Fine Pitch Micro Probe Tips
using Thin Film Amorphous Alloy
under the Micromachining Fabrication Technology

Koichi Wada, Hidenori Kitazume, Wataru Narazaki, 
Masaru Miyazaki, Takehisa Takoshima, Yasuhiro Maeda, 
Seiichi Hata*, Akira Shimokohbe*

Advantest Laboratories Ltd. 
*Precision and Intelligence Laboratories, 
Tokyo Institute of Technology

2001/6/6
Contents

1. Background
2. Materials
3. Probe Card Structure
4. Fabrication Process
5. Results
6. Conclusion
1. Background

The progress of LSI Manufacturing

- **Shrink**
  - Pad pitch is also becoming fine (100um order)

- **High frequency**
  - Performance is GHz order

---

2001/6/6  Advantest Laboratories Ltd.
1. Background

**The necessity of micro probe tips**

<table>
<thead>
<tr>
<th>Adjusting to fine pad pitch</th>
<th>High frequency transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>The width of probe tips will be under 100um.</td>
<td>The length of probe tips will be much less than a quarter of wave length.</td>
</tr>
</tbody>
</table>
1. Background

How to fabricate micro probe tips?

1. Under the micromachining fabrication technology

   Micro 3D structure can be realized.

2. Using a kind of amorphous alloys as material

   Amorphous alloys are strong even in micro scale (in the shape of thin film, for example) because of no grain boundary.
2. Materials

Thin film amorphous alloy

The features of amorphous alloys:

- Hardness
- Mechanical strength
- Small Reactivity to chemicals
- No grain boundary
- etc…
2. Materials

Thin film metallic glass (TFMG)

Metallic glass is a kind of amorphous alloys

Amorphous alloys

Metallic glasses

Pd-based metallic glass
The features of metallic glasses:

In addition to ones of amorphous alloys...

Wide supercooled liquid region

Temperature

2001/6/6 Advantest Laboratories Ltd.
2. Materials

DSC curve of the Pd-based TFMG:

\[ T_g = 630 \text{K} \]

\[ T_x = 661 \text{K} \]

Exothermic

2001/6/6

Advantest Laboratories Ltd.
The preparation of TFMGs

• Deposition:
  
  DC-magnetron sputtering with an alloy target.

• 3D-deformation:
  
  Heating up to the supercooled liquid region and applying force.
3. Probe Card Structure

Key Technologies:

• Process under the micromachining fabrication technology on Si substrate

• Pd-based TFMG as material

• Process on Si substrate, and bonding directly on another substrate with transmission lines (e.g. micro-strip lines, coplanar lines)
A series of Tips

Substrate

Tip
3. Probe Card Structure

Cross section of a tip

- Transmission line
- Substrate
- Bump
- Tip
4. Fabrication Process

Process flow:

1. Etching micro mesa on Si surface
2. Deposition of cantilever shaped TFMG pattern
3. Au electroplating on the TFMG pattern
4. Backside etching of Si substrate by ICP
5. Plastic deformation of TFMG cantilever
6. Direct bonding on another substrate
4. Fabrication Process

Process Chart
5. Results

Size of Sample Tips

Length: 300um
Width: 60um
Thickness: 5um
Height: 200um
Pitch: 150um
5. Results

SEM Image:
Contacting with Au electroplating film:

<table>
<thead>
<tr>
<th>Over Drive (um)</th>
<th>Contact Resistance (ohm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.0</td>
</tr>
<tr>
<td>5</td>
<td>2.0</td>
</tr>
<tr>
<td>10</td>
<td>1.0</td>
</tr>
<tr>
<td>20</td>
<td>1.0</td>
</tr>
<tr>
<td>50</td>
<td>1.0</td>
</tr>
<tr>
<td>100</td>
<td>0.5</td>
</tr>
</tbody>
</table>

2001/6/6 Advantest Laboratories Ltd.
5. Results

Scrub marks:

100um
5. Results

Contact Force:

<table>
<thead>
<tr>
<th>Contact Force (mN)</th>
<th>0</th>
<th>0.5</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over Drive (um)</td>
<td>0</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

2001/6/6

Advantest Laboratories Ltd.
6. Conclusion

Micro probe tips are realized under the micromachining fabrication technology

- Using TFMG as material
- Adjusting to fine pad pitch
- Direct bonding to high frequency structure
Acknowledgment

A part of this work was supported by NEDO. (NEDO stands for New Energy and Industrial Technology Development Organization)