Technical Brief

Impacts of Point-of-Use Filtration on an ILD CMP Process

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Abstract

Single stage, single pass filtrations were performed to remove large particles from Klebosol 1501-50, a colloidal silica Chemical-Mechanical Polishing (CMP) slurry. Several polypropylene depth filters with micron ratings of 0.5 and 1.0 µm were used for point-of-use filtration. Influent and effluent CMP slurry samples were collected for determining CMP process parameters including filtration, percent solids, and defectivity data. Filtration tests showed a reduction in large particle counts and no change in total percent solids. The resulting effluent CMP slurry samples were used to conduct wafer polishing studies via an Applied Mirra® CMP polisher. Wafer polishing studies were performed and monitored over a six month period to evaluate the impact of point-of-use (POU) filtration on wafer metrology data. The polishing results demonstrated a significant reduction in defect counts while maintaining the target polishing rate.

Introduction

Chemical Mechanical Planarization, CMP, has become the standardized technology for planarizing interlayer dielectric (ILD), metal, and shallow trench isolation (STI) fill material for making multilevel microelectronic devices.

Experimental

Polypropylene melt-blown depth capsule filters with micron ratings of 0.5 and 1.0 µm were used for POU filtration. Single stage, single pass filtrations were performed to remove large particles from Klebosol 1501-50, a KOH based colloidal silica CMP slurry having a pH of approximately 10.8, and percent solids of ~30%. Influent and effluent CMP slurry samples were collected for determining particle size distribution via AccuSizer® Model 780A by Particle Sizing Systems.

The resulting effluent CMP slurry samples and the unfiltered CMP slurry were supplied at 200 mL/min to an Applied Materials Mirra CMP polisher. Wafer polishing was performed using 15K thick TEOS blanket wafers and monitored over six month period to evaluate the impacts of POU filtration on wafer metrology data. Defect measurements were taken by using Applied Materials Compass® inspection tool.

All of the polishing data and comparisons were collected on a process using the same stacked IC 1010™ (grooved) with Suba® subpad and diamond conditioner disk,Kinik® AD3CG-181060. Post CMP clean was accomplished using Lam Research Corporation Synergy™ cleaning system. The embossed Politex® buff pad was utilized for buffing with 1.7% ammonium hydroxide cleaning chemistry.

Results and Discussion

Particle Size Distribution Before and After Filtration

Figure 1 shows the large particle size distribution of Klebosol 1501-50 slurry before and after filtration with 3M Purification Inc. 0.5 µm Betapure™ CMP and two other point-of-use filters.

When compared with no filtration, POU filtration is beneficial in decreasing the overall large particle distribution as indicated in **Figure 1**. 3M Purification 0.5 µm Betapure CMP filter demonstrated effective reduction of LPC when compared with other competitive filters.

Wafer Polishing Performance

Percent Solids - The percent solids of both the influent and effluent were sampled before and after filtration and tested by gravimetric analysis. No difference in total percent solids was observed comparing the filtered and unfiltered slurry samples. Therefore, the 3M Purification and competitive filters did not alter the percent solids of the CMP effluent.

Defectivity - The resulting effluent CMP slurry samples and the unfiltered CMP slurry were supplied at 200 mL/min to an Applied Materials Mirra® CMP polisher. The normalized defect data of 15K thick TEOS blanket wafers is presented in **Figure 2**.

As demonstrated in **Figure 2**, 3M Purification 0.5 µm Betapure™ filter resulted in the lowest defect counts overall while maintaining similar removal rates. To evaluate long term impacts of the POU filtration on the ILD CMP process, wafer polishing was performed using slurry filtered by the 0.5 µm Betapure filter and monitored over a six month period. The resulting normalized defect data is presented in **Figure 3**. The overall defect counts were significantly less over the six month study with the Betapure 0.5 µm POU filter compared to no filtration.

Conclusions

POU filters resulted in a reduction in large particles while not altering the percent solids after filtration. 3M Purification's 0.5 µm Betapure POU filter showed excellent performance in lowering overall wafer level defectivity.

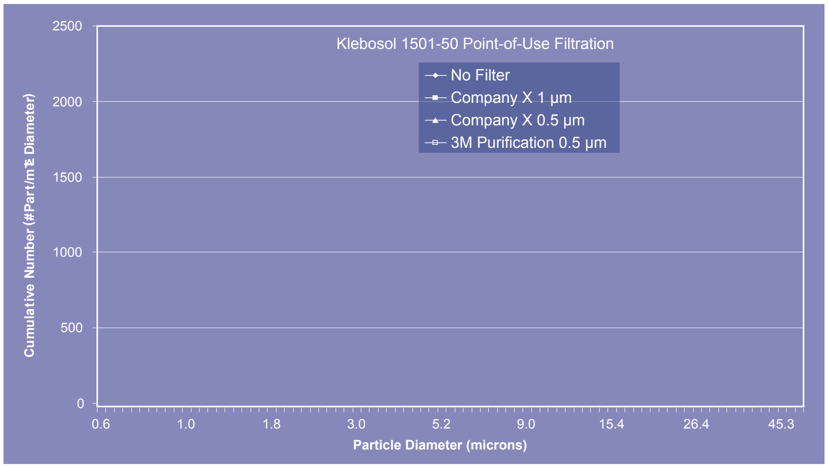


Figure 1. Large Particle Size Distribution of POU Filtered vs. Unfiltered Klebosol 1501-50 I Slurry

Figure 2. Normalized Defect Data of Polished 15K TEOS Blanket Wafers Measured by Applied Compass Inspection Tool

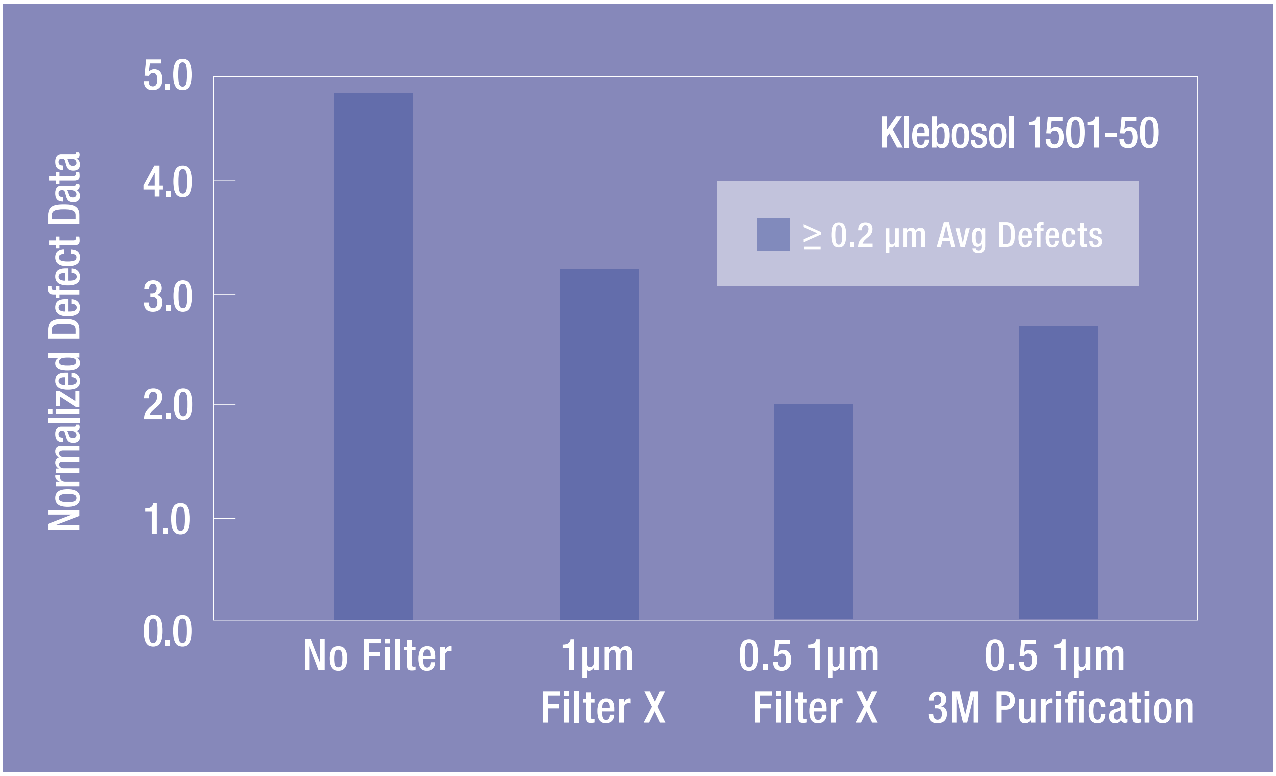
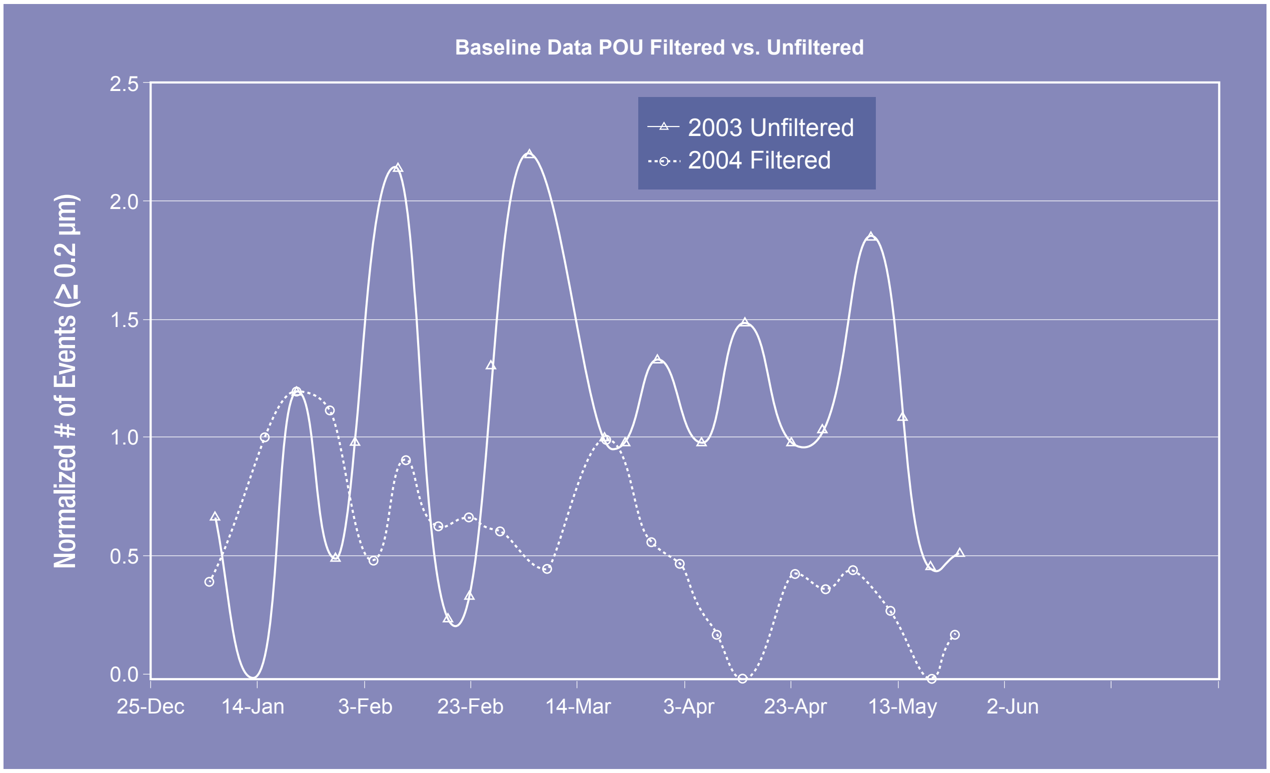


Figure 3. Six Month Baseline Defect Results of Unfiltered vs. Filtered (Betapure™ 0.5µm)



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