The Effect of Additives in Cu CMP Slurry on Cu Polishing

Yi-Koan Hong, Dae-Hong Eom and Jin-Goo Park
Department of Metallurgy and Materials Engineering,
Hanyang University, Ansan, 425-791, Korea

A CMP(Chemical Mechanical Planarization) process for copper damascene has been introduced as a new interconnection technology in integrated circuits manufacturing. Because of the many benefits, Cu is now used almost extensively as the main interconnect material, which has the lower resistance, superior resistance to electromigration and reducing RC time delay compared with aluminum [1]. The mechanism of the surface reaction between Cu surface and slurry is important to understand Cu CMP. The Cu CMP mechanism is composed of Cu surface oxidation by oxidizer, protection of the Cu surface oxidation by an inhibitor and removal of passivation layer on top of protrusions by mechanical action of pad and abrasive particles [2]. The Cu slurry typically consists of hydrogen peroxide(H_2O_2) as the oxidizer, organic acids as the etchant, and benzotriazole(BTA) as corrosion inhibitor and alumina or silica particles as abrasive. The organic acids can act not only as an etchant but also as a complexing agent.

The purpose of this study was to investigate the effects of additives in alumina(Al_2O_3) based slurry on Cu CMP in terms of removal rate, etch rate and corrosion rate at pH 6. Since the large ratio of removal rate to etch rate and corrosion rate is required for reducing the Cu dishing [2], the etch, removal and corrosion rates were carefully studied at the different ratio of additives in Cu slurry, All polishing experiments were carried out using a Logitech polisher and Suba IV pad of Rodel. The carrier speed was set at 30 rpm and platen speed was at 30 rpm. The down pressure of carrier was 6.5 psi and the flow rate of slurry was 100 ml/min. Polishing time was set for 1min. The additives in the Cu slurry was used to change the removal and etch rate. Hydrogen peroxide(H_2O_2), BTA and organic acids were very effective in controlling removal, etch and corrosion rate when they were added into the slurry. As the concentration of organic acids increased, the removal and the etch rate increased linearly. Although there was no difference in the etch rate of Cu with respect to types of organic acids, the Cu polishing rate was dependent on the kinds of organic acids and mean particle size as shown in Fig. 1 and Fig. 2. However the removal and etch rate were sensitive to the concentration of hydrogen peroxide(H_2O_2) and BTA.

As the concentration of hydrogen peroxide(H_2O_2) was increased from none to 10 vol%, the removal and etch rate was increased. Removal rate has saturation regions at above 5 vol%. While, etch rate was increased continuously as shown in Fig. 3. In BTA added slurry, the polishing and etch rate decreased as BTA concentration increased in the slurry as shown in Fig. 4.

The optimization of slurry composition was carried out by the measurement of corrosion, etch and removal rates for the Cu CMP.

References
[1] Peter Singer, Semiconductor international, June, 91 (1998)
[2] S. Kondo, N. Sakuma, Y. Homma and N. Ohashi, PV 98-6, pp.195-205, The Electrochemical Society Proceeding Series, Pennington, NJ (1998).

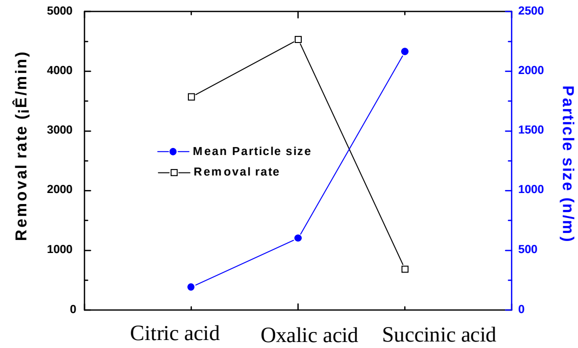

Fig.1. Removal rates of Cu and particle sizes of alumina slurries upon the addition of different organic acids.

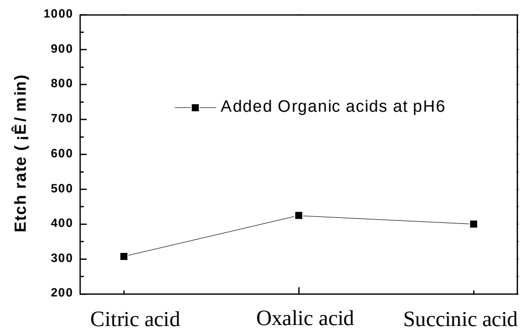

Fig.2. The etch rates of Cu when different organic acids were added in Cu slurry.

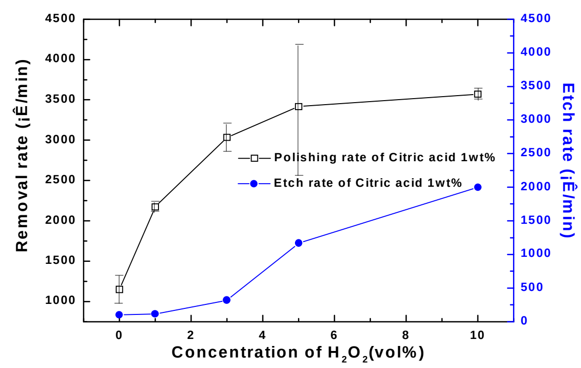

Fig.3. The comparison of polishing and etch rate as a function of concentration of H_2O_2.

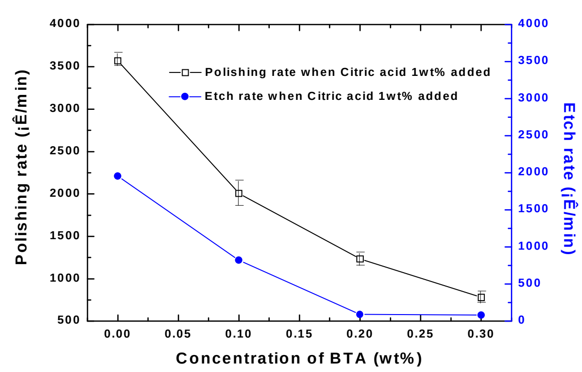

Fig.4. The comparison of polishing and etch rate as a function of the concentration of BTA.