Exploring Chemically Activated p-CMP Cleaning for the development of "Low Stress" Processes

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As integrated circuit and logic devices continue to decrease it is imperative to limit induced defectivity during Chemical Mechanical Planarization (CMP) process (polishing and substrate cleaning). Defects resulting from the CMP process can be classified as mechanical (i.e., scratching), chemical (i.e., corrosion), or physiochemical (i.e., adsorbed contaminants) according to the mechanism of formation. Traditionally, a contact cleaning method involving a poly-vinyl alcohol (PVA) brush is used to transfer cleaning chemistry to the substrate of interest as well as provide the necessary mechanical energy for defect removal. While this process is effective in contaminant removal its reliance on shear forces can induce secondary defect modes, such as scratching. The implementation of cleaning processes that balance the modulation of surface reaction kinetics (chemical and adsorption) with advanced low shear force environment are of utmost importance.

This work will focus on the design of p-CMP cleaning processes for emerging materials (SiC, carbon-doped oxides, and metals). These designs will use chemical activity at the substrate interface under "low stress". Furthermore, "low stress" implies reduced mechanical forces to enhance defect mitigation without catalyzing secondary modes of defectivity. For example, by modulating the dynamic redox active environment at the brush/wafer interface, an alternative pathway to control the propagation of secondary corrosion defects can be achieved via an "over-cutting" organic residue removal mechanism. Figure 1 is a comparison of an undercutter and an overcutter to assess the film removal via open circuit potential (OCP) over time. Initial results show that the overcutter effectively removes the surface film residue without inducing further corrosion as seen in the undercutter case post clean.

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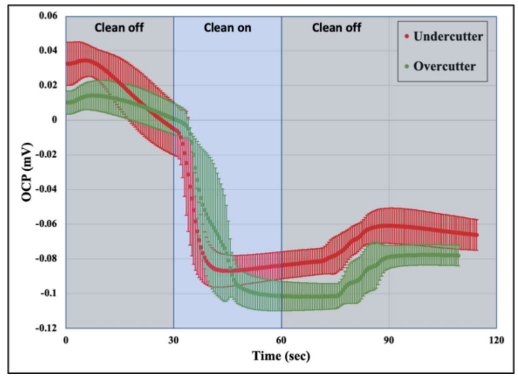

In addition, employing supramolecular cleaning chemistries coupled with reactive oxygen species (ROS) generating complexes under megasonic action were evaluated for effective SiC and STI cleaning. Figure 2 demonstrates the particle removal efficiency depicted by a second order kinetic model. Results indicate that processing conditions (i.e., time and power), "soft" cleaning chemistry structure (i.e., shape and charge), and the generation of ROS all play a critical role in cleaning efficacy under low stress conditions in the megasonic field. Optimal cleaning processes are highly dependent on generation of a chemically active environment via external stimuli.

Figure 1: Time dependent OCP for undercutter and overcutter chemistry.

Figure 2: Particle removal of SiC cleaning using a second order kinetic model.

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