Evaluation of Additives for Enhanced Particle Removal from SiC Under Megasonic Conditions

Mantas M. Miliauskas, Kiana A. Cahue, Adam T. Caridi, and Jason J. Keleher
Lewis University

Wide band gap (WBG) materials (i.e., Silicon Carbide (SiC)) have attracted much attention in the semiconductor arena because of their intrinsic properties (i.e., high capacitance, thermal stability, and wear resistance). In order to achieve the desired removal rate and surface planarity during the Chemical Mechanical Planarization (CMP) process of SiC substrates, high shear force and chemically aggressive conditions are employed. Although effective this process can result in significant surface contamination/defectivity (i.e., organic residue, abrasive particles, etc.) post-polish. Current p-CMP cleaning processes for SiC implement a Polyvinyl Alcohol (PVA) brush scrubbing step coupled with chemistries to enhance defect removal. To effectively remove rouge contaminates without generation of secondary defects it is necessary to explore the interfacial reaction dynamics to design effective adsorptive and redox active cleaning solutions.

This research focuses on the development of a low-stress non-contact post-CMP cleaning process for SiC. More specifically, the use of megasonic energy in the presence of supramolecular assemblies (micellar structures) were employed for a "soft" defect removal process. In Figure 1, contact vs. non-contact cleaning efficiency is compared with DI water and a representative micelle containing formulation. Results indicate the "soft" cleaning additive (i.e., micelle) shows enhanced simulated defect removal under both brush and megasonic conditions. The clear advantage is that under megasonic cleaning the micellar assemblies exhibited considerably lower secondary defect generation on the substrate surface post cleaning (Figure 2). This result indicates the need to reduce the interfacial energy of particle absorption on the SiC substrate.

Corresponding Author:
Jason J. Keleher
Tel: +1 815-836-5978
E-mail: keleheja@lewisu.edu
Lewis University, 1 University Pkwy
Romeoville, IL 60446, USA

Figure 3 shows the initial evaluation of time dependent particle absorption to a slurry chemistry modified SiC substrate. More specifically, there is increased particle absorption to a $KMnO_4$ modified SiC wafer, suggesting stronger abrasive particle/modified substrate attraction under highly oxidative conditions. This result further supports the need for SiC p-CMP cleaning chemistries that disrupt the interfacial adsorption kinetics.

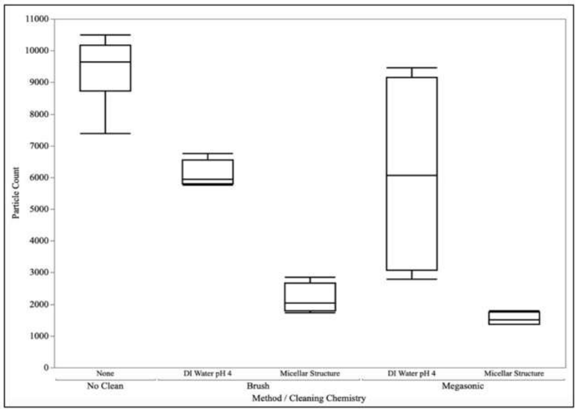

Figure 1: Contact vs. Non-Contact Particle Count

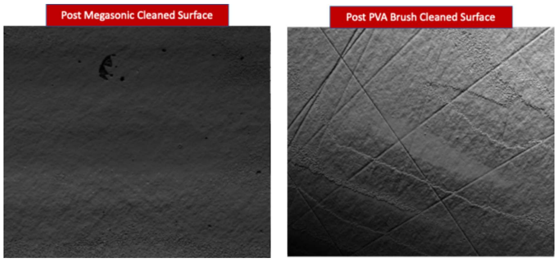

Figure 2: Post Cleaned Surface Images

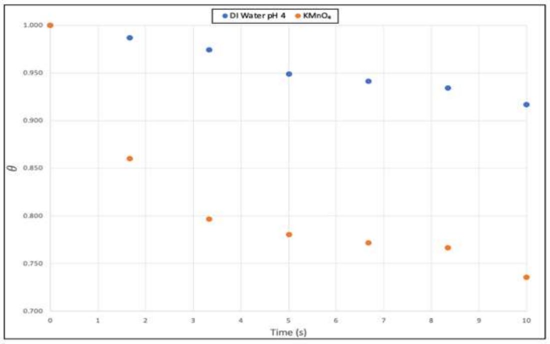

Figure 3: Contact Angle of Modified SiC Surface

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