kSA MOS Ultra-Scan Performance Test Data

Standard 200mm Silicon Wafers

Introduction: kSA MOS Ultra Scan

The kSA MOS Ultra Scan is a flexible, high-resolution scanning curvature and tilt-measurement system. Based on the proven technology of our standard in-situ kSA MOS system, the Ultra Scan uses a laser array to map the two-dimensional curvature and stress of semiconductor wafers, optical mirrors, lenses—practically any polished surface. The standard system provides a 200 mm x,y scanning range with 2 um scanning resolution. Optionally, larger scanning stages (up to 300 mm x,y scanning range with 4 μm resolution) are available. Scans are fully programmable for selected area, line scan, or full area map. The system also provides quantitative film stress analysis with full area map by first scanning the bare substrate and then re-scanning the sample post-process.

Test Conditions:

Data was collected with the kSA MOS Ultra-Scan curvature and stress mapping system from 200mm silicon wafers. Bare wafers were scanned with data provided as outlined under ‘Requirements’ below. Excellent performance and resolution was achieved via patented kSA MOS 2D laser spot array and high resolution x,y stage.

No. of samples: 4
Wafer size: 8-inch
Wafer type: Bare Si substrate

<table>
<thead>
<tr>
<th>Parameter Checked</th>
<th>Description</th>
<th>Wafer</th>
<th>Testing Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scanning resolution</td>
<td>Line scan both at X and Y axes</td>
<td>1</td>
<td>Scanning points as many as possible</td>
</tr>
<tr>
<td>Curvature repeatability</td>
<td>Line scan both at X and Y axes for 10 times</td>
<td>2</td>
<td>No. of scanning points on each line: 24</td>
</tr>
<tr>
<td>Curvature mapping</td>
<td>Scan full area</td>
<td>3 4</td>
<td>Provide the curvature of each point and 2D curvature mapping</td>
</tr>
<tr>
<td>Stress analysis</td>
<td>Wafer Slot 3 as the bare substrate and wafer Slot 4 as the sample post-process, simulate the stress of film</td>
<td>3 4</td>
<td>Provide the stress of each point and 2D stress mapping</td>
</tr>
</tbody>
</table>

Material data
Substrate Modulus: 160 Gpa
Substrate thickness: 750um
Film thickness: 100nm
Poisson ratio: 0.3
Wafer #1: High Resolution Scan Testing (0.01mm = 10µm)

Horizontal Curvature Scan

High Resolution X Scan, Data Zoom-in +/- 1mm Scan Area
High Resolution Y Scan

Sample #1
High Resolution Y Scan

High Resolution Y Scan, Data Zoom-in +/- 1mm Scan Area

Sample #1, Zoom-in +/- 1mm
High Resolution Y Scan
Wafer #2:  Repeatability of 10 Sample Measurements

Horizontal (X) Curvature Scans:

<table>
<thead>
<tr>
<th>Wafer</th>
<th>Average Curvature Scan (1/m)</th>
<th>Standard Deviation of 10 Scans (1 sigma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wafer #2</td>
<td>-2.64 E-04</td>
<td>6.04 E-06</td>
</tr>
</tbody>
</table>
Vertical (Y) Curvature Scans:

<table>
<thead>
<tr>
<th>Wafer</th>
<th>Average Curvature Scan (1/m)</th>
<th>Standard Deviation of 10 Scans (1 sigma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wafer #2 Vertical</td>
<td>1.43 E-03</td>
<td>4.75 E-06</td>
</tr>
</tbody>
</table>
Wafer #3 and #4 Horizontal Curvature Mapping

Note stage support pin locations indicated by localized curvature changes in purple/blue

Wafer #3:

![Graph showing end point horizontal curvature mapping with minimum and maximum values indicated.](image-url)
Wafer #4:
Wafer #4 Horizontal Stress

- Wafer #3 used for pre-process map
- Given 160 GPa substrate modulus (assumed to be Young’s Modulus)
- Calculated Biaxial Modulus as 228.57 GPa
- Sample holding pin positions seen during pre/post scans do not affect stress measurement (subtract out during subtraction of pre- and post-scan curvature data)

<table>
<thead>
<tr>
<th>Wafer</th>
<th>Average Stress (MPa)</th>
<th>Standard Deviation (1 sigma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wafer #4</td>
<td>-11.0</td>
<td>130</td>
</tr>
</tbody>
</table>