MicroForce™ Probing for Devices with Low-k ILD Materials

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Industry Requirements for Probing Advanced Flip Chip Bumped Devices

- **Lower Force Probing**
  - Low-k ILD materials are more fragile
  - Low probe force desired to minimize damage to flip chip bump and ILD materials

- **Low and Consistent Contact Resistance**
  - High frequency and high power applications require tighter Cres control
  - Applications require higher current to pass through probe system without much resistance

- **Finer Pitch**
  - Roadmap to 100µm pitch requires revolutionary probing approach
FormFactor BladeRunner™ Probe Cards
(For Probing Bumped Wafers)
FormFactor Probe Card Architecture

Controlled Impedance Tester Interface
PCB Assembly

Interposer With MicroSpring Contact

Space Transformer

MicroSpring™ Contact for Probing Flip Chip Bumps
**MicroForce™ Probing Definition**

- What is MicroForce™ probing?
  - It is a coordinated X-Y-Z probing motion
  - Developed to satisfy a number of stringent requirements for probing devices with low-k ILD materials
  - Breakthrough results with 10:1 reduction of probe force yet achieving consistent and low contact resistance

1. Prober Chuck Moves in Z-axis
2. Contact with Flip Chip Bump
3. Chuck moves in X-Y-Z

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MicroForce™ Probing on Pb/Sn Bump

MicroForce™ Probing Motion

Chuck Translation Direction

MicroSpring™ Contact
Probing on
High-Pb Bump
FormFactor Laboratory Development
**TEL Synchronous XYZ Drive**

3D drive control method

(Synchronous 3D Drive)

HOST → Servo Driver → Target Position

Control Position Data

HOST → Stepping Driver → Target Position

XYZ Motion Contact

Servo Driver

Stepping Driver

M M M

M

1Drive

Start T_s Time

Simultaneous XYZ Drive

**Benefits**

- Increased throughput with simultaneous XYZ drive
- Smooth drive creates desired probe contact
Experimental Setup - Predictive Probing

**Force/Displacement**

**Fixture**

**Force**
**Displacement**

**Data**
**Acquisition**

**Test Wafer**

**Micro-ohmmeter**
**(4-wire)**

**Test Spring**
Significantly Lowered Probe Force with MicroForce Feature

Scrub Ratio = Movement in X/Y
Movement in Z
Repeatability of Cres Study on Pb/Sn Bumps

Stable and Low Contact Resistance with MicroForce Probing
Definition
PCMS is a measurement system that can measure the probe card displacement under load. The result of PCMS includes the displacement of head plate, probe card and probe card holder.
Low Probing Force Using MicroForce Feature

• Used TEL’s PCMS to evaluate probe card deflection under varying loads. Data generated included actual spring compression and probing force per dialed chuck motion.

• Max probing force = 13N at 80µm of spring over-travel

• Max force/probe = 0.3g/mil with MicroForce vs. 3 – 4g/mil without MicroForce
Probing of Microprocessor Devices

- Testing
  - Sort tests were run with and without MicroForce probing
  - Correlation of device binning and other parametric indicators measured
  - 3 production lots of microprocessor devices were tested

- Results
  - Binning data collected under MicroForce had a correlation rate of 95.9 – 97.4% vs. existing probing Recipe (target is >95%)
  - Other parametric measurements indicated comparable results
  - No issues in terms of the mechanical and electrical behavior of the springs under MicroForce Probing. Metrology data remained within the defined specifications.
Probe Mark Comparison

Pb/Sn Bump

Standard Probing

MicroForce Probing
Validation of MicroForce Low Cres

- Good convergence of Cres
- Mean Cres at different programmable overtravels: 0.1 – 0.35Ω
- Enabling a wide manufacturing process window

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MicroSpring Contact After Aging Test

After 500,000 Touchdowns

New (after probing 6 wafers)
Cres Stability After Aging Test

Conclusions

- MicroForce Technology provided new capabilities to meet new-generation probing requirements.

- MicroForce Probing offered low contact resistance necessary for high power delivery requirements.

- MicroForce Probing delivered very low probing force (<2g) thus minimizing the risk to damage die with low-k ILD materials.

- Sort on production devices proved very stable and correlated to existing probing recipes. The solution satisfies Intel probing requirements.

- Future work will be targeted at:
  - Throughput Optimization
  - Production Sort Certification
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