Henkel Adhesive Solutions for SiP Packaging

October 17-19, 2018
Shanghai, China
## Agenda

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Henkel Adhesive - Electronics
Our fields of expertise

- Semiconductor Packaging
- Consumer Electronics
- Automotive Electronics
- Industrial & Infrastructure
Henkel has a global presence with a footprint in every geography. Globally aligned infrastructure to serve our customers locally.
## Agenda

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Major Trends Driving Heterogeneous Integration

Big Data / AI
• Advanced memory packaging for client and server side
• 2.5D / 3D; Flip-chip

5G Mobile / Telco
• AP, RF FE, Memory, Sensors
• Fan-in, Fan-out, Flip-chip, PoP

Auto / Industrial
• Sensors, Memory, processor; GPU for computing
• 2.5D / 3D, Flip-chip, Fan-out, Embedded.
Why System in Package (SiP)?

Drivers for SiP

- **Heterogeneous integration** – modules with different device types, different silicon technology
- **Improved performance** – signal integrity with lower power consumption
- **Design Flexibility** – module level testing and validation
- **Miniaturization** – smaller form factor and footprint

SiPs inch into automotive beyond mobile, wearable and consumer
SiP Design Challenges

SiP will dominate hetero-function semiconductor packages. Key design challenges:

- Thermal dissipation
- Small form factor
- RF interference
- High reliability, Automotive Grade 0

SiP takes on a broader scope as more sensors & modules become or go into a (sub)system
Agenda

1. Overview: Henkel Adhesive Electronics
2. Semiconductor Market Trends & SiP Drivers
3. Henkel Adhesive Solutions for SiP Packaging
4. Summary
### Adhesive Solutions for SiP Packaging

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<td>Advanced Sensing → Precision Assembly</td>
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Applications for High Thermal Die Attach Pastes

- High Reliability
  - High Reliability (MSL1)
  - Moderate Heat Dissipation

- Solder Replacement
  - High Reliability (MSL1)
  - High Heat Dissipation, Pb free

- Eutectic Alloy Replacement
  - Ultra High Heat Dissipation

- Miniaturization
  - High Reliability (MSL1 / 10k ~ 1M power cycle)
  - Smaller, Thinner
  - Higher Integration (SIP/MCP)

End Use

- Power Module
- Power IC
- Discrete & HB LED
- Power Module

- Higher Thermal Requirement
- Ultra High thermal
- Semi-Sintering

- Silver Sintering
- Moderate High thermal

- High Thermal

- High Reliability (SIP/MCP)

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LOCTITE® ABLESTIK Conductive Die Attach Portfolio

Thermal Need
- Ultra High Thermal
- High Thermal
- Moderate High Thermal

Bulk TC
- >100 W/mK
- 30-100 W/mK
- <30 W/mK

Die Size
- 2mmx2mm
- 4mmx4mm
- 6mmx6mm
- 8mmx8mm

* Patent Pending
** Electrically Insulating

- ABP 8068TA and ABP 8068TB
- CDF 800P
- CDF 700P

Moderate High Thermal Film Alternatives

ABP 8060T, ABP 8062T, ABP 8065T, ABP 8066T
ABP 8064T
FS 849-TI
QMI529HT(LV), QMI529HT-2A1
ABP 8910T**
84-1LMISR4, QMI519, 3230, 3290P, 8290, 8302

SSP 2020 (pressure-less)

CDF 800P
CDF 700P

Moderate High Thermal Film Alternatives

Samples and presentations from the SiP Conference China 2018
LOCTITE® ABLESTIK Semi-Sintering System

Semi-Sintering Die Attach Paste (DAP) Value Statement
Robust Reliability with Best In-Cass Electrical & Thermal Performance & High Volume Manufacturing Ready Material

Customer Value Proposition
Enables Design Robustness With Sintered Metal Connection for Reliable Operation of Devices
LOCTITE® ABLESTIK Semi-Sintering System
In Package Thermal Resistance (Rth)

In-package thermal resistance comparable to soft solder on multiple lead frames
# Adhesive Solutions for SiP Packaging

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Controlled Flow Technology for Small Form Factor

Controlled Flow applications

Die/Glass Attach
- DAF
- cDAF

Flip-Chip / PoP
- CUF, gapfill
- NCP, NCF
- WIA
- Lid/stiffener attach

Fan-in WLP
- Laser marking paste (printable)
- LCM
- Printable encap

Fan-out WLP
- LCM
- DAF (face-up)
- CUF (Chip-last face-down)

2.5D / 3D
- CUF, NCP, NCF
- LCM
- Stiffener attach
- WIA

Embedded Die
- CUF, NCP
- LCM

Henkel Solutions

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Henkel Solutions

Henkel Solutions

Henkel Solutions

Henkel Solutions

Henkel Solutions

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Use Cases in System in Package (SiP)

**Semi Sintering**
For high thermal die attach

- Robust reliability
- Best in-class electrical and thermal performance
- HVM ready material

**CUF**
For improved processability

- Wafer-level and substrate-level
- Long stage life, fast flow, High UPH
- High thermal CUF in development

**LCM or Printed**
For WLP Encapsulation

- Wafer-level package encapsulation
- Low warpage
- High UPH
- Excellent chemical resistance

**NCF or NCP**
for FC KoZ control

- Enables fine-pitch and narrow gap interconnects
- Bump protection during TCB process
- Tight KoZ control for dense SiP architectures

**WIA**
Warpage improvement adhesives for SiP

- Controls and improves warpage of large die package
- Warpage control for PoP architectures

**EMI Shield**
For compartmental and conformal

- Enables miniaturized and integrated designs
- Excellent shielding effectiveness
- High reliability performance
Encapsulation for 2.5D/3D TSV stack
Pre-applied Underfill: NCP & NCF

- NCP is ideal for fine pitch Cu pillar and NCF is best for TSV die stacking
- Both in HVM and have proven excellent reliability performance
Encapsulation for WLCSP
LCM for 5-side/6-side protection

Encapsulation of WLCSP ensures better handling and improved reliability
## Adhesive Solutions for SiP Packaging

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Compartmental Shielding
A conductive partition inside a package isolating multiple components within a single package.

Example: System-in-Package

Conformal Shielding
An outer conductive coating layer on the package surface (top + sidewalls) for package-to-package isolation.

Epoxy Mold Compound
Component/silicon

Substrate

Grounding

Isolated Compartment

Isolated Device

Image of Final Device Package
Henkel’s Compartment Shielding Material
Conductive Trench Fill Paste

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<tr>
<th>Physical Properties</th>
<th>LOCTITE ABLESTIK EMI 3620FA</th>
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<tr>
<td>Technology</td>
<td>Electrically conductive</td>
</tr>
<tr>
<td>Application Method</td>
<td>Jet dispensed</td>
</tr>
<tr>
<td>Viscosity, 5rpm 25°C (cps)</td>
<td>4950</td>
</tr>
<tr>
<td>Thixotropic Index</td>
<td>1.3</td>
</tr>
<tr>
<td>Curing Condition</td>
<td>Convection, 30 min to 175°C, hold 60 min</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Volume resistivity (ohm·cm) 1X10⁻⁴</td>
</tr>
<tr>
<td>DSC</td>
<td>DSC on set temperature (°C) 123</td>
</tr>
<tr>
<td></td>
<td>DSC peak temperature (°C) 136</td>
</tr>
<tr>
<td></td>
<td>DSC delta H (J) 25</td>
</tr>
<tr>
<td>DMA</td>
<td>Modulus (25degC) / Mpa 4173</td>
</tr>
<tr>
<td></td>
<td>Modulus (150degC) / Mpa 1395</td>
</tr>
<tr>
<td></td>
<td>Modulus (250degC) / Mpa 510</td>
</tr>
<tr>
<td>Adhesion</td>
<td>DSS surface Molding compound</td>
</tr>
<tr>
<td></td>
<td>DSS die size 3x3mm</td>
</tr>
<tr>
<td></td>
<td>DSS at 25C after cure 9.5</td>
</tr>
<tr>
<td>Sample Availability</td>
<td>Now</td>
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Cross Sections
Front
Side
# Henkel’s Conformal Shielding Material

## Conductive Spray Coating

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<tr>
<th>General Properties</th>
<th>Material Requirements</th>
<th>LOCTITE ABLESTIK EMI 8660S</th>
<th>LOCTITE ABLESTIK EMI 8880S</th>
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<tr>
<td>Application Method</td>
<td>Spray technology</td>
<td>Anagotic</td>
<td>Anagotic</td>
</tr>
<tr>
<td>Technology</td>
<td>High EMI shielding performance</td>
<td>High electrical conductivity</td>
<td>High electrical conductivity</td>
</tr>
<tr>
<td>Viscosity, 5rpm (cps)</td>
<td>Optimal resistance to flow for application method</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Thixotropic Index</td>
<td>Ability to hold its shape with external stress</td>
<td>1.2</td>
<td>1.3</td>
</tr>
<tr>
<td>Curing Condition</td>
<td>Cured in convection oven with no ramp</td>
<td>175°C, 1 hour in air (no ramp)</td>
<td>175°C, 1 hour in air (no ramp)</td>
</tr>
<tr>
<td>Filler Type</td>
<td>Filler technology with high conductivity</td>
<td>Proprietary silver</td>
<td>Proprietary silver</td>
</tr>
<tr>
<td>Volume Resistivity (ohm-cm)</td>
<td>Extremely low resistivity similar to pure metal</td>
<td>1.5 x10⁻⁵</td>
<td>7.9 x10⁻⁶</td>
</tr>
<tr>
<td>Shielding Effectiveness (dB)</td>
<td>Bulk material shielding performance</td>
<td>~90</td>
<td>~90</td>
</tr>
<tr>
<td>Supported Thickness (μm)</td>
<td>Supported frequency and shielding effectiveness</td>
<td>3 ~ 40</td>
<td>3 ~ 40</td>
</tr>
<tr>
<td>Recommended Dried Coating Thickness (μm)</td>
<td>&gt;100MHz GHz: Ultra-thin layer with good uniformity</td>
<td>3~6</td>
<td>3~6</td>
</tr>
<tr>
<td>10-100MHz: Thicker layer with good uniformity</td>
<td>10+</td>
<td>10+</td>
<td></td>
</tr>
<tr>
<td>Adhesion (Cross Hatch Test)</td>
<td>Adhesion and reliability using ASTM 3359 standard</td>
<td>Classification 5B (0% peel)</td>
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<tr>
<td>Compatible Surface</td>
<td>Good adhesion to various package surface types</td>
<td>Mold compound (Wide range)</td>
<td>Mold compound (Narrower range)</td>
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<tr>
<td>Target Frequency Range</td>
<td>Targeting shielded frequency ranges</td>
<td>500 MHz ~ 10 GHz</td>
<td>10 MHz ~ 10 GHz</td>
</tr>
<tr>
<td>Production Sample Availability</td>
<td></td>
<td>Now</td>
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**Silver-based Material Advantages**

- Silver is a noble metal that doesn’t react with air even at red heat. Silver oxide can only be formed with strong oxidation agents, but is decomposed to silver and oxygen at above 160°C.
- Silver oxidation has no effect on appearance and conductivity. Other typical metals, such as stainless steel and nickel, oxidize after exposure to air with impact to conductivity and hence shielding performance.
Henkel’s Conformal Shielding Material
Shielding Effectiveness Comparison

Non-Coated

Sputter-Coated (3um)

Spray-Coated (4um)

1 GHz

5 GHz
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Henkel offers a series of “UV + Thermal” dual cure adhesives for precision assembly of sensor systems.
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Summary

- Henkel is committed to enabling the SiP packaging market and dedicating significant resources to development and testing of new adhesives to solve key challenges:
  - High thermal dissipation
  - High density (TSV Memory)
  - Robust EMI shielding
  - Precision assembly in Sensors/Modules
  - High reliability, capable of Automotive Grade 0

- Henkel is the market leader in semiconductor packaging and component assembly solutions and will continue to develop new technology to meet the new requirements

- Henkel strives to be the total solution provider

Henkel is the Right Partner to Enable the Potential of SiPs!
Thank you!