Task ID: 425.020
Task Title: An Integrated, Multi-Scale Framework for Designing Environmentally-Benign Copper, Tantalum and Ruthenium Planarization Processes

Deliverable: Improved pad, conditioning, and slurry usage based on optimized pad/wafer/particle and pad/diamond/particle interactions.

I. Summary/Abstract.

This report summarizes recent experimental results to illustrate the effect of novel pad groove design and conditioner aggressiveness on the slurry film thickness in the pad and wafer interface during chemical mechanical planarization process. The results indicate that the pad with the concentric slanted Plus 30° and 20° groove design generates a higher slurry film thickness in the pad and wafer interface than the pads with the concentric slanted Minus 30° and 20° groove design and conventional concentric groove design. The results also indicate that a more aggressive diamond disc generates a thicker slurry film in the pad and wafer interface area.

II. Technical Results and Data.

Dual emission UV enhanced fluorescence technique was used to measure the slurry film thickness in the pad and wafer interface.

Slurry film thickness for pads with novel concentric slanted groove design was investigated and results were compared with the conventional concentric groove design. Figure 1 shows the concentric slanted groove design. The slanted angle can be varied. As the slurry is injected onto the pad center, the positive slanted groove design will enhance slurry flow from the groove towards the land area while the negative slanted groove design will hinder slurry flow. Figure 2 shows the slurry film thickness for pads with concentric slanted Plus 30°, Plus 20°, Minus 20°, and Minus 30° groove design, as well as the conventional concentric groove design (0°). The slurry film thickness was measured in four regions (A, B, C, and D) underneath the quartz wafer under three different pressures (1, 2 and 3 PSI). The results illustrate that regardless of the pressure, a positive degree of groove slanting (Plus 30° and Plus 20°) results in a higher slurry film thickness in the pad and wafer interface, than in the case of a negative degree of groove slanting (Minus 20° and 30°) or no slanting (0°).

Two diamond discs were used to condition dyed Cabot Microelectronics Corporation D100 pads. Disc A was less aggressive than Disc B. For each disc, the slurry film thickness was measured at two polishing pressures (3 and 5 PSI) and one sliding velocity (1.7 m/s). For each polishing condition, the slurry film thickness was measured twice (Run 1 and Run 2) to confirm the experimental reproducibility. Each measurement included the slurry film thickness in two regions (A and B) underneath the quartz wafer. Figure 3 shows the measured slurry film thickness. As Disc B generates a more abrupt pad surface, it creates a thicker slurry film in the pad and wafer interface area than Disc A.

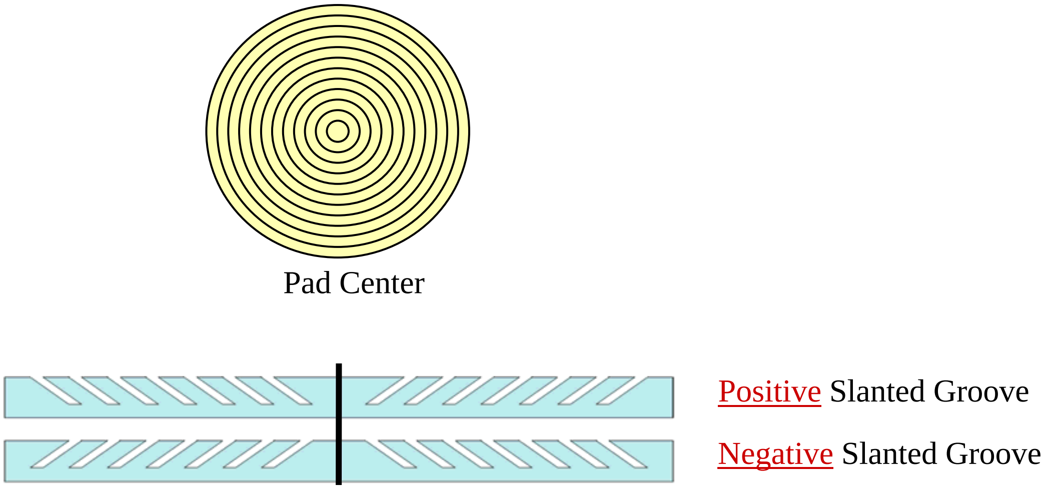


Figure 1. Positive and negative concentric slanted groove design

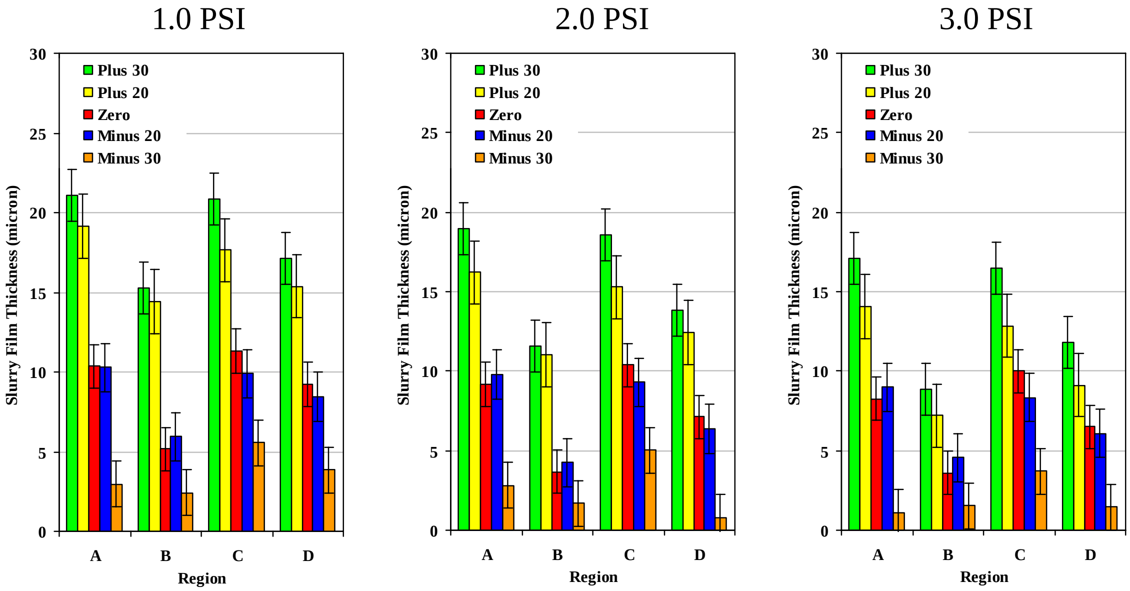
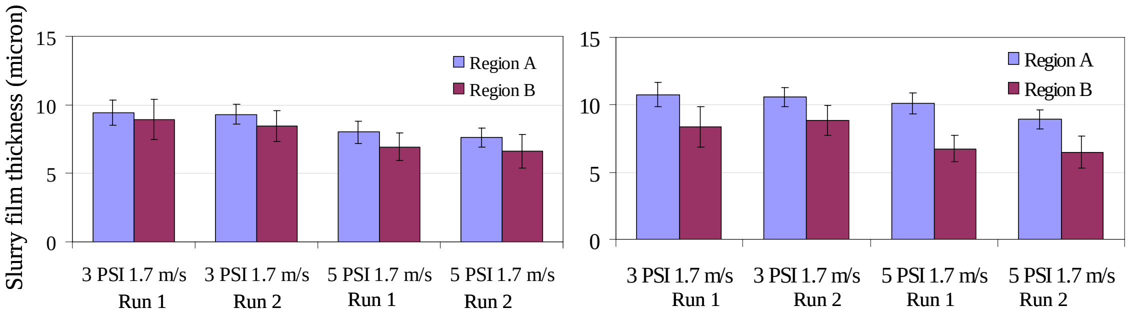


Figure 2. Slurry film thickness measurement for pads with concentric slanted groove design and conventional concentric groove design



(a) (b)

Figure 3. Slurry film thickness measurement for (a) Disc A and (b) Disc B