Fine Pitch
P4 Probe Cards

Photolithographic Pattern Plating Process

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MITSUBISHI MATERIALS CORPORATION Sanda Plant

June 1998
Contents

- What is a P4 probe card?
- Specification
- Some test results
- Tip cleaning
- RF performance
# SANDA PLANT SUMMARY

<table>
<thead>
<tr>
<th>Employees</th>
<th>311</th>
<th>(As of Feb. 1st 1998)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Area</td>
<td>33,000m²</td>
<td></td>
</tr>
</tbody>
</table>

## Products

- **Probe Cards**
- Gold Bonding Wire
- Sputtering Targets
- Precious Metal
- Fine Rolled Materials
- Precious Metals Clay
- Ornament Materials
Picture of P4 Flex and P4 Probe Card

P4 Flex

P4 Probe Card

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P4 Probe Card Properties

(Photolithographic Pattern Plating Process)

1. Ni Alloy probe by Plating Process
2. For Fine Pitch (<50 micron Min. 40 micron) and High Pin Counts (>1000 pins)
3. Scrub Contact
4. Impedance Matching by Microstrip Structure
5. High RF Performance
6. Easy Maintenance

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## Properties of Each Probe Material

<table>
<thead>
<tr>
<th>Property</th>
<th>Ni</th>
<th>W</th>
<th>Cu-Be(C17200)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Resistance</td>
<td>6.844</td>
<td>5.4</td>
<td>9.85</td>
</tr>
<tr>
<td>(µ Ω * cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Conductivity</td>
<td>88</td>
<td>167</td>
<td>84</td>
</tr>
<tr>
<td>(W m * k)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific Heat</td>
<td>435</td>
<td>134</td>
<td>419</td>
</tr>
<tr>
<td>(J/Kg * K)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>8.9</td>
<td>19.3</td>
<td>8.25</td>
</tr>
<tr>
<td>(g / cm³)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young Modulus</td>
<td>2.05</td>
<td>4.03</td>
<td>1.27</td>
</tr>
<tr>
<td>(×10¹¹ Pa)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poisson’s Ratio</td>
<td>0.3</td>
<td>0.284</td>
<td>0.345</td>
</tr>
<tr>
<td>Heat Expansion Coefficient</td>
<td>13.3</td>
<td>4.5</td>
<td>17</td>
</tr>
<tr>
<td>(10⁻⁶ / K)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardness</td>
<td>280-350</td>
<td>550-700</td>
<td>250-400</td>
</tr>
</tbody>
</table>
What are some of the difficulties to achieve a pitch of 45 microns?

- Manufacturing
- Alignment
- Contact Force
Mechanical Structure of a P4 Probe Card

- Mounting Base
- Leaf Spring
- Top Clamp
- Bottom Clamp
- Flex (Contact Quadrant)
- TIP

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Assembly Drawing of a 3 Layer Flex

CONTACT LAYER
(Pattern Plated)
Ni Alloy

GROUND LAYER
WITH DIELECTRIC
(Print and Etch)
Cu

POWER LAYER
WITH DIELECTRIC
(Print and Etch)
Cu / Ni + Au

LAMINATED
CONTACT SET

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Example Shape of a P4 probe Tip

- 0.0115 mm R
- 0.023 mm
- 0.05 mm
- 0.15 mm
- 0.10 mm
SEM Photograph of P4 Tips

Top View

Contact Side

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Applications for P4 Probe Cards

• P4 is available for:
  Fine Pitch LOGIC
  Fine Pitch LDI (LCD Driver IC)
  For Al Pads, Au Bumps

• P4 started on
  Multi Chip Memory
  Area Bump (Solder Bumps)

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Sanda Plant
Standard Specifications of P4 Probe Cards

• Mechanical Properties
  1) Overdrive : 50 - 100 micron (2.0-4.0mil)  
     (Max. 150 micron (6.0mil))
  2) Scrub Length : 20 - 25 micron (0.8-1.0 mil)
  3) Flex Precision : +/- 5 micron (0.2mil)
  4) XY Position : +/- 10 micron (0.4mil)
  5) Z Position : < 20 micron (0.8mil)
  6) Distance between Tip and PCB : >3.0mm (0.12inch)
  7) Thickness of PC : PCB Thickness +15mm(0.6 inch)

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Standard Specifications of P4 Probe Cards-2

Electrical Properties

1) Contact Resistance : < 0.5 Ohm
   (Circuit Resistance Not Included)

2) Isolated Resistance : > 100M Ohm

3) Maximum Current : 250 mA
   (100 micron pitch, 20sec.)

4) High Frequency : 50 Ohm Impedance Matching
   by Microstrip Structure

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The Scrub Marks on Al Pad

- Overdrive 100 micron
- Probe Angle 20°

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The Scrub Marks on Au Pad (45 micron pitch probe)

- Overdrive 100 micron
- Probe Angle 20°
The Scrub Mark on Solder Bump (65 micron pitch probe)  
(Sn:63% ; Pb37%)

- Overdrive  100 micron
- Probe Angle  20°
The Relationship between Force and Overdrive

- Probe Pitch: 45 micron

For Al Pad

For Au Pad
The Relationship between Contact Resistance and Overdrive

- Probe Pitch: 65 micron

- Pb-Sn
- Al
- Au
Tip and Scrub Mark after Contact Test to Au

OD : 100 Micron
Pitch : 45 Micron
Probe Angle : 15 degree
Temp. : 125C

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Sanda Plant
The Variation of Contact Resistance (Au)

<table>
<thead>
<tr>
<th>Touch Down</th>
<th>MAX</th>
<th>MIN</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

Left Side Flex: Measured 10 pins

MITSUBISHI MATERIALS CORPORATION      Sanda Plant
<table>
<thead>
<tr>
<th>Tip and Scrub Mark after Contact Test to Al</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TIP</strong></td>
</tr>
<tr>
<td><strong>SCRUB MARK</strong></td>
</tr>
<tr>
<td>1000</td>
</tr>
<tr>
<td>10,000</td>
</tr>
<tr>
<td>100,000</td>
</tr>
<tr>
<td>500,000</td>
</tr>
<tr>
<td>1,000,000</td>
</tr>
</tbody>
</table>

**Specifications:**
- OD: 100 Micron
- Probe Angle: 20 degree
- Temp: 125C
- Pitch: 100 Micron

**Mitsubishi Materials Corporation**  Sanda Plant
The Variation of Contact Resistance (Al)

The graph shows the variation of contact resistance over different touch down values. The data is represented for the Sanda Plant with measurements of 10 pins. The graph indicates that cleaning is required for the contact resistance values exceeding a certain threshold at high touch down values.

**Touch Down**

Left Side Flex: Measured 10 pins

**MITSUBISHI MATERIALS CORPORATION** Sanda Plant
Evaluation Results of Fine Pitch P4 by Customer

• Probe Card
  Pitch : 45 micron
  Pin Counts : Around 500
  Pad materials : Au Bump

• Contact condition
  100,000 (at room temp.) + 30,000 (at 90 C)

• Results
  XYZ position : No problem (too small to measure)
  Contact Resistance : No problem (without any cleaning)
Tip Cleaning for P4

25 micron

Before Cleaning  After Cleaning  Sticking Tape

Same Pin

After Cleaning

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TDR Results of P4 Flex

1, 2. Probing Point

3. Contact Point
   (PCB and P4 Flex)

4. Max. Point in P4 Flex

5. Min. Point in P4 Flex

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TDR Results of 100 micron Trace Width P4 Flex

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Example of Band Width Result of P4 Flex Sanda Plant

Band Width Results of 100 micron Trace Width Flex

Transmission

dB

10MHz 4.23GHz 8.4GHz

Band Width Results of 100 micron Trace Width Flex

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End of Presentation

• P4 Probe Cards are developed jointly between Cerprobe Corporation and Mitsubishi Materials Corporation.

• P4 Probe Cards are available in Japan from Mitsubishi Materials Corporation through Innotech Corporation (Sales)

• P4 Probe Cards are available elsewhere from Cerprobe Corporation