Determining the Effect of Wafer Geometry and Thermal History on Pressure Distributions on Wafer Surface during CMP

Ara Philipossian[1], Jam Sorooshian[1], Michael Goldstein[2] and Stephen Beaudoin[3]

[1]University of Arizona
Department of Chemical & Environmental Engineering
Tucson, AZ 85721

[2]Intel Corporation
Fab Materials Operation
Santa Clara, CA 95052

[3]Arizona State University
Department of Chemicals & Materials Engineering
Tempe, AZ 85287

The overall objective of this study is to:

- Empirically identify the effect of wafer diameter, bow and thermal history on the extent pressure distributions across the wafer surface during CMP
- Determine if experimental data obtained on 100 mm wafers correlate with 100, 200 & 300 mm von Mises stress simulations across the diameter of the wafer
- Use this information to drive performance-based specifications for silicon, and value-added engineering and design for cost optimization for silicon

This study uses real-time pressure measurement during actual wafer polishing to understand the effect of various wafer properties (see above) on pressure non-uniformity across the wafer. In addition, the effect of wafer-to-ring gap size, as well as wafer pressure, rotation speed, and type of polishing pad will be investigated.

Our research group has developed a method for determining the pressure underneath the wafer under pseudo-dynamic conditions (the method can be easily extended to accommodate dynamic conditions). This technique has been found to be sensitive to the type and concentration of abrasive particles used in slurries. Top and center figures show that under a constant applied load of 6 psi (with all other parameters kept constant), colloidal silica abrasives result in a net higher and more uniform actual pressures across the wafer compared to fumed silica slurries. Additionally, it has been determined that the abrasive concentration in fumed silica slurries has a measurable effect on the pressure across the wafer (Bottom figure).

By taking advantage of this pressure measurement technique, this study aims to understand and eliminate unwanted pressure gradients across the wafer during CMP which occur as a result of wafer geometry or heat treatment.