probing@hot temperature
a new thermal approach to probing accuracy

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Introduction

• You cannot beat physics
• probing at high temperatures generates a very high amount of heat energy
• main problem is drift of X/Y/Z position
• Detailed explanation of these values and a model to explain these drifts are well known [Berger/Seitz, SWTW 2013]
## Present Solutions

<table>
<thead>
<tr>
<th>Methode</th>
<th>Action</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical realignment</td>
<td>correcting the drift</td>
<td>very accurate; no investment</td>
<td>time consuming; thermal disbalance while realignment; no control between realignments</td>
</tr>
<tr>
<td>Pre soaking</td>
<td>accelerates reaching a balanced situation</td>
<td>no investment</td>
<td>time consuming;</td>
</tr>
<tr>
<td>Pre-heating of probecard and / or headplate</td>
<td>accelerates reaching a balanced situation</td>
<td>faster than just soaking; not only probecard effected</td>
<td>time consuming; static, non local solution; cost of invest</td>
</tr>
<tr>
<td>mathematical prediction</td>
<td>Control of position by temperature sensors an math. methodes</td>
<td>Local, no time loss</td>
<td>uncertainty remains (no controlling, no monitoring)</td>
</tr>
</tbody>
</table>
## Present Solutions

<table>
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<tr>
<th>Methode</th>
<th>Action</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive shielding</td>
<td>prevents heat soaking for a certain time</td>
<td>few investment</td>
<td>Static, non local; retarding but not solving</td>
</tr>
<tr>
<td>Cooling of probe card</td>
<td>prevent heat soaking of probe card</td>
<td>Instant effect, no time lost; high invest</td>
<td>Static, non local</td>
</tr>
<tr>
<td>“thermal design” of probe card</td>
<td>Fit the design to high temperature use</td>
<td>Intrinsic solution, no other countermeasures</td>
<td>compromise to other PC features; expensive materials; high invest</td>
</tr>
</tbody>
</table>
Measurement of Temperature and Displacement

- Measurement Unit: µm
- Chuck +200°C, -0.2mm under needle
- Probes: Chuck +200°C, -0.2mm under needle
- Air cooling: 70 l/min

**Process of Temperature**

- T1: no cooling
- T2: no cooling
- T3: no cooling

**Process of Displacement**

- T1: no cooling
- T2: no cooling
- T3: no cooling

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Measurement of Temperature and Displacement

Process of Temperature

- T1 no cooling
- T2 no cooling
- T3 no cooling
- T1 cooling
- T2 cooling
- T3 cooling

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Process of Displacement

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Concept of dynamic thermal shielding (DTS)

Air entry
Air exit

Probecard Center TBD

Fixture of DTS

Enlargement of cooler
Temperature Measurement w/o DTS

Temperature distribution on Probecard with +165°C Chuck at rear position
Temperature Measurement w/o DTS

Temperature distribution on Probecard with +165°C Chuck at rear position
Temperature Measurement w DTS

Temperature distribution on Probecard with +165°C Chuck at rear position
Temperature Measurement w DTS

Temperature distribution on Probecard with +165°C Chuck center position (no delay)
Feedback of dynamic thermal shielding (DTS) to wafer

\[ T(\text{chuck}) = 175^\circ \text{C} \]
PC with DTS at 175°C Testing Temperature

Thermal Pin-Shift [µm]

Testing Time

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Number of realignments necessary:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Probecard w/o cool shield</th>
<th>Probecard w cool shield</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>23</td>
<td>3</td>
</tr>
<tr>
<td>Y</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Z</td>
<td>34</td>
<td>4</td>
</tr>
<tr>
<td>sum</td>
<td>71</td>
<td>13</td>
</tr>
</tbody>
</table>
Outlook:

- Thermal stabilizing of ceramic head will result in further improvement

- Docking of probecard has to be simplified for production
Summary:

• Stable thermal equilibrium reached by cool shield
• Accuracy improved by factors
• Especially fast changes of heat source can be completely compensated
• Effort for realignment can be reduced dramatically