Multi Sensor 3DIC Metrology

DAETEC and FRT - Fries Research & Technology – Booth 2532
FRT MicroProf®
Wafer Metrology Tools

MicroProf® 300
Multi Sensor metrology tool with 300 mm stage and optional housing

FRT MFE - Metrology for Frontend
Fully automated Multi Sensor metrology tool with 300 mm stage, bridge tool, class 1 EFEM, SECS/GEM interface

MicroProf® 300 TTV MHU
Multi Sensor metrology tool with 300 mm stage, sensor setup for wafer thickness measurement (TTV), fully automated
FRT MicroProf®
Semi Automated Metrology Tools

- substrates measured on the MicroProf®
- established metrology tool
- easy to use, highly reliable
- 2D profile and 3D raster scan measurements
- variable scan area selection
- chromatic white light sensors
- IR and film thickness sensors
- TSV depth measurements
FRT MicroProf® TTV
Semi And Fully Automated Wafer Metrology Tools

- full thickness, thinned and bonded wafers
- 2D profile and 3D mapping measurements
- additional IR and film thickness sensors
- thickness, TTV, bow and warp
- cassette to cassette
- pre-aligner
- SECS/GEM interface
FRT MicroProf® TTV
Measurements According to Semi Standards

- fully Semi compliant
- sawn, ground, polished wafers
- material independent (Si, sapphire, glass,..)
- recipe driven Semi compliant software

<table>
<thead>
<tr>
<th>Value</th>
<th>MF1390</th>
<th>MF657</th>
<th>MF534</th>
<th>MF1530</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>2-probe</td>
<td>2-probe</td>
<td>1-probe</td>
<td>2-probe</td>
</tr>
<tr>
<td>Flip wafer</td>
<td>Yes, wafer inversion method</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Fixture</td>
<td>By mutual agreement</td>
<td>3-point reference plane</td>
<td>3-point</td>
<td>By mutual agreement</td>
</tr>
</tbody>
</table>

Overview over relevant Semi standards
FRT MicroProf® TTV
Measuring Parameters

Profile:
- Wafer Thickness
- Center Thickness
- Wafer TTV
- Bow BF
- Wafer Warp
- Sori
- TIR
- TIR95
- Sag X
- Sag Y
- Profile Warp
- Profile Sori
- NTD
- NTV
- Profile
- Profile TTV
- TV5 / TV9
- 3D map

Roughness:
- Ra
- Rmax
- Rz
- Rp
- Rt
- Rv
- Rq
- Wt

3D Map:
- Thickness
- Center Thickness
- Wafer TTV
- Bow BF
- Wafer Warp
- Sori
- TIR
- TIR95
- GBID
- GF3D
- GF3R
- NTV
- NTD
- Sag X
- Sag Y
- SBID
- SF3D
- SF3R
- SFLD
- SFQR
- Wafer FPD
FRT MicroProf®
FRT IR Thickness Sensor Technology

- high spectral resolution
- large measurement range
- no moving parts, fast
- maintenance free

- thinned device wafer thickness
- adhesive thickness
- total thickness

FRT CWL IR - Infrared Film Thickness Sensor

<table>
<thead>
<tr>
<th>Model</th>
<th>IR 50</th>
<th>IR 250</th>
<th>IR 500</th>
<th>IR 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range film thickness</td>
<td>4 – 200 µm</td>
<td>28 – 1100 µm</td>
<td>34 – 1900 µm</td>
<td>60 – 3500 µm</td>
</tr>
<tr>
<td>Working distance</td>
<td>39.7 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resolution film thickness</td>
<td>15 nm</td>
<td>75 nm</td>
<td>130 nm</td>
<td>240 nm</td>
</tr>
<tr>
<td>Resolution x,y</td>
<td>25 µm</td>
<td>4.5 µm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numerical aperture</td>
<td>0.09</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring angle</td>
<td>90° ± 5°</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring rate</td>
<td>4,000 measurements / sec. (4 kHz)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light source</td>
<td>Halogen lamp</td>
<td>IR superluminescence diode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeatability</td>
<td>&lt; 0.0002 x measuring range</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>+ 5°C to + 50°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensions (W x H x D)</td>
<td>260 mm x 115 mm x 310 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) At refractive index n=1

**Notes**

- Measuring head, optical fiber, sensor electronics, operating manual

---

**Film**

- Measuring head
- I₀, I₁, I₂
- Thickness d, refractive index n

---

**the art of metrology™**
FRT MicroProf®
IR Wafer Thickness Measurement
FRT MicroProf®
TSV Measurements
FRT MicroProf®

TSV Measurements

Φ = 15 mm, depth = 50 mm

Φ = 5 mm, depth = 50 mm

Pixel size = 1.5 mm x 1.5 mm
Interposer Initial Bow/Warp

- Bow, measured by optical profilometry.
- Beginning bow varies from 100-120um.
- Convex from top point of view.
- Must reduce bow to <40um to allow subsequent chip bond operations
Baseline Interposer Review

- Substrate ~100um thickness
- Underlying bumps ~100um height

Top side

Bottom side (contains solder bumps)
Process (Coating)

1. Substrate w/Topography Flat Support
2. Application Coverage
3. Cure to Planarize
4. Apply/Cure to Carrier
5. Apply to Substrate Bond to Carrier
6. Cure to Mount

Recyclable porous substrate
Post-Bonding Process

7 Customer Process

Bonded interposer, attach chips to interposer, Reflow 250-300C

8 Debond & Cleans

Debond and Cleans rinse, dry
Recycle carrier

9 Acquire Final Product
Adhesive Planarization

No adhesive

Adhesive

~75% Bump height
Planarization and Thermal Reflow
Peripheral Bond

- The adhesive is applied on the edges of the carrier – known as *peripheral bond*
- Thin substrate is bonded onto carrier
- Adhesive is cured
Description of Adhesive

Top View
Film Adhesive

Horizontal View
Film Adhesive

Side View
Peripheral Bond
Porous Carrier

Porosity higher for inside material (A). Outer coating (B) is lower porosity.

A = 0.5 – 0.8mm  
B = 0.1 - 0.25mm  
C = 0.5 – 1mm
Baseline ITP – Adhesive Bond
Bonded ITP – Bow Reduction
Post Processing - Cleans

- Debond & cleans all occurred <15min, batch
- Cleans chemistry varied with adhesive, solvent to detergent
- Silicone film – solvent cleans
- High temp acrylic – detergent cleans
DAETEC provides development, consulting, and technical training/support to solve manufacturing problems and introduce new options of doing business.

Diversified Applications Engineering Technologies (DAETEC)
Camarillo, CA (USA) (805) 484-5546
jmoore@daetec.com; www.DAETEC.com