Effect of Amine Functional Group on Removal Rate Selectivity between Copper and Tantalum-nitride Film in Chemical Mechanical Polishing

Hao Cui[*], Hee-Sub Hwang[*], Jin-Hyung Park[*], Ungyu Paik[**], and Jea-Gun Park[*]

Advanced Semiconductor Material & Device Development Center, Hanyang University, Seoul 133-791, Korea[*]

Division of Advanced Materials Science Engineering, Hanyang University, Seoul 133-791, Korea[**]

Abstract : Copper (Cu) Chemical mechanical polishing (CMP) has been an essential process for Cu wiring of DRAM and NAND flash memory beyond 45nm. Copper has been employed as ideal material for interconnect and metal line due to the low resistivity and high resistant to electro-migration. Damascene process is currently used in conjunction with CMP in the fabrication of multi-level copper interconnects for advanced logic and memory devices.

Cu CMP involves removal of material by the combination of chemical and mechanical action. Chemicals in slurry aid in material removal by modifying the surface film while abrasion between the particles, pad, and the modified film facilitates mechanical removal. In our research, we emphasized on the role of chemical effect of slurry on Cu CMP, especially on the effect of amine functional group on removal rate selectivity between Cu and Tantalum-nitride (TaN) film.

We investigated the two different kinds of complexing agent both with amine functional group. On the one hand, Polyacrylamide as a polymer affected the stability of abrasive, viscosity of slurry and the corrosion current of copper film especially at high concentration. At higher concentration, the aggregation of abrasive particles was suppressed by the steric effect of PAM, thus showed higher fraction of small particle distribution. It also showed a fluctuation behavior of the viscosity of slurry at high shear rate due to transformation of polymer chain. Also, because of forming thick passivation layer on the surface of Cu film, the diffusion of oxidant to the Cu surface was inhibited; therefore, the corrosion current with 0.7wt% PAM was smaller than that without PAM. the polishing rate of Cu film slightly increased up to 0.3wt%, then decreased with increasing of PAM concentration. On the contrary, the polishing rate of TaN film was strongly suppressed and saturated with increasing of PAM concentration at 0.3wt%. We also studied the electrostatic interaction between abrasive particle and Cu/TaN film with different PAM concentration. On the other hand, amino-methyl-propanol (AMP) as a single molecule does not affect the stability, rheological and corrosion behavior of the slurry as the polymer PAM. The polishing behavior of TaN film and selectivity with AMP appeared the similar trend to the slurry with PAM. The polishing behavior of Cu film with AMP, however, was quite different with that of PAM. We assume this difference was originated from different compactness of surface passivation layer on the Cu film under the same concentration due to the different molecular weight of PAM and AMP.

Key Words : amine; copper; selectivity; CMP