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CMP Process Optimization for DIW conservation and metal loss reduction

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In 2 nm nanosheet technology, the feature size and dimension of metallization shrink to only a few 10s of nanometers, imposing serious challenges to control metal dissolution from corrosion during CMP, especially in the case of W vias in MOL module and Cu interconnects in BEOL. By nature, W surface is not passivated at pH > 4.0 As a consequence, exposure of W to DIW can lead to serious corrosion. Therefore, optimizing WCMP process by reducing the amount of DIW consumption, e.g., on platen rinse and post buff clean DIW rinse steps would help mitigate W loss and preserve via height. Such process optimization also helped reduce DIW consumption by more than 25% of current usage, making it a more sustainable and environmentally friendly manufacturing process.

"Cu" is most widely used metal for interconnect applications. But it is more prone to corrosion in the CMP step because of the nature of chemicals used in CMP slurry. Similar to W, exposure of un-passivated Cu wafer to DIW and ambient oxygen in CMP tool can induce galvanic corrosion on both Cu conductor and Co liner. For 2nm technology node, Cu barrier polish is usually much shorter than the subsequent brush clean process. As a consequence, "traffic jam" would occur where wafers would sit wet and idle in transient until the cleaner is ready to receive new wafer. Such time lag to reach the wafer from polisher output station to the cleaner module inside the tool will cause galvanic corrosion by extended exposure to DIW and oxygen. By shortening the DIW rinse time and brush cleaning time during brush clean, it is demonstrated that Cu and Co corrosion can be reduced without compromising the cleaning efficiency to remove particles and polish residues.

The two case studies above demonstrate how process co-optimization for CMP performance improvement can co-exist with the conservation of DIW consumption in high volume semiconductor manufacturing.

Ref:

1. W.-T. Tseng, E. Motoyama, K. Motoyama, A. Jog, P. Chu, D. Capaneri, "*Nano-scale metal loss during chemical-mechanical planarization*", *Inter. Conf. Planarization. Technol*. (ICPT), #O32 C-03 (2023).
2. P. Chu, "*Tungsten Dissolution in MOL-Root Cause Investigation*", *2024 CAMP Inter. CMP Symp*., Lake Placid, NY, USA, Aug. 11 ~ 14, 2024.