Pico-Second Laser and Broad Argon Beam Tools For Characterization Of Advanced Packages And Devices

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Where Did this Product Come From?

Joint effort between Gatan-3D-Micromac and Fraunhofer-Halle

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http://3d-micromac.com
Overview

Picosecond laser ablation sample preparation tool to rapidly remove material for electron and x-ray microscopy. Complements or replaces mechanical, focused and broad ion beam (FIB and BIB) tools.

- Table top system that operates with compressed air
- Cross section packages as large as 110 x 110 x 4 mm
- Simple interface to adjust laser power level
- Diode pumped solid state laser (Wave length: 532 nm)
Large Area and Volume Capabilities

Box cuts
- Excavate large volumes
  3.0 x 0.3 x 0.3 mm (L x W x D) in <25 min

Line cuts
- Cross-section large samples
  25 x 1.5 mm (L x D) in 15 – 25 min
Quickly Trench Large Areas – Silicon with TSV’s

<table>
<thead>
<tr>
<th>Sample</th>
<th>Size (mm)</th>
<th>microPREP (actual)</th>
<th>Ga FIB (calc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#70</td>
<td>0.3 x 0.3 x 0.3</td>
<td>3 min, 40 s</td>
<td>17.5 days</td>
</tr>
<tr>
<td>#69</td>
<td>3.0 x 0.3 x 0.3</td>
<td>23 min, 40 s</td>
<td>0.5 years</td>
</tr>
</tbody>
</table>
Post microPREP + Ga FIB
Solutions for Dissecting Advanced Packages

- Deliver near perfect surface for high-resolution, analytical analysis for root cause determination
- Cross-section stacked devices and advanced packages
- Prepare large ROI within minutes
Workflow for Sectioning Stacked Chips

- **microPREP**
  - Slice entirely through package
  - Time = 15 min

- **Ilion II**
  - Cross-section polish
  - Time = 1 h
Cross-Section Stacked Chip

- Cut through large, 4-layer stack (9 x 1.1 mm (L x D)) within 15 min

Top view of multi-layer device

X-ray image of ROI

Sample courtesy of Chipworks
High-Resolution Image – 4-Chip Stack
Visualize Large Features – TSV
Workflow for Sectioning Ball Bonds and Package

- **microPREP**
  - Slice entirely through package
  - Time = 7 min

- **Ilion II**
  - Cross-section polish
  - Time = 1 h
Cross-Section Ball Bonds

- Cut through three ball bonds plus complete silicon device and package (11 x 0.5 mm (L x D)) within 7 min
- Post Ilion II polish within 1 h
microPREP (7 min) + Ilion II (1 hr) result ROI 16 times larger than P-FIB

Cross-section of a solder ball with a diameter of 400 μm completed in 4 hr using Xe Plasma FIB and Rocking Stage for a curtaining-free surface.

Comparison microPREP + Ilion vs. Plasma FIB
High-Resolution Detail at the Interface

- Kirkendall voids indicate defect formation caused by different diffusion rates
- Presence of intermetallic compounds may point toward wire bond failures in device
EBSD MAPS of Ball Bond
EBSD of Ball Bond/UBM Interface
Transistors Below the Ball Bond/UBM Layer
Workflow for Sectioning Home Button

- MicroPREP
  - Slice entirely through package
  - Time = 45 min

- Ilion II
  - Cross-section polish
  - Time = 1 h
Cross-Section Home Button in 45 min

- Shows initial cross-section made by the microPREP
- Follow-up with broad ion beam tool to polish
Overview of Home Button
Post Ilion Polish

Home button post laser ablation and broad ion beam polishing
Summary

Solutions for Dissecting Advanced Packages

- Deliver near perfect surface for high-resolution, analytical analysis for root cause determination
- Cross-section stacked devices and advanced packages
- Prepare large ROI within minutes

*microPREP opens opportunities to expand the size, volume and speed of preparing samples for*

- XRM samples
- Atom probe tips
- High volume TEM prep
Thank You