PVA Roller Brushes Post-CMP Cleaning and Tribological Performance Characterization Approaches

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An efficient post-CMP (PCMP) cleaning process should consistently remove particles, organic residues, and ionic contamination from the wafer surface. In PVA (Poly Vinyl Acetal) brushes PCMP cleaning, the particle removal is accomplished by a direct contact between the brush and the wafer surface in which the brush PVA asperities engulf the wafer surface contaminants and the rotational motion of the brush and the cleaning fluid supplied to the wafer surface dislodges and carries the particle away from the wafer. The chemical cleaning action dependents on the nature of chemicals in the PCMP cleaning chemistries, which typically provide a desirable zeta potential environment for efficient removal of particles away from the wafer surface and brush PVA, and also resist any particle redeposition on the surfaces.

Stable tribological behavior of PVA brush-wafer contact-pressure, contact-area, and dynamic-friction could be useful indicators of PCMP cleaning performance and mechanical consistency of PVA over brush lifetime. PCMP cleaning and tribological performance characterization can be important tool in comparing different PVA brush designs in next generation processes. Newly developed polypropylene core molded-through-the-core (MTTC) PVA brush design constitutes a disposable core and provides positive anchoring and absolute adhesion of PVA with the core. This significantly reduces brush initial installation time and eliminates any possibility of slippage of PVA at the PVA-core interface, unlike slip-on-the-core (SOTC) conventional brushes, especially in the latter part of the brush lifetime.

This paper presents information on characterization approaches for the PVA roller brushes. Advantages and limitations of commonly used PVA brush designs in double-sided PVA brush scrubbing processed are discussed with tribological performance consistency and comparative PCMP cleaning performance data from 3rd part evaluations. Accelerated tribological test runs of PVA brushes employing SOTC and MTTC brushes demonstrate unique behavior of wafer-liquid-brush contact–pressure, contact–area, and mean and fluctuating coefficient of friction (COF). Results show that those brushes that experienced the least amount of deformation variability during the extended period PCMP simulation test also exhibited the least amount of variability in their frictional attributes.

The post-CMP cleaning comparative performance of the MTTC design PVA brushes in a Cu/Low-k process was found to be similar or better than the fab POR SOTC design brushes in a 3rd party characterization. This study highlights the importance of PCMP clean brush design (chemically, mechanically, and dimensionally), and the methods of PCMP cleaning and tribological evaluations to ensure consistent wafer cleaning performance, throughout the brush lifetime. These characterizations can be very useful tool in comparing PVA brush designs with different PCMP chemistries for the next generation advanced applications. This study shows the enhanced performance consistency of MTTC design PVA brushes in Cu/low-k PCMP cleaning applications.