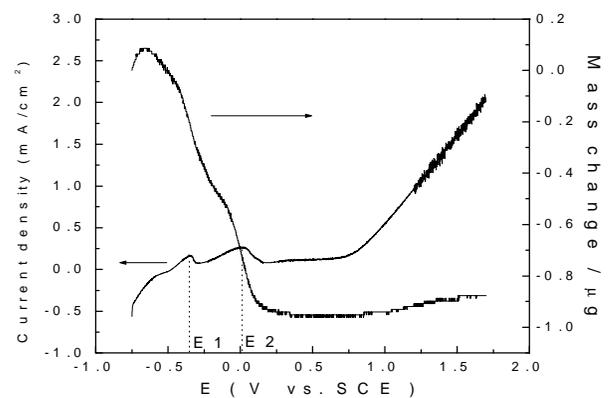


Fig. 1. Linear sweep voltammetry and mass change of Cu in 0.5M  $\text{NH}_4\text{OH}$  solution (scan rate : 20mV/sec)