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East Meets West

"WLP Probing Technology Opportunity and Challenge"
Clark Liu - PowerTech Technology Inc.

"Pushing the Envelope in DFM (Design for Manufacturing) for 0.2mm Pitch WLCSP Socket"
Colin Koh - Test Tooling Solutions Group

"Signal Integrity & Impacts by Connector Structures"
Jiachun (Frank) Zhou - Smiths Connectors

"LPDDR4 Signal & Power Performance Optimization By Hardware"
Yuanjun Shi - TwinSolution Technology
WLP Probing Technology
Opportunity and Challenge

Clark Liu
Powertech Technology Inc.

2015 BiTS Workshop
Shanghai
October 21, 2015
Probing at 2Gb Wide I/O Bump Pad

Source: 2011 IEEE Samsung

WLP Probing Technology Opportunity and Challenge
More for WLP Probing Technology!

2012 SWTW ASE_SV 50um Pitch Array  2014 SWTW FFI 80um Pitch CPB

WLP Probing Technology Opportunity and Challenge
Wafer-level-packages have emerged in many different varieties that can be categorized into different advanced packaging technology platforms.

*Source: 2013 SEMICON Taiwan _ Yole*
WLP Key Connection Technology

Wafer Level Package

- Bump
- RDL
- CPB
- TSV
- Probing
Electrical Fault Model for WLP Connectivity

Source: 2010 IEEE 3D IC Workshop _TSMC
### Fault Model for different test items

<table>
<thead>
<tr>
<th>Test Item</th>
<th>Misalignment</th>
<th>Abnormal Cu pillar</th>
<th>Impurity</th>
<th>Substrate</th>
<th>micro-bump</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type 1</td>
<td>Type 2</td>
<td>Type 3</td>
<td>Type 4</td>
<td>Type 5</td>
</tr>
<tr>
<td>Continuity test</td>
<td>V</td>
<td>V</td>
<td>*V</td>
<td>V</td>
<td>*V</td>
</tr>
<tr>
<td>Resistance test</td>
<td>*V</td>
<td>V</td>
<td>*V</td>
<td>V</td>
<td>*V</td>
</tr>
<tr>
<td>Capacitance test</td>
<td>*V</td>
<td>V</td>
<td>*V</td>
<td>V</td>
<td>*V</td>
</tr>
<tr>
<td>Leakage test</td>
<td>*V</td>
<td>V</td>
<td>*V</td>
<td>V</td>
<td>*V</td>
</tr>
<tr>
<td>AC test</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
</tbody>
</table>

* means need high resolution measurement tool/method

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**WLP Probing Technology Opportunity and Challenge**

- **Supplier A**
- **Supplier B**
- **Supplier A or C**
- **Supplier B or C**

---

**WLP Probing**

[Diagram showing WLP Probing process and supplier connections]
Opportunity?

Challenge?

Cost?

Technology?

New Model?

Cooperation?

Source: NTHU

WLP Probing Technology Opportunity and Challenge
Case 1: Tools Short Delivery Cycle Time?

- Design Type Out
- Wafer Process
- Wafer Test

4~10 Weeks

MP card

WLP Probing Technology Opportunity and Challenge
[Ex] WLCSP 256DUT Probe card

- Device: WLCSP
  - a. Diameter: 300um
  - b. Height: 180um ± 10%
  - c. Pitch: 500um
  - d. TD : 10
  - f. Total Pin Count 2560 Pins

Delivery Time : 8 Weeks
Case 2: Process Change for more Chip Probing?

Existing Process

Wafer Process

Wafer Test

Assembly

Final Test

Process X

Wafer Process

Wafer Test (KGD)

WLP

WLP Test

Assembly

Process Y

Wafer Process

WLP

WLP Test (KGD)

Assembly
More WLP Test or More Final Test?

WLP Test

- Fine Pitch
- Contact Force
- Silicon Base

Final Test

- Pitch Limit
- Clean/10K Cleanness
- Package Base

Pictures Source: Mitsubishi

WLP Probing Technology Opportunity and Challenge
**Wafer Test or Final Test Vendor @ WLP Testing?**

- Wafer Test Vendor
- Final Test Vendor

- Cycle Time Challenge
- Cost Challenge
- New Process Challenge
- Cooperation Model Challenge
- Wafer Level Business and Quality Requirement

*Source: Mitsubishi*

WLP Probing Technology Opportunity and Challenge
WLCSP / CPB Probe Card Roadmap

Source: SWTW

WLP Probing Technology Opportunity and Challenge
Bump _ CPB Process & Probing Roadmap

Mature Production

400um 200um 100um

WLP Probing

Electrical Performance
Mechanical Performance
Production Performance

R&D ?

Source: SWTW
WLP Probing Technology Opportunity and Challenge
uBump for 25µm Probing Challenges

Case 2: 40 µm pitch direct µbump probing
IMEC – Technoprobe - TEL

- Imec’s Blanket Micro-Bump (BMB) Design
  - Includes JEDEC WIO2 foot-print (40 µm pitch)
  - Micro-bumps: 25 µm Cu and 15 µm Cu/Ni/Sn

- Technoprobe’s Probe Technology
  - FT1.0 vertical needles, micro-wired space transformer
  - Probe card with single-bank WIO2

- Test Equipment @ imec
  - TEL P-12XLM automatic probe station
  - Agilent 4073 parametric tester

- Evaluation Criteria
  - Contact resistance (C_RES)
  - Probe marks

Source: SWTW 2015 IMEC/Technoprobe/ITS
WLP Probing Technology Opportunity and Challenge
HBM for 25um Probing Challenges

HBM Stack Probing
- Bottom of SoC device in the stack provides test pads in the field of Micro bumps

Probing challenges
- Challenges:
  - Probe without damaging Micro Bumps
  - No issue with FormFactor MicroSpring®

Source: SWTW 2015 FFI
WLP Probing Technology Opportunity and Challenge
CPB for 50um Probing Challenges

Evaluation result by using wire type

Process change for cost reduction

Source: SWTW 2015  Samsung
[Ex] Mechanical Performance:
Probe Force v.s Over Drive @ WLP Probing

- Probe Force Depend on Material
- Over Drive Depend on Material
- Electrical All Pass Point
- Low Force Keep No Damage
- Ideal Pad Probing Curve
- Low Force Probing Curve
- Over Drive Depend on Material
Case 3: Probe mark analysis Technology

AOI Probe Mark Analysis Challenge

- Probing Position / Depth / Sharp
- Different Layer
- User Expect Data

Bump

AOI Probe mark Analysis

RDL

OD / Force / Probe area / Bump Height

CPB

WLP Probing Technology Opportunity and Challenge

Data Mining:
(1) Prober Performance
(2) Probe card Performance
[Keep Under Development]
Case 4: Business or Process Change?

- Chip Design
- Wafer Process
- WL Test
- A.P
- Final Test

- Customer
- Foundry
- OSAT

WLP Probing Technology Opportunity and Challenge
### SCM: Same Issue but different site?

- Customer
- Foundry A
- Foundry B
- Foundry C
- ATE Vender
- Prober Vender A
- Prober Vender B
- Probe card Vender A
- Probe card Vender B
- OSAT A
- OSAT B
- OSAT C

**Gap**

**Cooperation**
- AOI Vender
- Clean Vender

**WLP Probing Technology Opportunity and Challenge**

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October 21, 2015
Conclusion

- Cooperation from Customer to Equipment Supplier (Design House /Foundry/OSAT/Vender).
- New opportunity for Wafer/Final Test I/F Suppliers.
- The Evolution Business Model will start changing.

Source: Google/Lexus