Lewis University
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Faculty Mentor – Project Application

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Research Project Title: Uncovering the Synergy Between Nanoparticles and Passivation Film Chemistry Relevant to Cu Chemical Mechanical Planarization (CMP) Slurry Formulation

As electronic devices become smaller and faster, their integrated circuits (ICs) must house more copper wiring in smaller spaces. This phenomenon has led to the extension of Moore's Law through chemical mechanical planarization (CMP), a semiconductor fabrication step that achieves angstrom level uniformity. Cu CMP slurries are formulated with abrasive silica (SiO_2) nanoparticles, among other additives, to enhance material removal rate (MRR) by increasing of both chemical and mechanical interactions. In order to control MRR and improve defectivity in low friction, low downforce systems without etching, it is crucial to uncover the dynamics of the coaction between nanoparticles and the passivation film. Common defects that arise from polishing pattern wafers include dishing and erosion, each having catastrophic impacts on device performance. This work investigates how varying the SiO_2 particle properties (i.e. size, charge, and functionalization) impacts the film formation mechanism and removal of two structurally different inhibition films. Specifically, a glycine-based complexing chemistry coupled with either benzotriazole (BTA) or salicylic hydroxamic acid (SHA) was evaluated to determine the correlation between removal rate and the particle/chemistry combinations. These combinations were further studied by assessing wafer defectivity using atomic force microscopy (AFM). Film formation was characterized by measuring the coefficient of friction, open circuit potential (OCP), and contact angle for each slurry formulation. Initial results indicate that, depending on the inhibitor, abrasive properties effect film formation and polishing performance. Therefore, altering the SiO_2 abrasive diameter can optimize the mechanical force and chemical etching to achieve high MRR without promoting further defects.