재생된 옥사이드 CMP 슬러리의 물리적, 화학적 특징에 대한 연구

(Physical and Chemical Characterization of Recycled Oxide CMP Slurry)

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Abstract

In recent years, as Chemical Mechanical Planarization(CMP) has been routinely utilized in integrated circuit(IC) fabrication, the consumption of slurry, main consumable in a CMP process, is greatly increased. Thus the reprocess of CMP slurries has been actively considered in the industry to reduce cost-of-consumable (COC). The main purpose of this study was to recycle the used oxide slurry using filters as a new method. As a result, Ultra Fine(UF) Filter could distinguish silica from the used oxide slurry and Reverse Osmosis(RO) Filter could distinguish DeIonized(DI) Water and chemistry from chemistry solution. The tetraethylorthosilicate removal rate was almost the same as the number of recycle polishing was increased, when it was modified by slightly adding new SS-12 slurry. The microscratch didnt found as the number of recycle polishing was increased.

1. Introduction

Chemical-Mechanical Planarization(CMP) of dielectric and metal films is becoming the planarization process of choice for multilevel metallization flow technologies. CMP also provides global and local planarization the can meet the increasingly stringent lithographic requirements of device manufacturing on silicon wafers(1). Oxide CMP uses alkaline silica slurries which contain approximately 10 to 12 % solids and are characterized by a pH in the vicinity of 11. Wastes from such processes contain alkalis, dissolved silicates and buffer salts in addition to silica particles (2,3).

As being widely used, the use of CMP equipment and consumables is expected to grow at a greater rate than any other integrated circuit manufacturing equipment category. The main consumables in a CMP process are slurry, pad and deionized water. Especially, the cost of slurry occupies about 50% of cost-of-consumable (COC) associated with CMP. Although a certain minimum amount of slurry is needed in order to achieve good removal uniformity, only a small fraction of the slurry is actually consumed during the process (4). In this reason, the reprocess and reuse of CMP slurries have been actively considered in the industry (5). After polishing, property of used oxide slurry decrease. pH decrease about 0.4, specific gravity decrease 0.029, and conductivity decrease 1430μs/cm. However, there is no published data regarding their chemical and physical properties of recycled oxide CMP slurry by filter modules which can reuse oxide slurry.

In this study, we characterized the filterated used oxide CMP slurry to explorer the possible way to reuse it. The pH, specific gravity and particle size distribution were measured as a function of number of CMP process by Filter modules. In order to compare the performance of the reprocessed slurry with the filterated the used slurry at a set polishing condition, the removal rates were measured.

2. Experimental

All polishing experiments were carried out using IPEC Avanti 472 CMP polisher with grooved and stacked Rodels IC1000/Suba500 pads. In the CMP process, the carrier and platen speeds were set at 20 and 35 rpm, respectively. The down and back pressure of carrier were 5.5 psi and 1.5 psi, respectively. A constant flow rate was used at 200 ml/min for the slurry supply. 8 PECVD TEOS wafers were used for the polishing. KOH based fumed oxide silica slurry (weight content: 25 %) was diluted with DI water and used for the polishing of TEOS wafers. After polishing, post-CMP cleaning was performed by OnTrak scrubber system using NH4OH and HF chemistry. The removal rate was analyzed by a Rudolph ellipsometer (FE-111D). Defects after post CMP cleaning were evaluated by KLA 2132 and particles were evaluated by Tencors laser surface particle scanner (SFS-6200). Ultra high purity DI water (18.2 Mi¤cm) and semiconductor grade wet chemicals were used for the experiment.

3. Results and Discussion

In order to obtain the recycled oxide slurry, at first, silica distinguished from the polished oxide slurry by UF filter. Figure 1(a) shows the change of specific gravity and conductivity when the used slurry is filterated by UF filter. As increasing filtering time, both specific gravity and conductivity increased linearly. And pH of filterated oxide slurry is constant as increasing filtering time as shown in Figure 1(b). The reason was that UF filter could separate only macromolecular particles for solution. Therefore silica was rejected from used slurry, chemical component and DI water were permeated. But since recovery rate of silica had decreasing as increasing filtering time, this had to be compensated by after filtering proper time and adding new slurry and KOH.

Specific gravity and pH of slurry played an important role on Removal Rate. So, Figure 2 shows efficiency of new slurry addition to achieved solution after proper UF filtering for increasing recovery rate of the recycled slurry. As a result of experiment, both specific gravity and conductivity increased linearly. Therefore, same value of specific gravity alike new slurry's could be achieved by adding a few amount of new slurry. And in order to compensate insufficient conductivity as a result of effect of pottassium hydroxide addition on UF filterated used slurry, both pH and conductivity increased continuously. Therefore, same value of pH alike new slurry's could be achieved by adding a few amount of potassium hydroxide .

Since DI Water was inflowed during polishing, it was necessary to drain DI Water from the used slurry in order to increase recovery rate of used slurry. RO filter was very efficient to distinguish DI Water from solution. Principal of RO filter was that ions were separated from solution using high pressure(7.5~10kg) by reverse osmosis method. Figure 3 shows change of property when the used slurry is filterated by RO filter. As increasing RO filtering time, pH increased at chemical port and decreased at DI Water port. But as efficiency of RO filter was declined, pH increased at DI Water port. This was due to separate OH- from solution to chemical port.

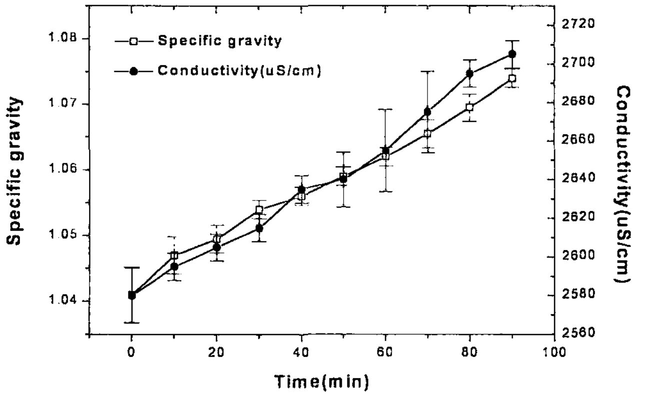

Figure 1(a). Change of specific gravity and conductivity when filterated by UF filtering

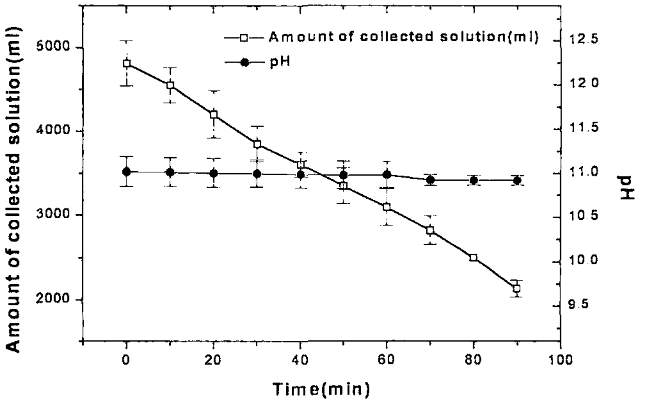

Figure 1(b). Change of amount of collected solution and pH when filterated by UF filtering

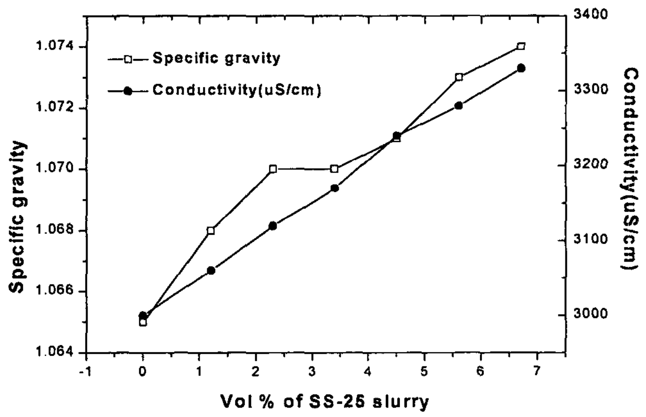

Figure 2. Effect of new slurry addition on UF filterated used slurry

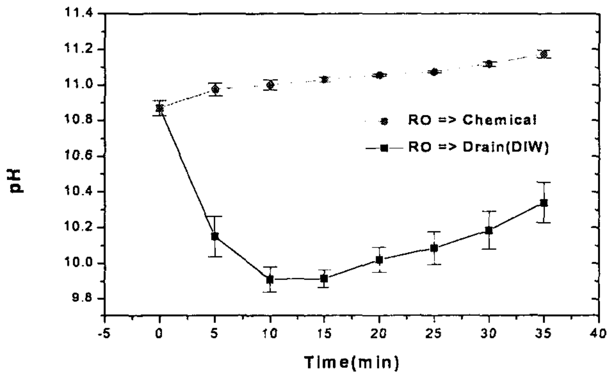

Figure 3. Change of pH when filterated by RO filtering

4. Conclusion

The physical and chemical characterization of filterated re-used oxide CMP slurry was performed to find out the possible way to recycle it. Specific gravity and conductivity increased as Ultra Fine filter separated silica from the used slurry. Conductivity could be compensated by Reverse Osmosis filtering. And insufficient property of filterated slurry could be compensated by unused slurry (SS-25) and potassium hydroxide.

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