TSV Reveal Process Metrology

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TSV Reveal Process

- TSV Etch
  - Etch Depth Metrology

- Flip and Bond Device Wafer to Carrier
  - Adhesive Layer Metrology

- Thin Device Wafer
  - Wafer Thickness, & RST Metrology
Optics – Setup #1

- Camera & measurement sensor are on opposite sides of the wafer
Enhancing Productivity

TSV Layout

Location of WTS Measurement

1 micron

3 micron

5 micron
TSV Etch

- 5 micron Diameter Via Fields
- 25 micron Depth

- 640 Die
- ~ 6 Min for Wafer
Wafer Bonding

Adhesive Thickness Map - 20 micron nominal
Optical Setup #1 Requires turning the wafer upside down
Typical Layer Cross Section

- Product Wafer
- Pattern
- Adhesive
- Carrier Wafer
Optics – Setup #2

- Common Objective
- Single Side of Wafer
  - No Open Chuck
- Solves Multiple Applications
  - Etch Depth
  - Wafer Thickness
  - Remaining Silicon Thickness (RST)
- Eliminates Critical Alignment of WTS and Camera
Wafers of Different Thickness

Full Thickness wafer – 760 Microns

Thinned Wafer – 55 Microns
SEMATECH Study

- 22 Wafers
  - 6 with TSV Etch
    - Etch time = 2 @ POR – 20%, 2 @ POR, 2 @ POR +20%
  - 2 TSV etch + bonding
  - 14 TSV etch + bonding + course/fine grind + CMP
- Measure: Wafer thickness, etch depth, RST
- Manually loaded, automatic alignment and measurements
Alignment Fiducial
- POR – 20%
- Depth = 45.5 - 48
TSV Etch

- POR
- Depth = 38.5 - 41
TSV Etch

- POR + 20%
- Depth = 52.5 – 55.5
TSV Etch Depth Summary

- POR – 20% 45.5 – 48 microns
- POR 38.5 – 41 microns
- POR + 20% 52.5 – 55.5 microns

- Something looks funny here!

- POR – 20%
  - Last recipe run
  - Clearly a process excursion
  - Isn’t that the whole point!
Bonded & Not Thinned

- Full Thickness Wafer
- Large RST

Patent Pending
Bonded & Not Thinned

- 42 Locations
- 3 Scans per location
- 1 Second per scan
- ~3.5 Minutes per wafer
  - M&M, Alignment

- Wafer = ~774 microns
- TSV Depth = ~48 to 51 microns
- RST = ~723 to 725 microns

Patent Pending
Bonded & Thinned Wafer

- Thinned Wafer
- Small RST

Patent Pending
Bonded & Thinned

- 42 Locations
- 3 Scans per location
- 1 Second per scan
- ~3.5 Minutes per wafer
  - M&M, Alignment

- Wafer = ~54 to 56 microns
- TSV Depth = ~49 to 52 microns
- RST = ~5 to 6 microns
## Repeatability

- 42 Locations
- 5 micron diameter
- ~3.5 minutes per wafer

<table>
<thead>
<tr>
<th>Wafer Thickness</th>
<th>RST</th>
<th>TSV Depth</th>
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</thead>
<tbody>
<tr>
<td>STD</td>
<td>0.007</td>
<td>0.043</td>
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<tr>
<td>3 STD</td>
<td>0.022</td>
<td>0.13</td>
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</table>

Units: microns

**Patent Pending**
**Full Wafer Map**

- Wafer = ~54 to 56 microns
- TSV Depth = ~49 to 52 microns
- RST = ~5 to 6 microns

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**Map View**

- 400 Locations
- 3 Scans per location
- 1 Second per scan
- ~30 Minutes per wafer
  - M&M, Alignment

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**3D View**

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**Patent Pending**
Conclusions

- Different configurations with sensors on top and bottom of sample can solve various application requirements

- IR scope coupled with WTS:
  - Uses common objective
  - Single-sided measurements
  - Etch Depth, Wafer Thickness & RST
  - Determine variation across wafer:
    - Etch Depth
    - RST
    - TTV after grind

  - Common Objective
  - Single Side of Wafer
    - No Open Chuck

  - Solves Multiple Applications
    - Etch Depth
    - Wafer Thickness
    - Remaining Silicon Thickness (RST)

  - Eliminates Critical Alignment of WTS and Camera
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Thank You For Your Time

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