LISA

Laser induced selective activation

Yang Zhang  Yazh@mek.dtu.dk

Peter Torben Tang, Hans N. Hansen, Jacob S. Nielsen

Department of Mechanical Engineering
Technical University of Danmark
Outline

- Introduction to the process
- Comparison with alternative techs
- Application and sample show
- Characterization work
- Conclusion
Main Steps of The LISA Process

1. After laser machining
2. Activation and rinsing
3. Electroless plating
Laser process

- PE, PP, ABS, PET/PBT (or with LPKF fillers), PC…
- Sample is submerged in distilled water
- Nd:YAG laser (1064nm), Fibre laser (1075nm) and UV laser (350nm)

1 pass 5 pass 20 pass
New Activation

Step 1: Wetting

Step 2: \( \text{PdCl}_2/\text{SnCl}_2 \) Activation

\[ \text{Pd}^{2+} + \text{Sn}^{2+} \rightleftharpoons \text{Pd}^0 + \text{Sn}^{4+} \]

Step 3: Rinsing in distilled water

Step 4: Rinsing in 10% HCl acid

Step 5: Rinsing in distilled water

The new activation results in a faster plating than the old one!
Metallization

- Commercial auto-catalytic electroless copper bath
- 45 Degree Celsius

\[
\text{Cu}^{2+} + 2 \text{H}_2\text{CO} + 4 \text{OH}^- \rightleftharpoons \text{Cu}^0 + \text{H}_2(\text{g}) + 2 \text{H}_2\text{O} + 2 \text{HCOO}^-
\]

- Rinse and dry the sample after plating
- Optional nickel + gold
**Reactivation to reduce the plating time**

- Copper plating is the rate-limiting step
- Reactivation using the same activation solution

Activity:
- **Activation (5min)**
- **Plating (1min)**
- **Faster!**
- **Reactivation (5min)**
- **Plating again**

Outcome:
- **5µm in 1 h**
- **5µm in 45 min**

Go on plating in Cu bath…
## Comparison with alternative processes

<table>
<thead>
<tr>
<th></th>
<th>LDS</th>
<th>MIPTEC</th>
<th>Full-Metallization</th>
<th>LISA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Materials</strong></td>
<td><strong>Special filler</strong> in materials, only a few materials are available</td>
<td>Thermoplastics and ceramics</td>
<td>Several thermoplastics are available for metallization</td>
<td>Common materials that absorb laser energy</td>
</tr>
<tr>
<td><strong>Laser or other equipment</strong></td>
<td>Special wavelength to crack the bonds, <strong>special laser</strong> head to shape the track</td>
<td>Special wavelength to <strong>remove the metal layer</strong></td>
<td>Special wavelength to <strong>remove the metal layer</strong></td>
<td>Most industrial lasers</td>
</tr>
<tr>
<td><strong>Wet step</strong></td>
<td>Electroless plating</td>
<td>Electroplating and metal <strong>etching</strong> after <strong>sputtering</strong></td>
<td><strong>Dangerous chemicals</strong> for <strong>f</strong> <strong>r</strong> Activated additive by laser ablation</td>
<td>Activation and electroless plating</td>
</tr>
</tbody>
</table>

[Diagram showing process steps: Primary molding, Metalizing, Laser patterning, Plating/etching]
Plating velocity compared to LDS®

<table>
<thead>
<tr>
<th></th>
<th>HSG-IMAT</th>
<th>LDS®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plating time*</td>
<td>0.5 hour</td>
<td>0.5 hour</td>
</tr>
<tr>
<td>Activity of the bath**</td>
<td>1262 seconds</td>
<td>900-1200 seconds</td>
</tr>
<tr>
<td>Substrate material</td>
<td>Polycarbonate 10% glass fiber</td>
<td>LCP</td>
</tr>
<tr>
<td>Temperature</td>
<td>52°C</td>
<td>52°C</td>
</tr>
<tr>
<td>Average thickness***</td>
<td>4.81µm</td>
<td>~2µm</td>
</tr>
</tbody>
</table>

* Electroless autocatalytic copper bath: Circuposit 4500 from Rohm and Haas
** It is tested by e-Cu: Check system provided by HSG-IMAT, Stuttgart. Long time stands for low activity.
*** The thickness is measured by Fischerscope® X-Ray system
## Adhesion test result

<table>
<thead>
<tr>
<th>Group</th>
<th>Average power</th>
<th>Average adhesion strength (MPa)</th>
<th>Standard deviation (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>4.2W</td>
<td>13.2*</td>
<td>2.9</td>
</tr>
<tr>
<td>Group 2</td>
<td>2.7W</td>
<td>13.0</td>
<td>2.1</td>
</tr>
<tr>
<td>Group 3</td>
<td>0.7W</td>
<td>11.7</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Dage® bond tester serie 4000
Demonstrator 1: 2.5D sample
Demonstrator 2: dipole antenna

Special thanks to Fan Cheng & David Bue Pedersen
Bearin area curve principle

- Quantitative characterization
- Peak, core and valley
- Core structure determines the plating
Bearing area curve for five cases

- YAG good
- YAG burnt
- YAG low energy
- UV good
- UV high frequency

Bearin area ratio

height (μm)
Normalization

![Diagram showing the relationship between height/Max height and Bearing area ratio for different materials: YAG good, YAG burnt, YAG low energy, UV good, and UV high frequency.]
Conclusion

• LISA: Laser induced selective activation for selective plating
• LISA copper coating: fast, strong adhesion
• One 2.5D demonstrator is showed
• LISA antenna works!
• Bearing area curve is proposed to characterize porous surface
Acknowledgement

Thanks for your attention!

DTU Mechanical Engineering
Department of Mechanical Engineering

IPU

Project Polymetal

HSG-IMAT

DTU Elektro
Institut for Elektroteknologi