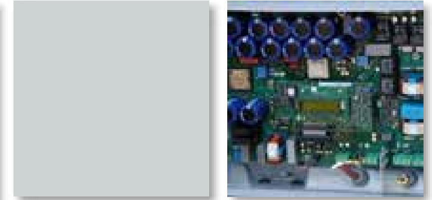
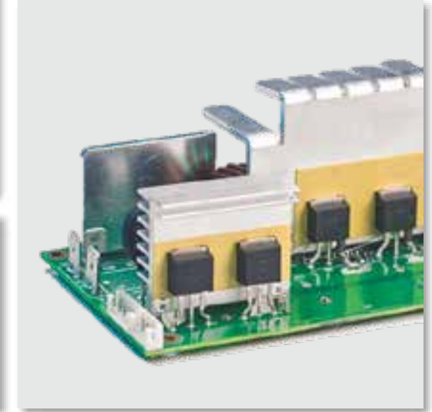
Power Supplies

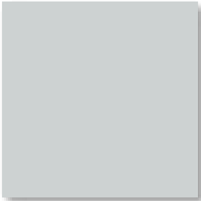
Advanced Materials for Higher Performance

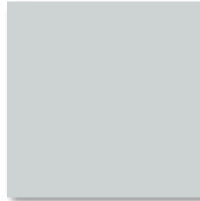
Tech Taipei 2017

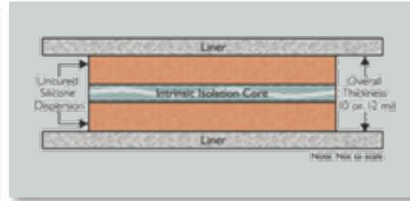
Sep 21, 2017

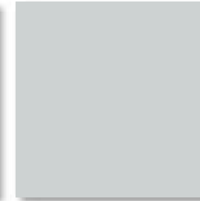






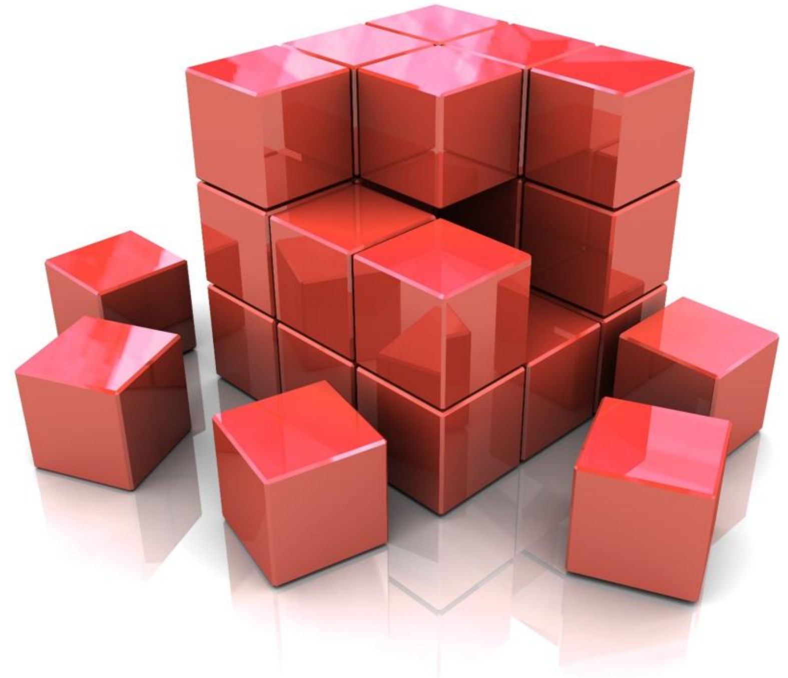






Agenda

1. **Henkel Company Introduction**
2. Power Technology Trend
3. Application & Solution Overview
   - Transistors to Heatsink
   - Coil to Heatsink / Case
   - PCB to Heatsink / Case
   - High Power Module
4. Product Roadmap & Key Products List
5. Conclusion



Who we are
140 Years of History

- Founded 1876, Headquarters: Düsseldorf, Germany
- Employees from **125 nations**
- **170 manufacturing** and **21 major R&D sites** around the world

Consumer Businesses

Industrial Business

Laundry & Home Care

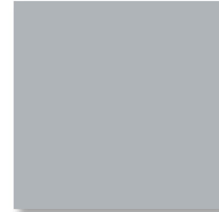
Persil Purex Pril

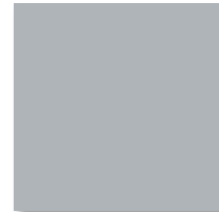
Beauty Care

Schwarzkopf syoss Dial

Adhesive Technologies

LOCTITE TECHNOMELT Pritt





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Adhesive Technologies
Over 90 years of adhesive innovation

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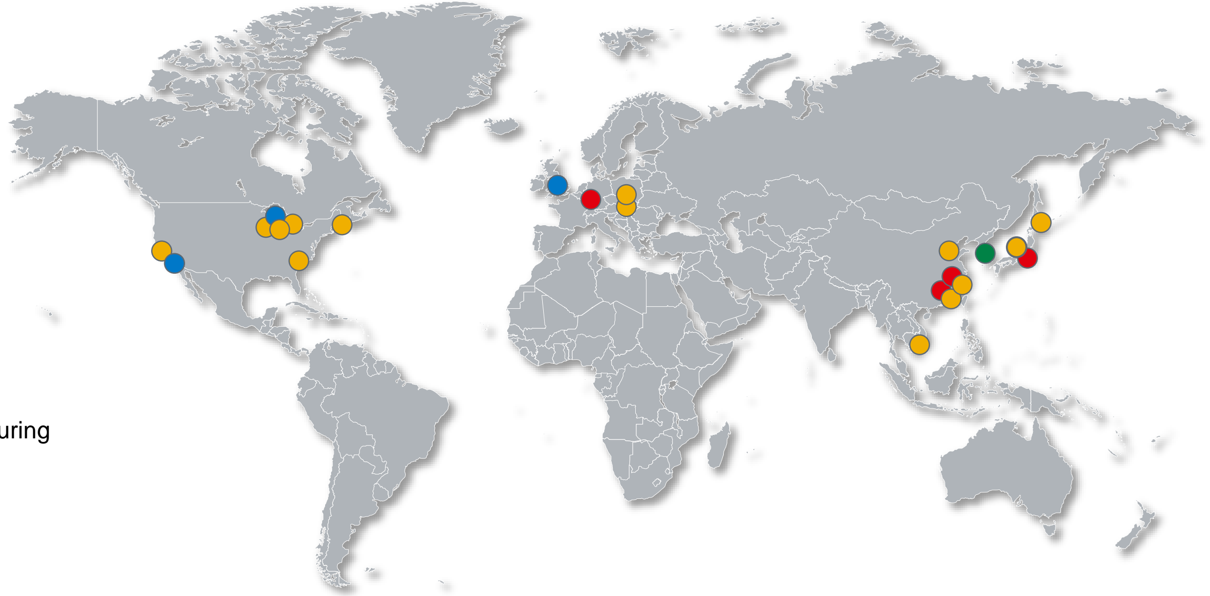
Serving Our Customers Worldwide
Global End-to-End Business

Electronics Headquarters:
Irvine, CA USA

Estimated Adhesive Electronics Employees: 3,086



- R&D, Technical Service, Sales
- R&D, Technical Service, Sales, Manufacturing
- Technical Service, Sales, Manufacturing
- Manufacturing

Globally aligned infrastructure to serve our customers locally

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Adhesive Electronics Steering Units

Semiconductor Packaging

- Wirebond Packaging
- Flip Chip Packaging
- 3D & TSV Packaging
- Wafer Level Packaging
- MEMS Devices
- Sensors
- Camera Modules
- Passive Devices
- LED Device Packaging

Display Assembly

- OLED Assembly
- LCD Assembly
- Touch Modules
- Display Cleaners

Consumer Electronics

- Mobile, Tablets, Accessories & Peripherals
- Computing
- Storage (HDD)
- Digital Printing
- Connectivity
- Entertainment

Automotive Electronics

- Automotive Lighting
- ADAS & Safety
- Chassis & Interior
- Powertrain
- New Energy Vehicle (NEV)

Industrial & Infrastructure

- Power & Automation
- Telecom/Datacom
- Defense/Aero
- Medical
- Batteries
- Safety & Security Appliances
- Solar
- Printed Electronics

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Adhesive Electronics: Technologies

Semiconductor Materials

- Die Attach Materials
- 1st Level Underfills
- Liquid Compression Molding Materials
- Adhesives for Speciality Module Packages (Fingerprint, Communication Camera, Opto)

Display Materials

- Optical Clear Adhesives (LOCA, OCA)
- LCD Cleaners
- Wafer Processing Materials
- Display Sealant
- Conductive Display Inks/ Pastes
- Adhesives for Display Module Assembly

Encapsulation

- 2nd Level Underfills
- Circuit Board Protections
- Sealants
- Low Pressure Molding
- Potting Materials
- Adhesives for Printer Heads

Component Assembly

- Electrically Conductive Assembly Adhesives
- Metal Sintering Adhesives
- Chipbonder
- Assembly Films
- General Adhesives

Printed Electronics

- Conductive Printable Inks
- Non-Conductive Printable Inks
- Dielectric Coating
- Switches

Soldering

- Solder Paste
- Liquid Flux
- Solder Wire

Thermal Management

- Thermal Interface Materials
- Thermally Conductive Adhesives
- Insulated Metal Substrate (IMS)
- Fans & Blowers

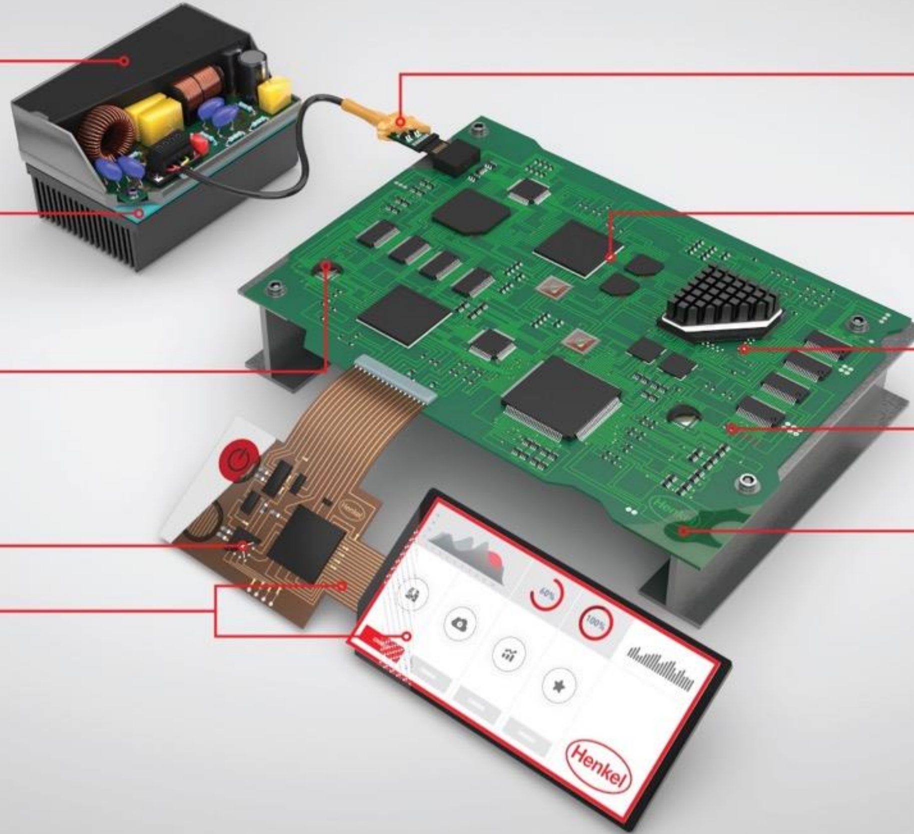
Device Assembly

- Structural adhesives
- Debondable Adhesives
- Surface Treatment
- Instant Bonding Adhesives
- Elastomeric Adhesives
- Temporary Masking
- Structural Bonding Adhesives
- 3D Printing

Equipment

- Motion Control
- Volumetric Dispensing
- Valves
- Controllers

Solutions Across the Board



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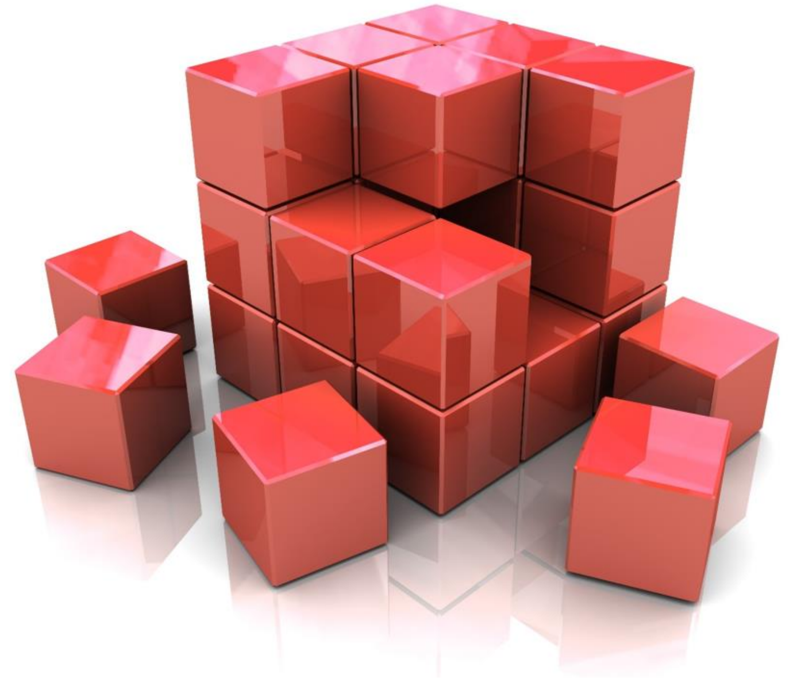

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Global Power Supply Trends

4 Market Drivers

Power Densities	Cost	Automation	Legislation
• Increasing Watts/In3 • Driving Higher Reliability Requirements • Si → SiC/GaN	• Low Cost Chinese Entrants • Process Improvement	• Manual to Semi or Fully Automatic • Reduced Manufacturing Footprint	• Improved Efficiencies • Sustainable • Environmental

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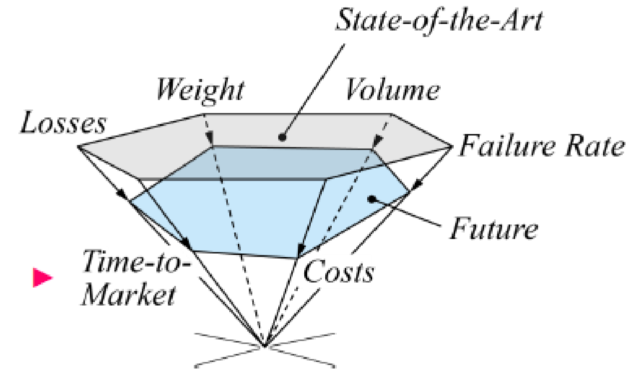
Power Conversion Performance Trends

1. — Power Density [kW/dm3]
2. — Power per Unit Weight [kW/kg]
3. — Relative Costs [kW/$]
4. — Relative Losses [%]
5. — Failure Rate [h-1]
6. — Time to Market [mo]



Vision – Power Electronics 2025
Johann W. Kolar
Swiss Federal Institute of Technology (ETH) Zurich
Power Electronic Systems Laboratory
www.pes.ee.ethz.ch

Impact of Trends & Drivers on Materials Selection

1. Power Density
   - **Better thermal performance materials**
   - **Move to WBG semiconductors – higher temperature materials with better thermal cycling reliability**
2. Cost
   - **Lower processing cost, reduction of fixturing / hardware, reduction in SKU's, lower BOM cost, better yields**
3. Efficiency
   - **Better thermal performance**
4. Reliability
   - **Softer materials, Moisture resistance, ionic cleanliness, environmental stability**
5. Time to Market
   - **EMI Absorption, thermal materials, design partnerships**

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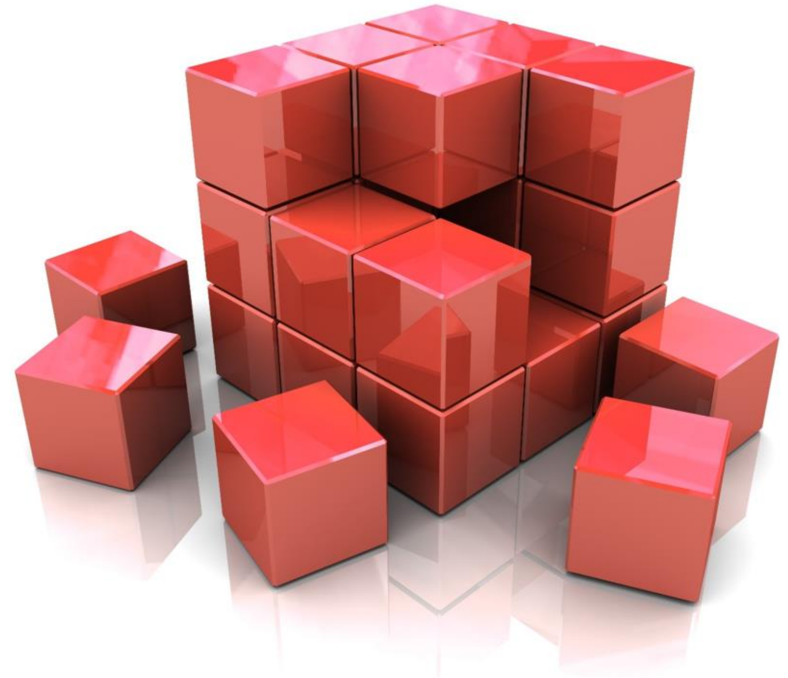

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Transistors to Heatsink
Conventional solution

Application:

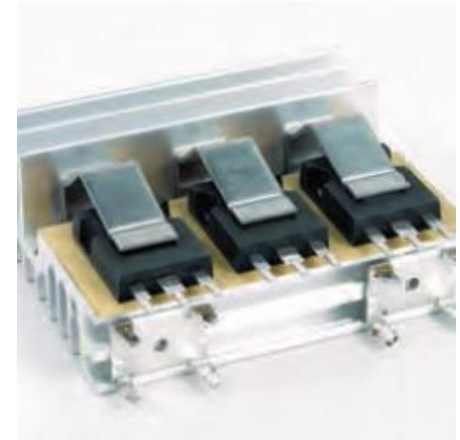
- Thermal interface material between Transistors (TO-220, 247,3P,etc.) and Heatsink for heat dissipation

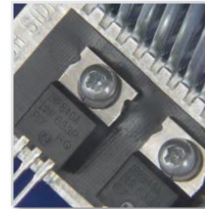
Traditional Thermal Solutions:

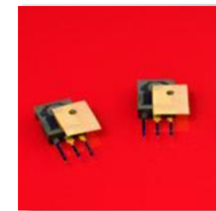
- Mica and Grease
- Thin Gap pad (eg. Henkel Sil-Pad)
- Electrical Insulative PCM (eg. Henkel PCM Film)

Mounting Method:

- Screw, Clip, Spring, bar, etc.







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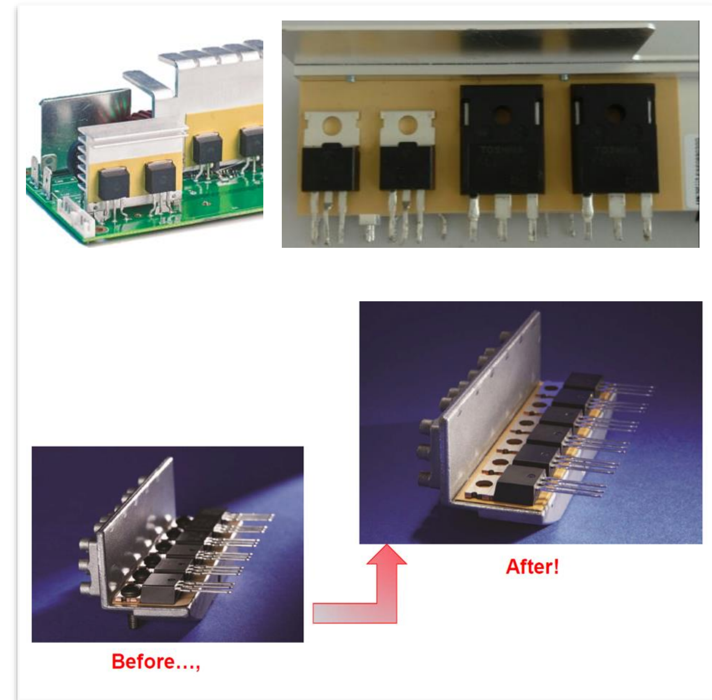
Transistors to Heatsink
Henkel Solution for Lowest Total Cost

- The Power Supply industry is advancing innovation through investment in *lean manufacturing* and *total cost solutions*….

- Henkel's Innovative Thermal Interface Materials (TIMs):
  +*Eliminate* Mechanical Fasteners
  +*Save* Space (2D & 3D)
  +*Ensure* Highest Dielectric Strength
  +*Ensure* Highest Thermal Performance
  +*Improve* L/T Reliability & Durability
  +*Increase* Production Though-put / Yields

= Lowest Total Solution Cost



Coil to Heatsink / Case

Application:

- Coil needs TIM for transferring heat to heatsink or case, or need Potting material for protection

Design Feature:

- Working temperature normally at 0~150°C.
- High thermal conductivity is required.
- High mechanical strength is essential.
- Not complicated processing procedure is preferred.
- Soft, so low stress in large potting applications

Recommended Solutions

- Curable liquid Gap Filler (Two-part), high thermal potting material for automatic processing

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PCB to Heatsink / Case

Application:

- Require TIM to be added between PCB and heatsink or case for heat dissipation

Traditional Solutions:

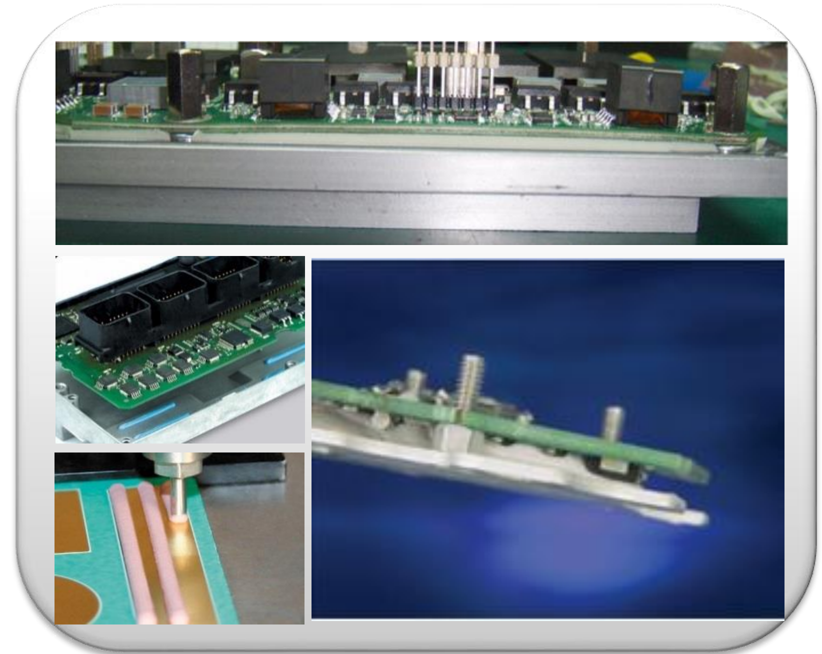
- Gap pad (Thermal Pad)

Recommended TIM:

- Curable liquid Gap Filler (Two-part)

Benefits:

- Highly automatable and repeatable
- Conformability
- Optimized material usage
- Low assembly stress



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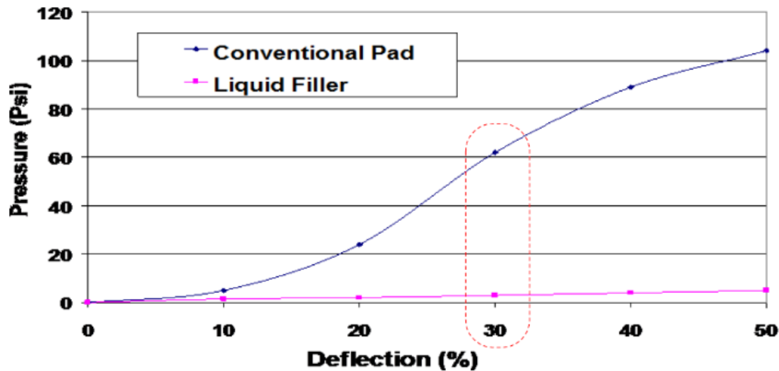
Liquid Gap Filler Dispense

Key Performance:

- Minimal stress during assembly
- Excellent wet-out ability
- Single solution for Multiple applications
- Multiple rheology and cure schedule



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Dispenser for Gap Filler

Volume measuring type digital control dispenser（2Head type）

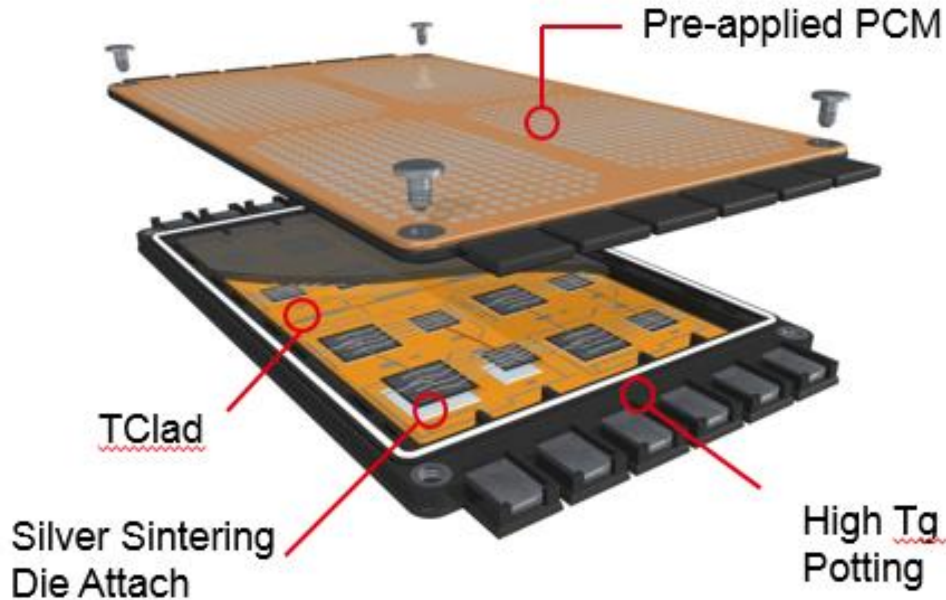
GAP FILLER 1500
dispense sample

Automate of weighing､mixing and dispensing specific amounts.
High precision dispensing has been achieved!!

GAP FILLER 1500 dispense data（N=20）

	吐出量
AVE [mg]	3191.2
MAX [mg]	3204.9
MIN [mg]	3169.8
3σ	38.0
精度 [±%]	0.6

High Power Module Application



1. **High temp resistance and reliability > High Tg potting material**

2. **Low thermal resistance > Insulative Metal substrate (T-Clad)**

3. **High die attach bonding strength > Silver sintering material**

4. **High performance and reliability > Pre-applied PCM**

Next Generation Materials Developed for high power application

1. High Tg Potting

Develop high temperature resistance potting products for *Power Electronic Applications.

*Power Electronics: >175 C operating Temperature.

Application temperature

Si	*~ 150 degC*
Si-IGBT and SiC, GaN	***175 degC ~***

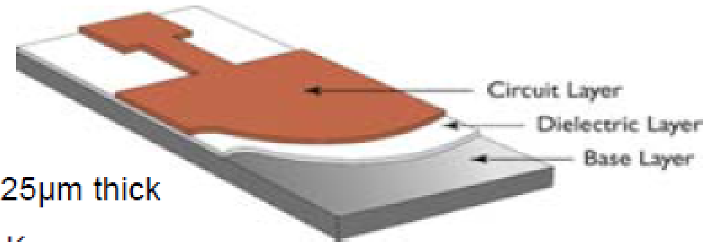
→ Heat generation from inside of packages.

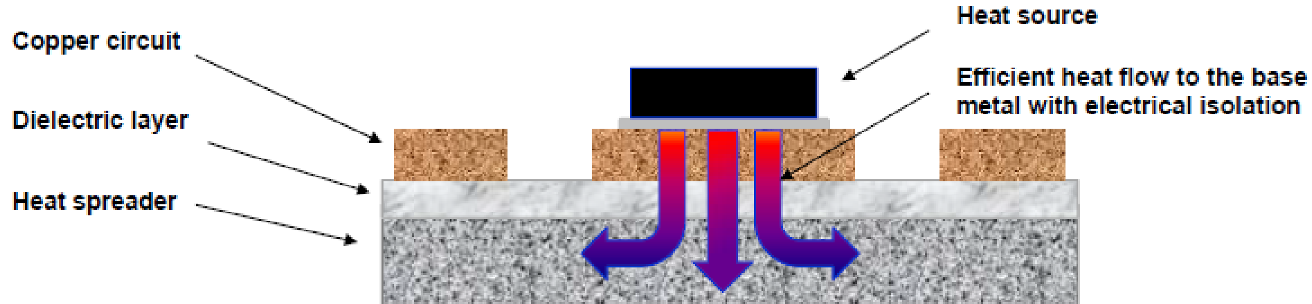
Operation temp. < Encapsulant's Tg

2. Insulative Metal Substrate

Single Layer constructions

- Circuit Copper → 17µm – 350µm
- Dielectrics: HRT, MP, HT, HPL → 38µm - 225µm thick
  - Thermal performance based on → 0.8 – 3 W/m-K
- Aluminum or copper base metals → 0.5 – 5 mm thick





Cross section view not to scale

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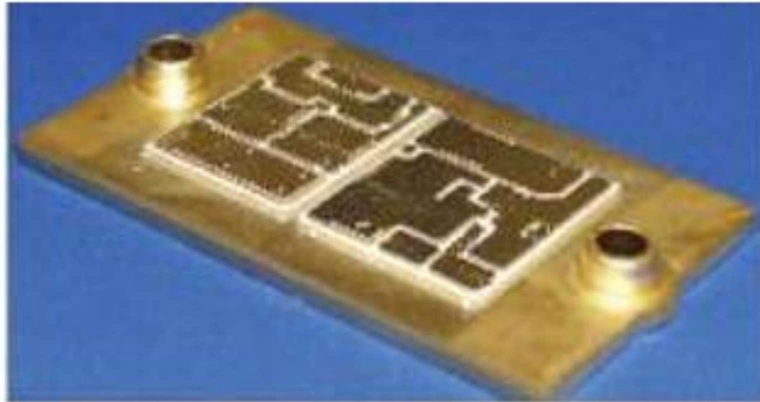
3. Ag Sintering Die Attach

Ag Sintering Formulation
Coating
Substrate
Screen printing
B-Staged
Substrate
Die-Bonding
Heat, P
Pressure
Metallized Die
Substrate
Metallized Die
Substrate



Copper base plate and DBC substrate
with Ni/Au metallization

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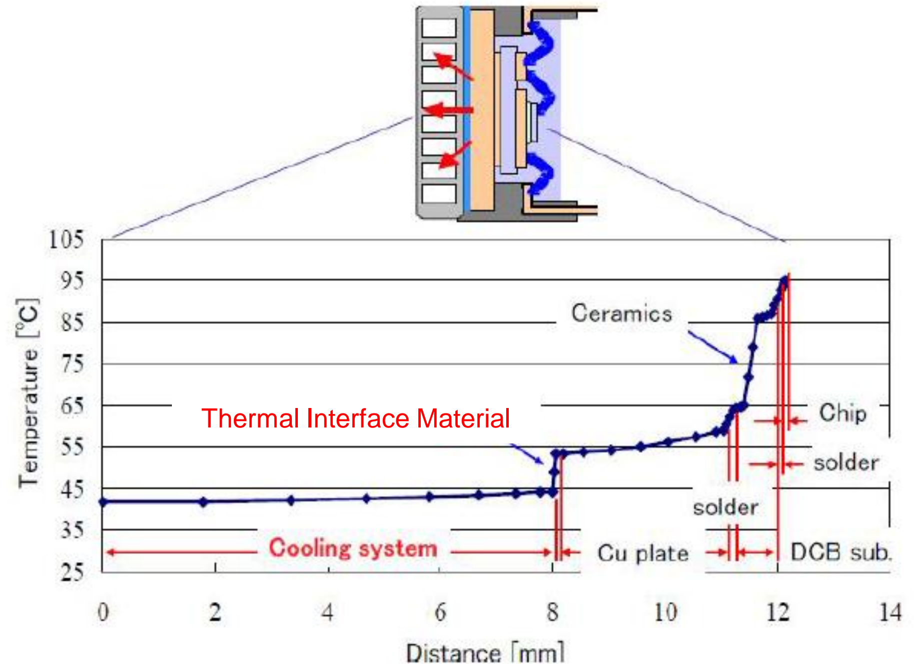
4. Pre-Applied Phase Change Material

- High Power Module technology trend is higher power and downsizing
- Developed PCM which is 150C durable & high thermal conductivity (>3 W/mK)
- Stencil printing with Pre-Applied PCM



TIM has great impact to increase High Power Module module temp

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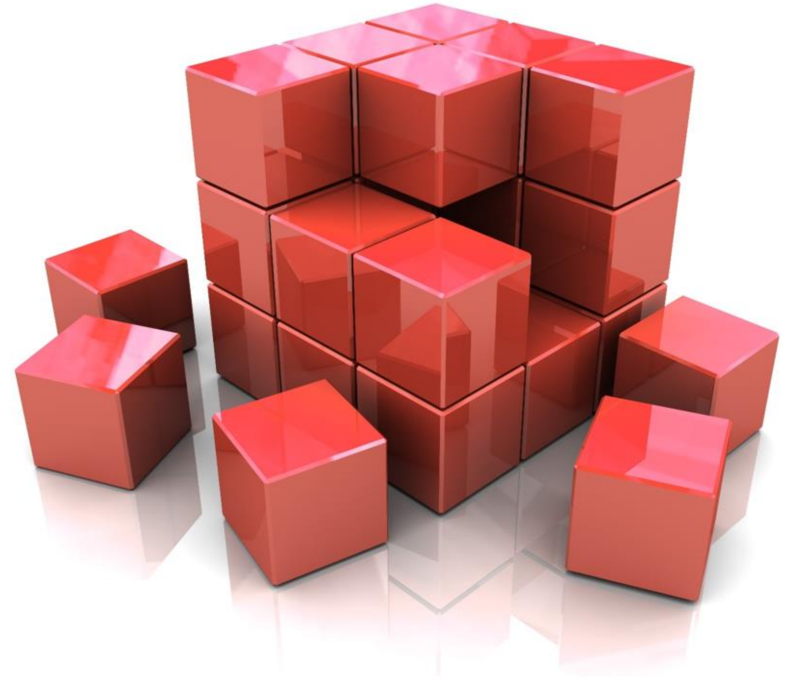

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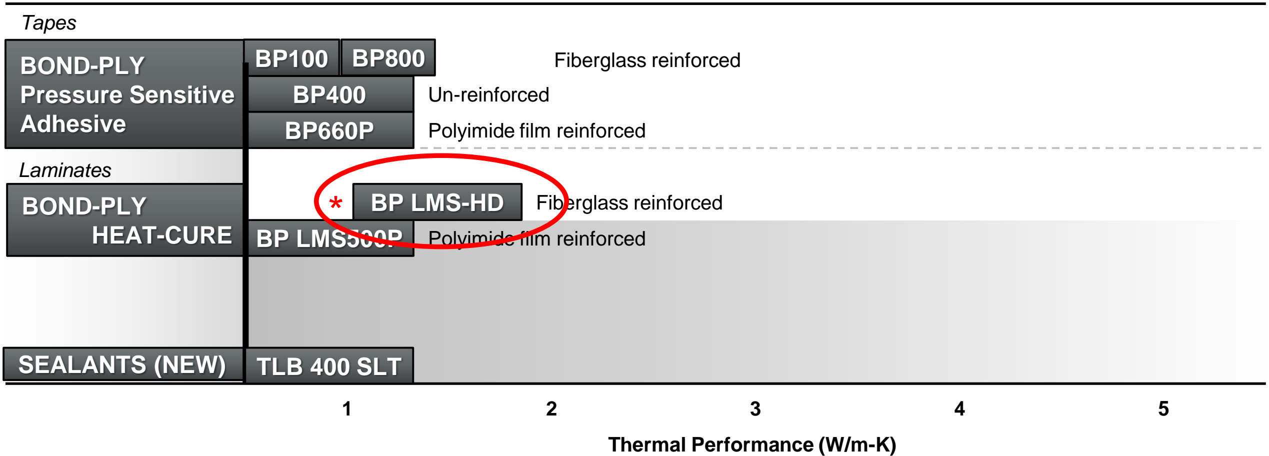
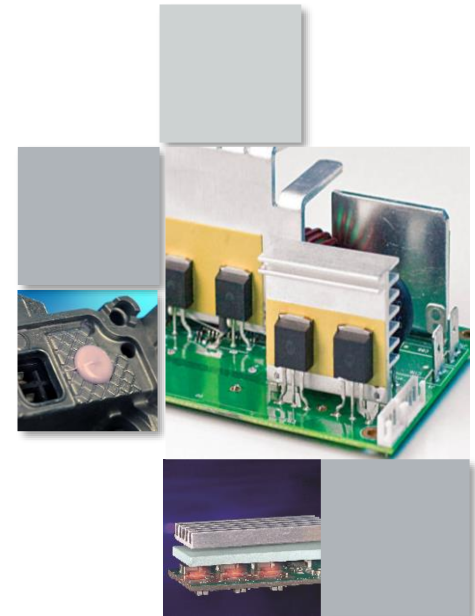
Adhesives (Pad form)

Pressure Sensitive Adhesives & Laminates

RELEASED





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Liquid TIMs
Market Leading Solutions

RELEASED

2K Cure-In-Place

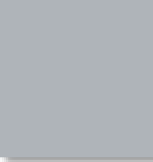
GAP FILLER 2K	GF1000/1000SR, 1500, 2000 · GF3500S35 · GF4000
LOW VOLATILE 2K	GF1500LV · GF3500LV
POTTING 2K	GF1400SL
LOW MODULUS 2K	
SILICONE FREE 2K	GF1100SF

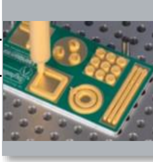
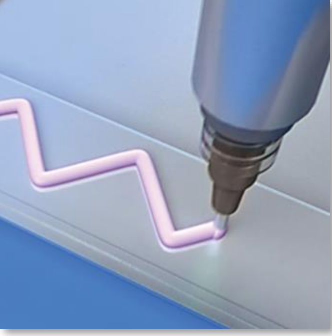
1K Pre-Cured Gel

LIQUI-FORM	LF2000 · LF3500

1 2 3 4 5 6

Thermal Performance (W/m-K)



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Gap Pad® TIMs
Expanding Pad-Form Innovation

RELEASED | Coming Soon!

Silicone

ULTRA LOW MOD: Putty-like GP3500 ULM; Lowest Modulus * GP7000 ULM

SOFT: HC1000; GPV0-S/US, 1500S, 2000S40; * GP HC 3.0; * GP HC 5.0

VALUE: GPV0-US-C; GPV0, 1450, 1500

HIGH DURABILITY: GP1000HD

Silicone-Free

POLYURETHANE: GP1000SF; GP2200SF; GP2202SF; GP3004SF

Specialty

* EMI Absorbing NEW LINE: GP EMI 1.0; EXP 1a

1 2 3 4 5 6 7

Thermal Performance (W/m-K)

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Key Product List

Power Segment Driver	Implication	Henkel Response	Description	Technology
Lower Cost	Reduce TCO	Bond-Ply LMS HD	1.4 W/mK, Reinforced insulation, structural adhesive film	TIM
Increased Power Density	Reduce thermal resistance	Gap Filler 1400SL	1.4W/mK, self leveling, very soft	TIM
Increased Power Density	Reduce thermal resistance	Gap Filler 3500S35	3.6W/mK, easy to dispense, ultra conforming	TIM
Increased Power Density	High temp resistance	Potting	High Tg >200C, Low modulus, High insulation at high temp	CBP
Increased Power Density	Reduce thermal resistance	T-Clad HPL	Low thermal impedance, reliable electrical insulative protection	IMS
Increased Power Density	Improve reliability	Silver Sintering	High die attach bonding strength for High Power Module	Die Attach
Increased Power Density	Reduce thermal resistance	TCP 7000 series	3.4W/mK, printable phase change interface material, high performance	TIM
Systems Integration	Reduction in design cycle	Gap Pad EMI 1.0	EMI absorbing, thermally conductive gap pad (1 W/mK)	TIM

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Conclusions
Henkel Solutions

- Offers a wide range of innovative and high performance materials to solve your most challenging thermal needs.

- New materials have been developed that save space, assembly costs and energy, yet provide great thermal and adhesion performance.

- Henkel maintains its industry leadership position by partnering with industry leaders to develop the next generation of thermal products.

- Please feel free to contact us with your challenging thermal needs!

Henkel

Thank you!

Henkel