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Effects of Slurry Flow Rate and Pad Conditioning Temperature on Dishing, Erosion and Metal Loss During Copper CMP

Gitis¹, Suresh Kuiry¹, S. Raghu Mudhivartha²,

Michael Vinogradov¹ and Ashok Kumar²

¹Center for Tribology, Campbell, CA 95008, www.cetr.com

²University of South Florida, Tampa, FL 33620, www.eng.usf.edu

Chemical-mechanical planarization (CMP) process is capable of achieving a global planarity across the wafer, and hence, is widely applied for fabrication of multi-level metallization structures, which are being adopted to reduce interconnect delay. Though the CMP is highly effective, there are defects that arise during the process and significantly impact the final device yield. Thus, it is very important to investigate the sources of these defects. In the present research, the effects of slurry flow rate and polishing pad temperature on the generation of dishing, erosion and metal loss during copper CMP process have been investigated using a bench-top polisher CP-4. Patterned copper wafer coupons were polished with varying polishing pressure and slurry flow rate using conventional slurry and pads. The post-CMP imaging of the patterned wafer surfaces was carried out to characterize wafer defects, using an AFM integrated into the tester UNMT-1. Also, the erosion and metal loss data at dense features both thin and wide, were measured using a surface profiler. The study ascertains a correlation between process parameters and the extent of planarity defects.

Conclusions

1. The effects of slurry flow rate, pad temperature and conditioning temperature on the copper CMP performance have been studied.
2. During copper CMP process, higher slurry flow rates resulted in decreased levels of friction, dishing, erosion and metal loss, while increased copper removal rate.
3. During ex-situ pad conditioning, friction reached steady-state faster at lower temperatures comparing to the elevated temperatures, thus, full-conditioning at higher temperatures was longer.
4. Higher removal rates and coefficient of friction between pad and wafer surface were noted at both very low and very high temperatures of conditioning.
5. Post-CMP dishing increased with increase in the pad temperature.
6. Pad temperatures during both conditioning and polishing play a major role in the generation of wafer defects like dishing and erosion during copper CMP process.