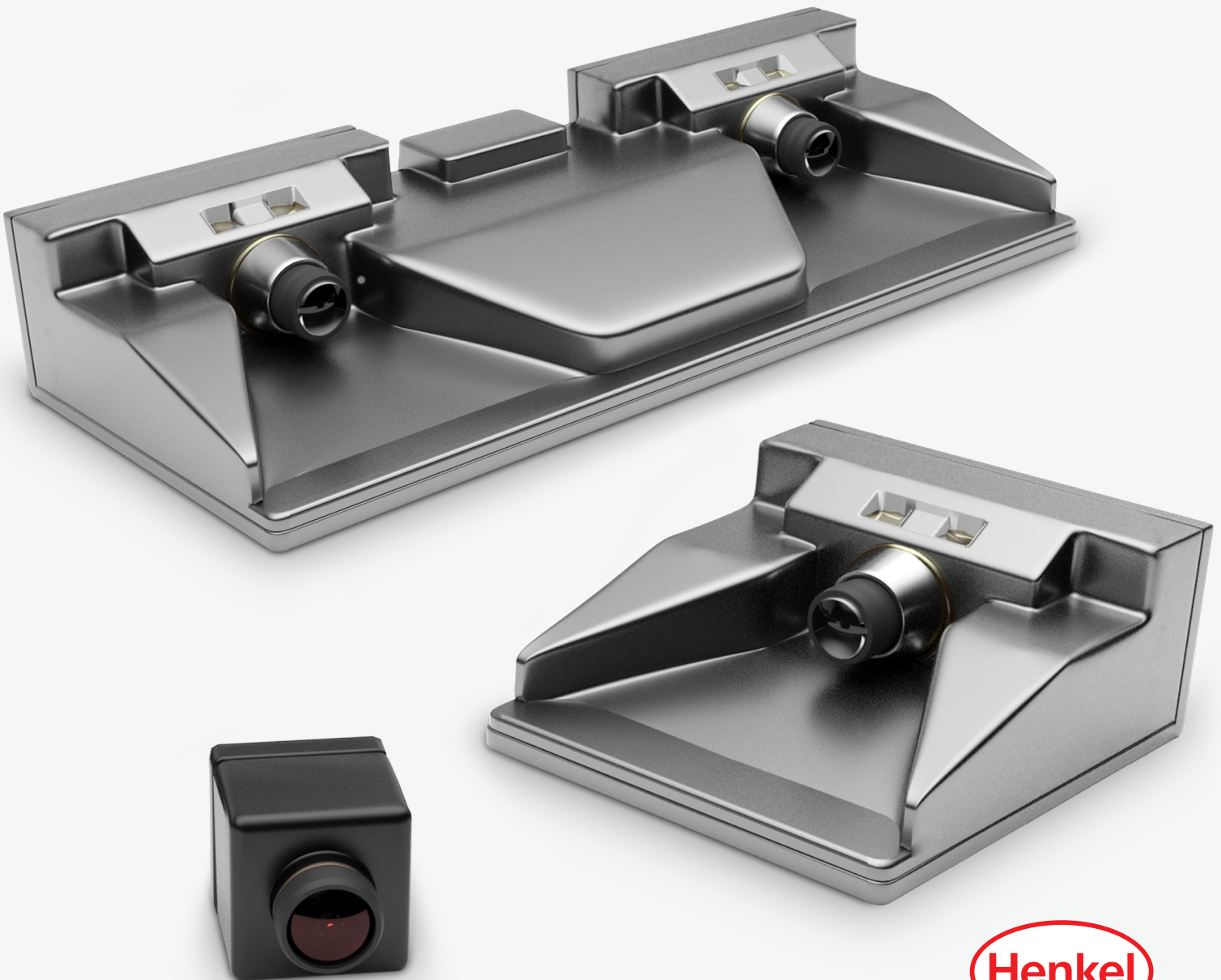


**LOCTITE®**  
**TECHNOMELT®**

**BERGQUIST®**

# MATERIALS FOR AUTOMOTIVE CAMERAS

BONDING, CONNECTING, PROTECTING AND THERMAL SOLUTIONS



**Henkel**

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## MATERIALS FOR ADAS CAMERAS

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# INTRODUCTION

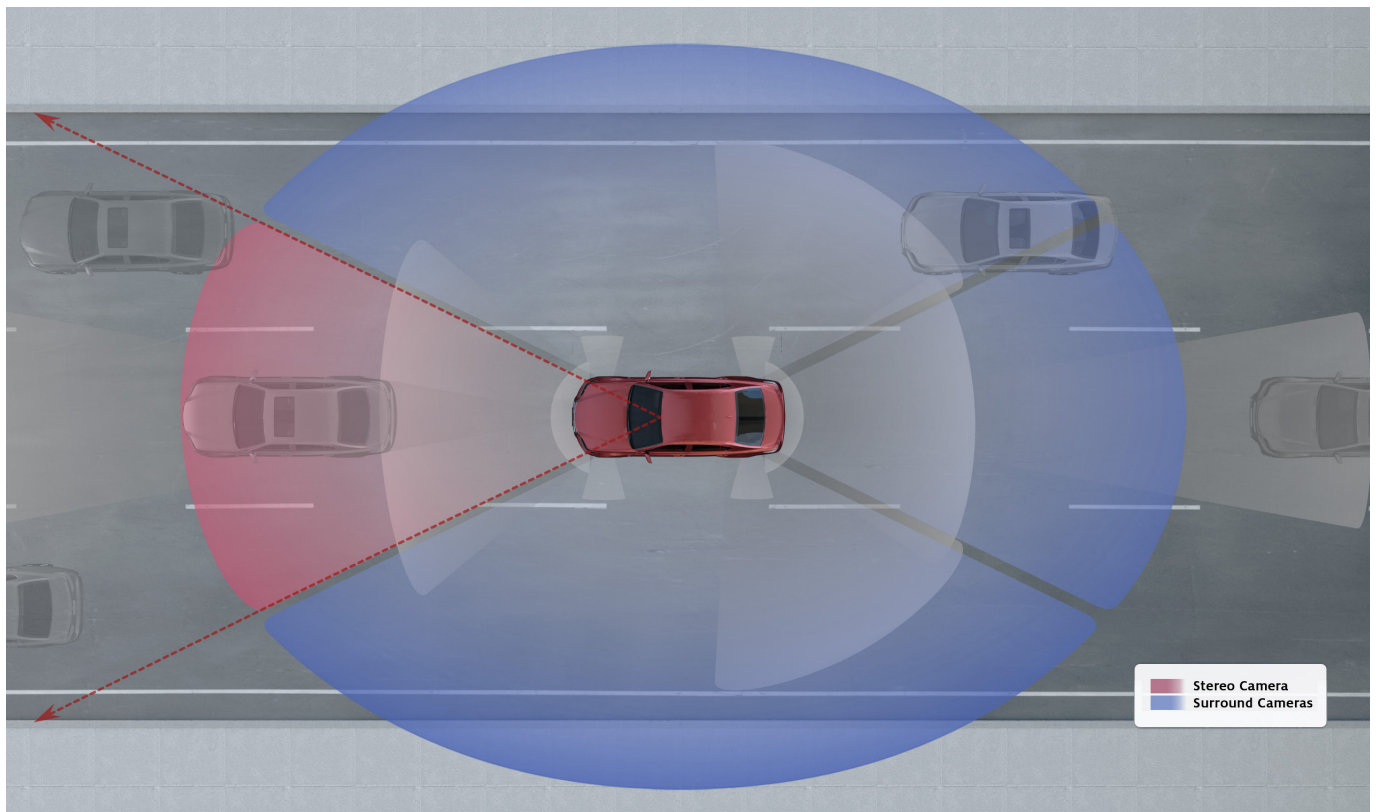
## ADAS: THE ROAD TO A SAFER DRIVING EXPERIENCE

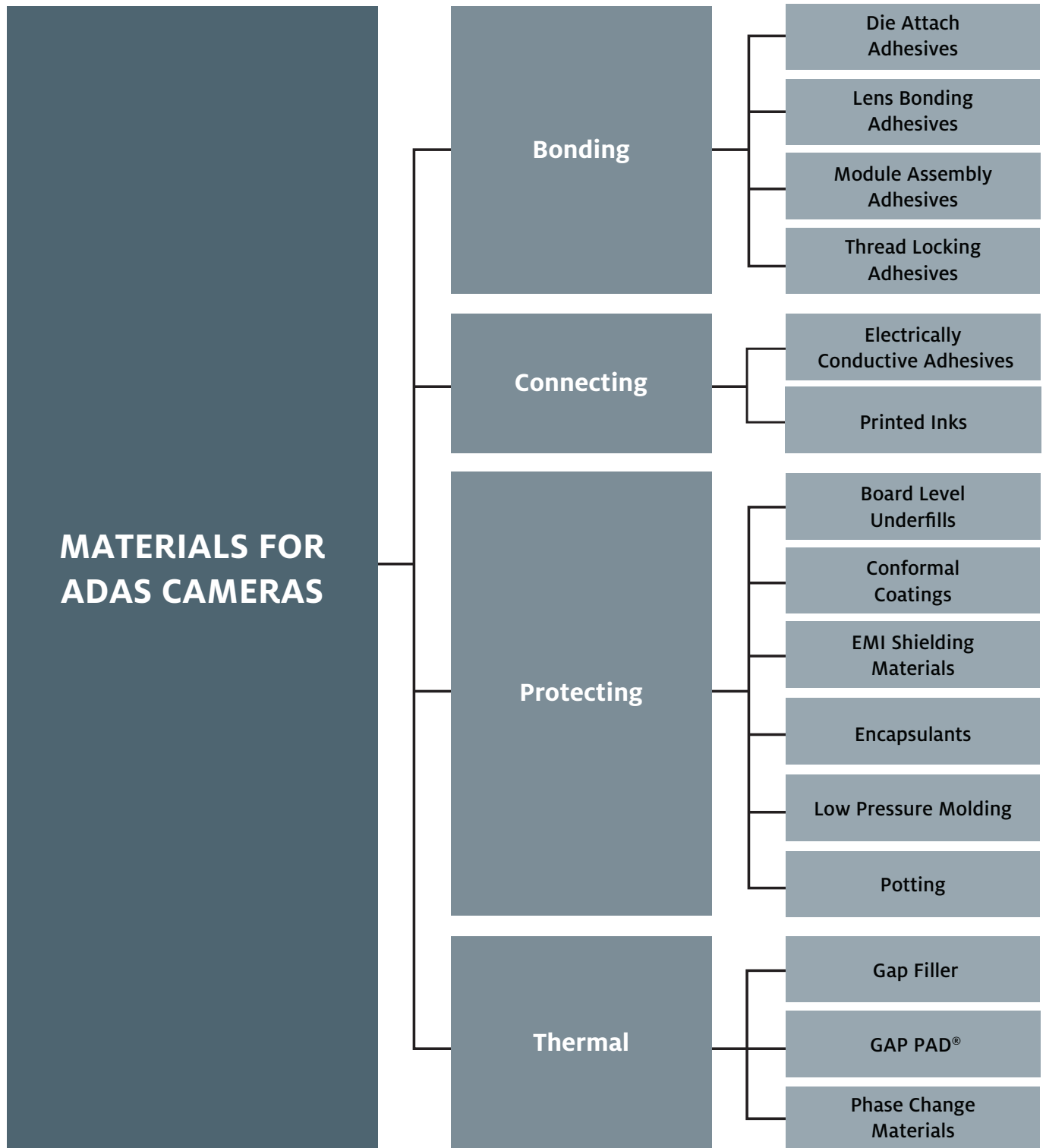
Advanced Driver Assistance Systems, commonly referred to as ADAS, are becoming far more common in modern-day vehicles. The current adoption rate of 20% is expected to grow dramatically over the next few years, as ADAS proliferation continues and new technologies deliver greater levels of safety behind the wheel. Key to enabling ADAS functionality is the cooperation of cameras, radar and LiDAR, as well as multiple ultrasonic sensor systems, all of which work in concert to identify objects, pedestrians and potential hazards for the driver. In some cases, these technologies even take independent action to ensure driver, passenger and pedestrian safety.

The camera component is essential, with today's automobiles incorporating as few as one or as many as nine cameras –and the number of cameras and the various technology types are expanding quickly. With driver safety often dependent on camera visibility, the performance reliability of these optical systems is crucial.

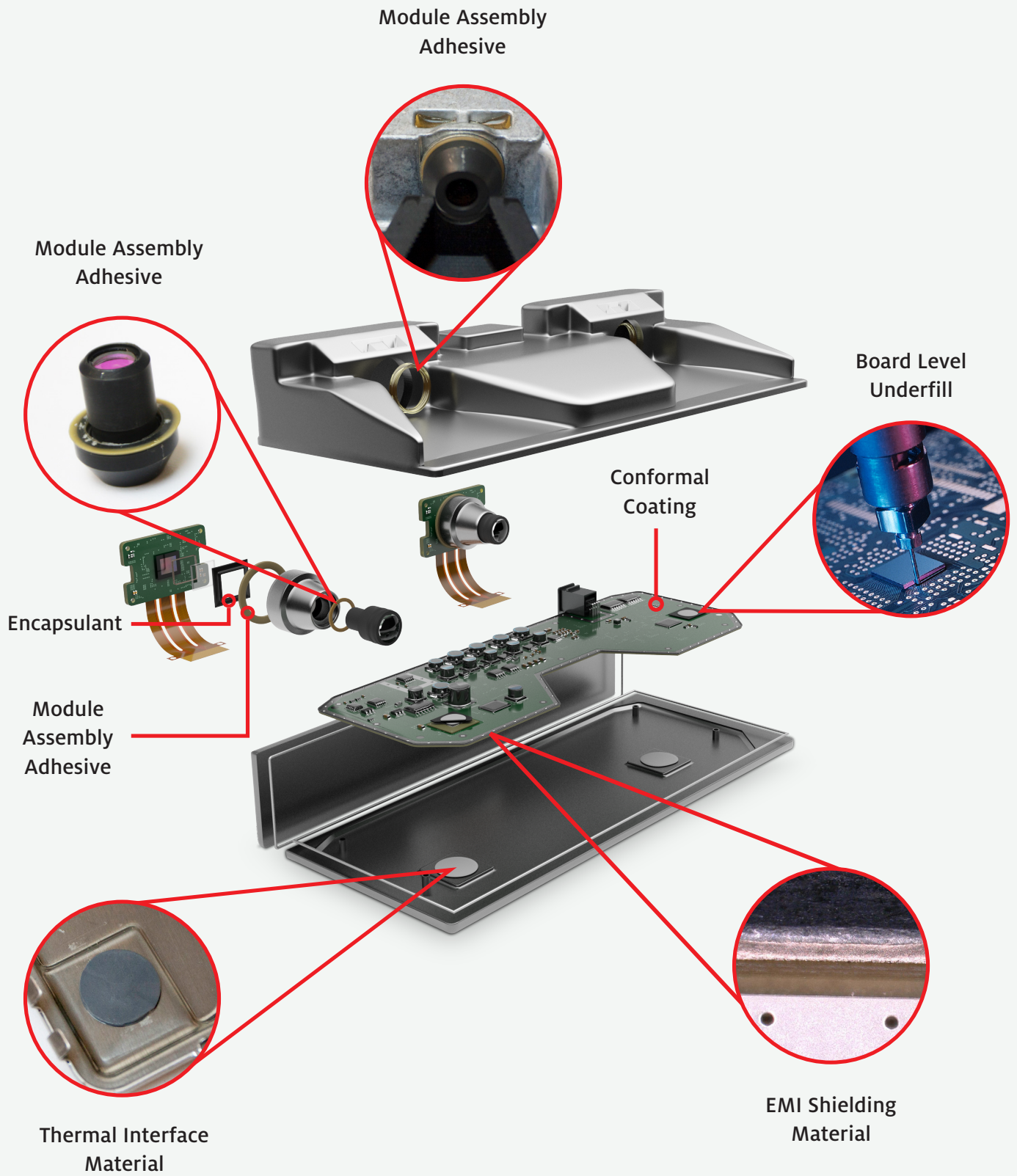
## FOCUSED EXPERTISE

As the world's leading adhesives and electronic materials supplier, Henkel's experience with innovative formulations for functional, reliability-enhancing products is broad and deep. Leveraging our successful work with the top global handheld manufacturers' camera technologies, Henkel has developed high-reliability camera materials solutions tailored to the unique requirements of automotive camera systems. At every level of camera construction – from the die within the image processor to component connection, thermal management, PCB protection and structural bonding of the final lens assembly – Henkel's automotive camera materials are the comprehensive, enabling factor for safety-enhancing functionality. The ability to facilitate reliable performance and a clear view in temperature extremes, during rough rides and after exposure to harsh conditions – all while making the move toward greener, more environmentally friendly formulations – is what sets Henkel automotive camera materials apart.

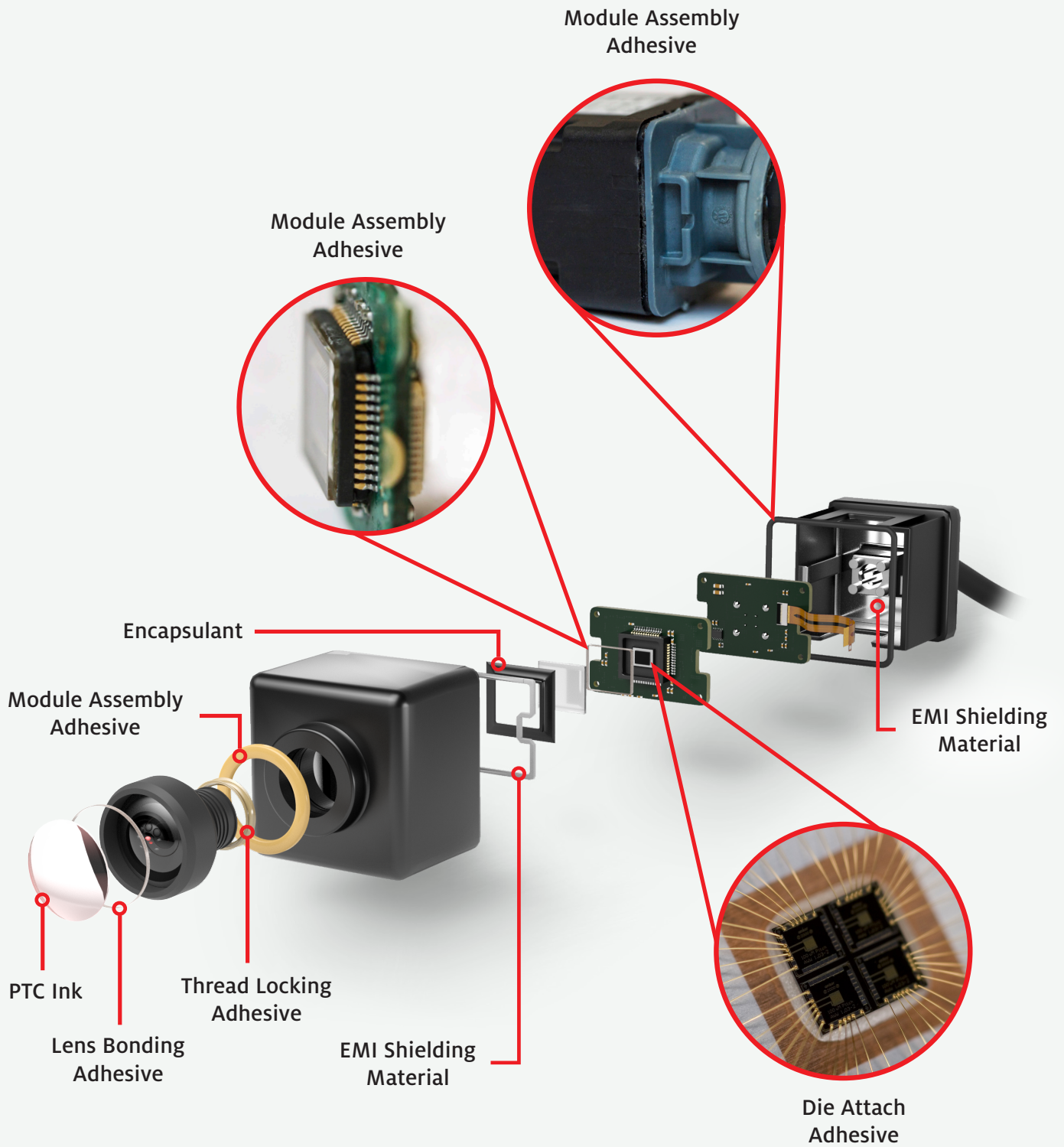




# ADAS STEREO CAMERA SOLUTIONS

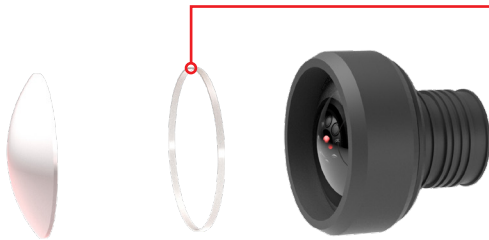


# ADAS SURROUND CAMERA SOLUTIONS



# BONDING SOLUTIONS FOR MULTIPLE ASSEMBLY APPLICATIONS

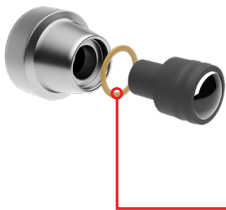
## Lens To Inside of Lens Barrel



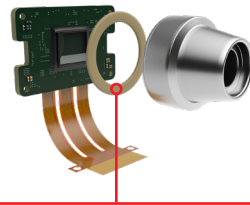
### Lens Bonding Adhesive

- Designed to attach lens to inside of lens barrel
- Specialized adhesives that accommodate low temperature processing with rapid UV cure

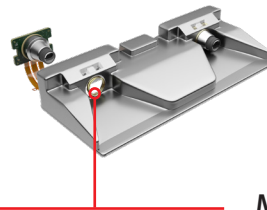
## Lens Barrel To Lens Barrel Housing



## Lens Barrel Housing To PCB



## Lens Barrel Housing To Camera Module Housing



### Module Assembly Adhesive

- Designed for bonding module housing assemblies with various surface materials

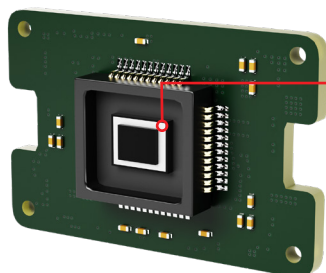
## Lens Barrel to Lens Barrel Housing



### Thread Locking Adhesive

- Designed for locking and sealing of threaded fasteners
- Used for active optical alignment of lens assemblies

## Image Sensor Die to Substrate



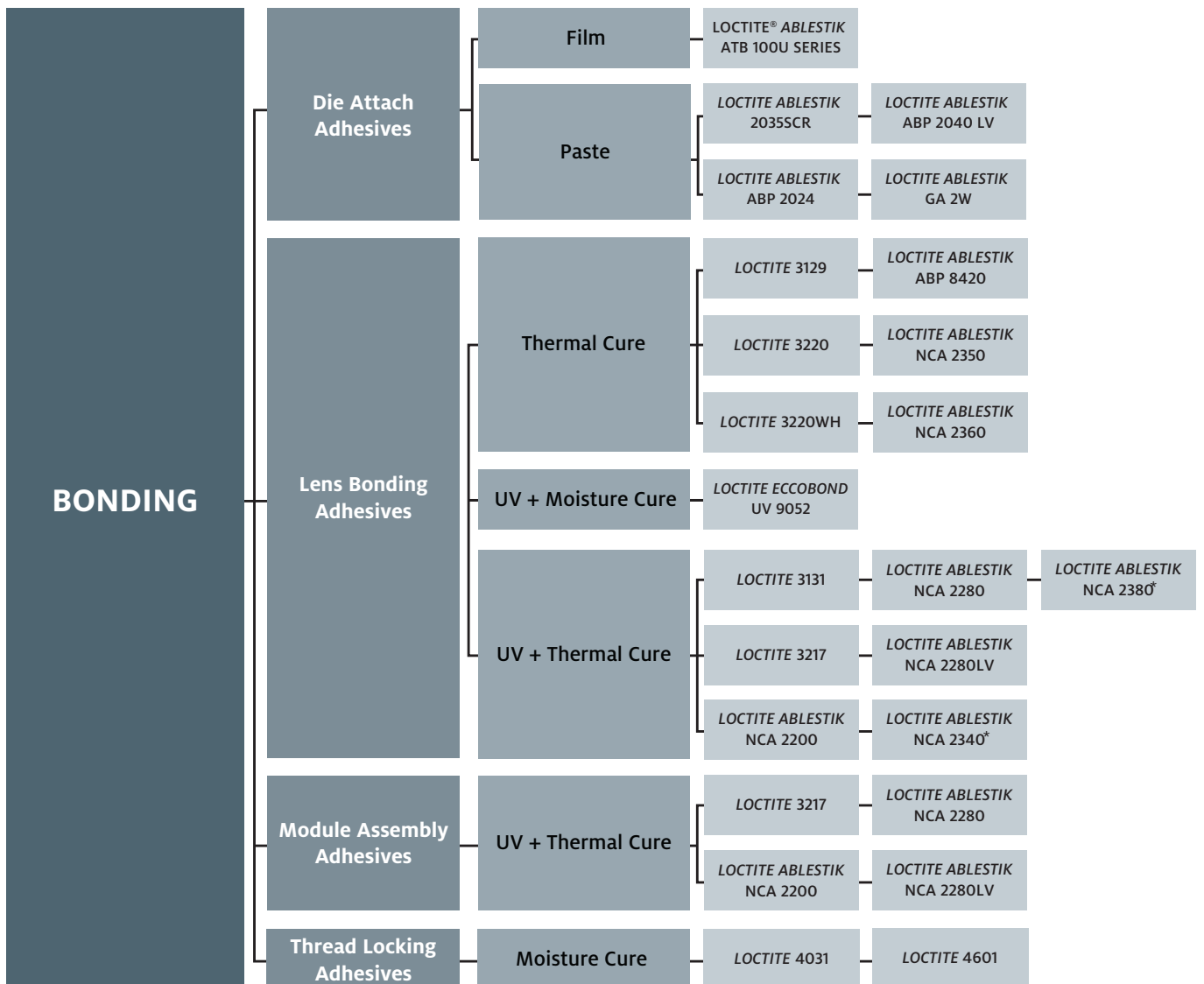
### Die Attach Adhesive

- Used to bond image sensor die to substrate
- Low-temperature cure, low-stress, low-outgassing adhesives

# BONDING MATERIALS FOR ADAS CAMERAS

## STRONG AND RELIABLE BONDS

When it comes to automotive safety, failure is not an option, making lens precision and module durability vital to camera effectiveness. Henkel’s broad portfolio of lens bonding, module assembly, thread locking and die attach adhesives– both in customized and original formulations – offer cure flexibility and processing adaptability. UV-, thermal- and dual-cure adhesives for lens bonding provide high stability, with less than a 1% change in size after cure to ensure precision active alignment and in-use focus reliability. Module assembly materials are also as versatile, with UV only, as well as dual-cure (UV and thermal) options for reliable bonding of the lens barrel, housing, PCB, camera module, IR filter and image sensor. At the chip level, non-conductive die attach adhesives in multiple formulations and mediums offer strong die bonding for reliable image sensor performance. Strong adhesion, robust temperature stability, application-specific customization and a move toward green formulations are why automotive camera specialists are increasingly turning to Henkel for bonding solutions.



\* Product not available in Europe



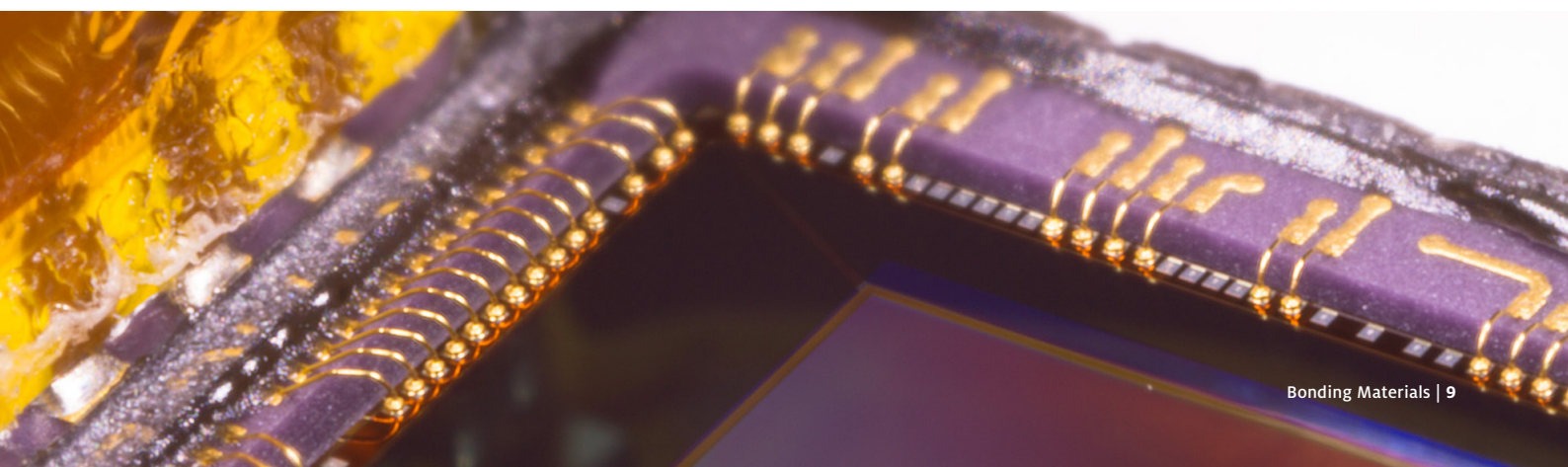
# DIE ATTACH ADHESIVES

## Die Attach Film

Product Name	Description	Key Attributes	Glass Transition Temperature, T <sub>g</sub> (°C)	Film Thickness (µm)	Coefficient of Thermal Expansion, CTE (ppm/°C)		Modulus at 25°C (MPa)	Recommended Cure
					Below T <sub>g</sub>	Above T <sub>g</sub>		
Non-Conductive								
LOCTITE® ABLESTIK ATB 100U Series	Silica-filled, rubberized epoxy die attach adhesive film	<ul style="list-style-type: none"> <li>Fast cure</li> <li>Thin bondline</li> <li>Excellent gap filling ability</li> <li>MSL2 260°C capable</li> <li>Compatible with Cu wire or Au wire packages</li> <li>Compatible with Stealth Dicing Before Grind (SDBG) process</li> </ul>	75	<ul style="list-style-type: none"> <li>15</li> <li>20</li> </ul>	62	238	875	30 min. ramp + 30 min. hold at 120°C

## Die Attach Paste

Product Name	Description	Key Attributes	Glass Transition Temperature, T <sub>g</sub> (°C)	Viscosity at 25°C	Coefficient of Thermal Expansion, CTE (ppm/°C)		Modulus at 25°C (MPa)	Recommended Cure
					Below T <sub>g</sub>	Above T <sub>g</sub>		
Non-Conductive								
LOCTITE ABLESTIK ABP 2035SCR	Silica-filled die attach adhesive	<ul style="list-style-type: none"> <li>One component</li> <li>Low stress</li> <li>Snap cure or low temperature oven cure</li> <li>Excellent dispensing performance for high throughput applications</li> <li>Compatible with dam and fill encapsulants</li> </ul>	118	9,830 at 5 rpm	50	135	1,500	2 min. at 120°C
LOCTITE ABLESTIK ABP 2024	BMI hybrid die attach adhesive	<ul style="list-style-type: none"> <li>Low outgassing</li> <li>One component</li> <li>High reliability</li> </ul>	47	13,000 at 5 rpm	127	156	510	30 min. ramp + 30 min. hold at 175°C
LOCTITE ABLESTIK ABP 2040 LV	Epoxy non-conductive die attach adhesive	<ul style="list-style-type: none"> <li>One component</li> <li>Fast cure</li> <li>Low temperature cure</li> <li>Low stress</li> <li>Low warpage</li> </ul>	28	11,000 at 5 rpm	39	129	2,603	2 min. at 120°C
LOCTITE ABLESTIK GA 2W	Acrylic die attach adhesive	<ul style="list-style-type: none"> <li>Very low stress</li> <li>Low chip warpage</li> <li>Improved viscosity</li> <li>Thixotropic</li> <li>Good dispensability</li> <li>One component</li> </ul>	25	10,000 at 5 rpm	58	164	70	30 min. ramp + 15 min. hold at 175°C



# BONDING MATERIALS FOR ADAS CAMERAS

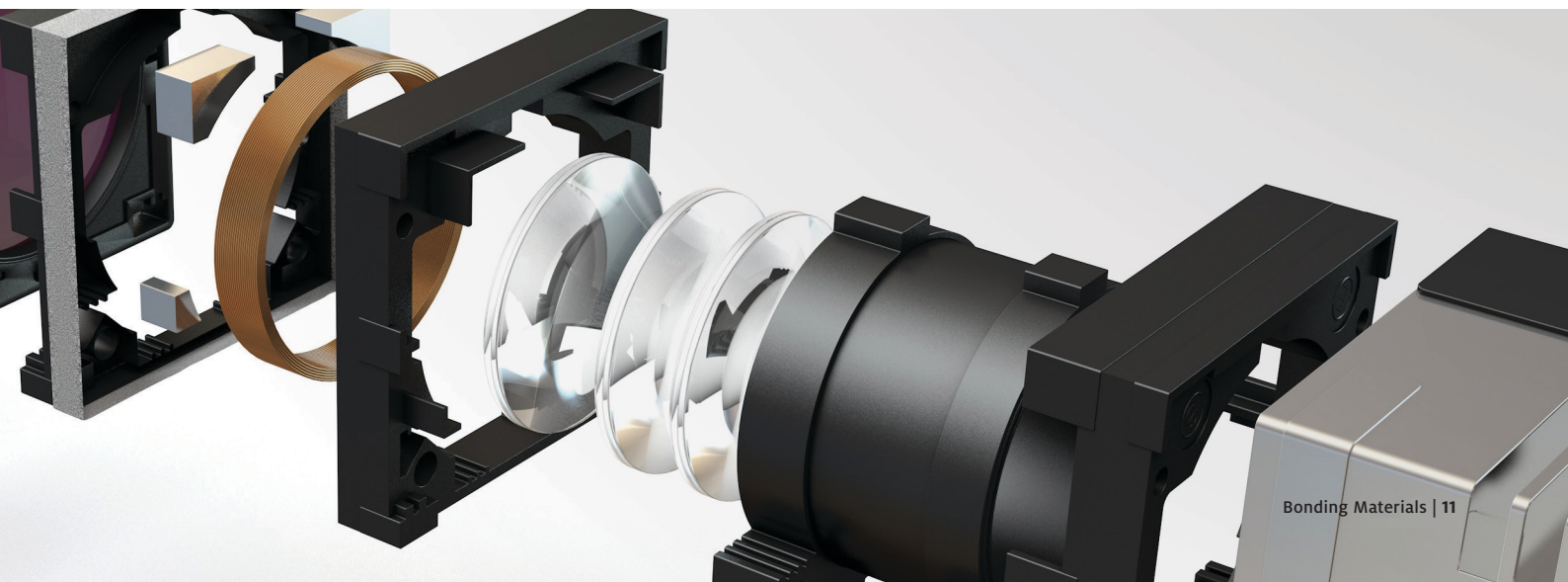
## LENS BONDING ADHESIVES

Product Name	Description	Key Attributes	Glass Transition Temperature, T <sub>g</sub> (°C)	Coefficient of Thermal Expansion, CTE (ppm/°C)		Viscosity at 25°C (cP)	Modulus at 25°C (MPa)	Recommended Cure
				Below T <sub>g</sub>	Above T <sub>g</sub>			
<b>Thermal Cure</b>								
LOCTITE 3129	Epoxy adhesive and sealant	<ul style="list-style-type: none"> <li>• Excellent adhesion</li> <li>• One component</li> <li>• Low temperature cure</li> </ul>	35	47	145	11,800	200	30 min. at 80°C
LOCTITE 3220	Epoxy adhesive and sealant	<ul style="list-style-type: none"> <li>• One component</li> <li>• Fast cure at low temperatures</li> <li>• Excellent adhesion</li> </ul>	26	47	145	8,200	3,240	5 – 10 min. at 80°C
LOCTITE 3220WH	Epoxy adhesive and sealant	<ul style="list-style-type: none"> <li>• One component</li> <li>• Fast cure at low temperatures</li> <li>• Excellent adhesion</li> <li>• White pigmentation for excellent light reflection</li> </ul>	29	55	162	8,940	550	5 – 10 min. at 80°C
LOCTITE ABLESTIK ABP 8420	Epoxy adhesive	<ul style="list-style-type: none"> <li>• Excellent resin bleed out (RBO) performance</li> <li>• Fast cure at low temperatures</li> <li>• One component</li> <li>• Good adhesion</li> <li>• Medium viscosity</li> </ul>	33	53	171	13,500	2,054	15 min. at 150°C
LOCTITE ABLESTIK NCA 2350	Epoxy adhesive and sealant	<ul style="list-style-type: none"> <li>• Fast cure at low temperatures</li> <li>• One component</li> <li>• Good adhesion</li> <li>• Hot plate or oven cure</li> <li>• Medium viscosity</li> </ul>	28	66	180	13,670	2,533	2 min. at 80°C in hot plate
LOCTITE ABLESTIK NCA 2360	Epoxy adhesive and sealant	<ul style="list-style-type: none"> <li>• Fast cure at low temperatures</li> <li>• One component</li> <li>• Good adhesion</li> <li>• Hot plate or oven cure</li> <li>• Low viscosity</li> </ul>	33	53	171	6,296	2,054	2 min. at 80°C in hot plate
<b>UV + Moisture Cure</b>								
LOCTITE ECCOBOND UV 9052	Acrylate adhesive	<ul style="list-style-type: none"> <li>• One component</li> <li>• Withstands exposure to ink</li> <li>• Cures in shadowed areas</li> <li>• No stringing</li> <li>• T<sub>g</sub> can be increased with alternative cure</li> </ul>	2	49	248	6,400	1,987	UV cure 0.5 - 1 J for 5 – 10 sec. + moisture cure at ambient humidity
<b>UV + Thermal Cure</b>								
LOCTITE 3131	Acrylated epoxy adhesive	<ul style="list-style-type: none"> <li>• Designed for image sensor module assemblies and temperature sensitive electronics components</li> <li>• Fast cure at low temperatures</li> <li>• Low viscosity</li> <li>• Low stress</li> </ul>	85	49	175	14,000	954	1 sec. at 100 mW/cm <sup>2</sup> + 30 min. at 60°C
LOCTITE 3217	Acrylated epoxy adhesive	<ul style="list-style-type: none"> <li>• Designed for image sensor module assemblies and temperature sensitive electronics components</li> <li>• Fast cure at low temperatures</li> </ul>	82	53	178	37,600	2,865	1 sec. at 100 mW/cm <sup>2</sup> + 30 min. at 60°C
LOCTITE ABLESTIK NCA 2200	Acrylated epoxy adhesive	<ul style="list-style-type: none"> <li>• One component</li> <li>• Low viscosity</li> <li>• Fast cure at low temperatures</li> <li>• Good adhesion to a variety of substrates</li> <li>• Designed for image sensor module assemblies and temperature sensitive electronics components</li> </ul>	97	43	150	22,000	5,000	2 sec. at 100 mW/cm <sup>2</sup> + 30 min. at 80°C

## LENS BONDING ADHESIVES – CONTINUED

Product Name	Description	Key Attributes	Glass Transition Temperature, T <sub>g</sub> (°C)	Coefficient of Thermal Expansion, CTE (ppm/°C)		Viscosity at 25°C (cP)	Modulus at 25°C (MPa)	Recommended Cure
				Below T <sub>g</sub>	Above T <sub>g</sub>			
UV + Thermal Cure – Continued								
LOCTITE ABLESTIK NCA 2280	Acrylated epoxy adhesive	<ul style="list-style-type: none"> <li>• One component</li> <li>• High thixotropic index</li> <li>• High viscosity</li> <li>• Black in color to prevent light penetration</li> <li>• Fast cure at low temperatures</li> <li>• Good adhesion to liquid crystal polymer (LCP) substrates</li> <li>• Designed for image sensor module assemblies and temperature sensitive electronics components</li> </ul>	90	45	156	54,000	4,500	2 sec. at 100 mW/cm <sup>2</sup> + 30 min. at 80°C
LOCTITE ABLESTIK NCA 2280LV	Acrylated epoxy adhesive	<ul style="list-style-type: none"> <li>• One component</li> <li>• High thixotropic index</li> <li>• Fast cure at low temperatures</li> <li>• Low transmittance</li> <li>• Good adhesion to liquid crystal polymer (LCP) substrates</li> <li>• Black in color to prevent light penetration</li> <li>• Designed for image sensor module assemblies and temperature sensitive electronics components</li> </ul>	75	54	160	32,800	3,000	2 sec. at 100 mW/cm <sup>2</sup> + 30 min. at 80°C
LOCTITE ABLESTIK NCA 2340*	Acrylated epoxy adhesive	<ul style="list-style-type: none"> <li>• Excellent adhesion</li> <li>• High viscosity</li> <li>• High thixotropic index</li> <li>• Designed for active alignment in camera module assemblies and temperature sensitive electronics components</li> </ul>	83	61	195	35,000	3,000	2 sec. at 100 mW/cm <sup>2</sup> + 30 min. at 80°C
LOCTITE ABLESTIK NCA 2380*	Acrylated epoxy adhesive	<ul style="list-style-type: none"> <li>• Excellent adhesion</li> <li>• Good flow performance</li> <li>• High T<sub>g</sub></li> <li>• Low CTE</li> <li>• Designed for active alignment in camera module assemblies and temperature sensitive electronics components</li> </ul>	95	56	183	35,000	3,000	3 sec. at 1000 mW/cm <sup>2</sup> + 60 min. at 80°C

\* Product not available in Europe



# BONDING MATERIALS FOR ADAS CAMERAS

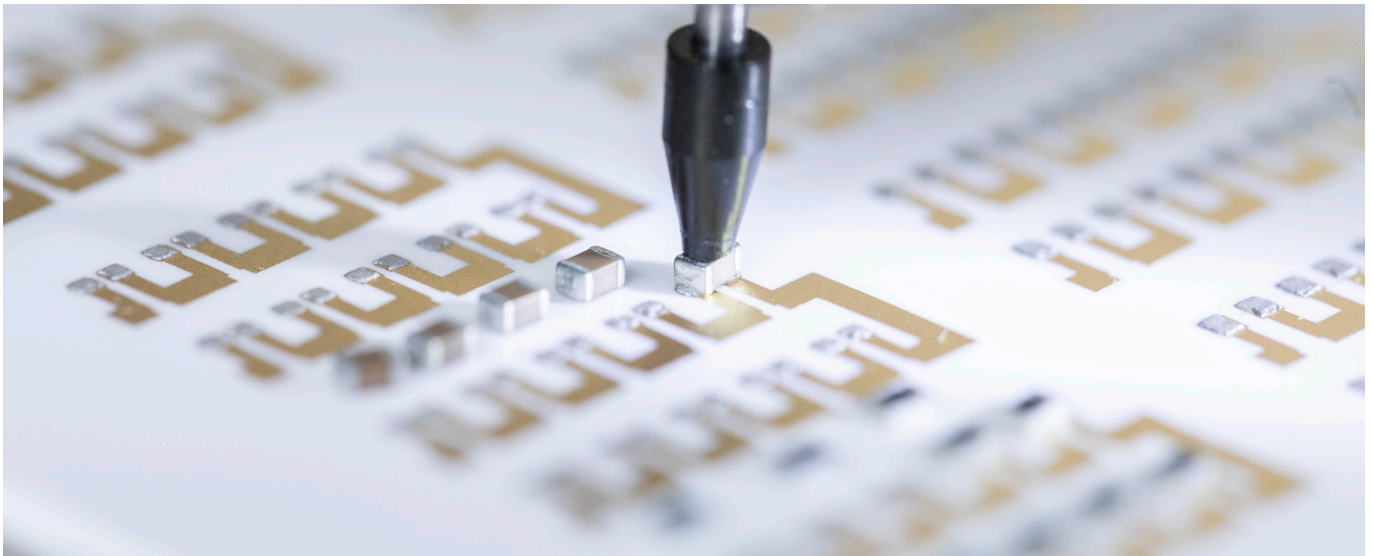
## MODULE ASSEMBLY ADHESIVES

Product Name	Description	Key Attributes	Glass Transition Temperature, T <sub>g</sub> (°C)	Coefficient of Thermal Expansion, CTE (ppm/°C)		Viscosity at 25°C (cP)	Modulus at 25°C (MPa)	Recommended Cure
				Below T <sub>g</sub>	Above T <sub>g</sub>			
UV + Thermal Cure								
LOCTITE 3217	Acrylated epoxy adhesive	<ul style="list-style-type: none"> <li>Designed for image sensor module assemblies and temperature sensitive electronics components</li> <li>Fast cure at low temperatures</li> </ul>	82	53	178	37,600	2,865	1 sec. at 100 mW/cm <sup>2</sup> + 30 min. at 60°C
LOCTITE ABLESTIK NCA 2200	Acrylated epoxy adhesive	<ul style="list-style-type: none"> <li>One component</li> <li>Low viscosity</li> <li>Fast cure at low temperatures</li> <li>Good adhesion to a variety of substrates</li> <li>Designed for image sensor module assemblies and temperature sensitive electronics components</li> </ul>	97	43	150	9,000	5,000	2 sec. at 100 mW/cm <sup>2</sup> + 30 min. at 80°C
LOCTITE ABLESTIK NCA 2280	Acrylated epoxy adhesive	<ul style="list-style-type: none"> <li>One component</li> <li>High thixotropic index</li> <li>High viscosity</li> <li>Black in color to prevent light penetration</li> <li>Fast cure at low temperatures</li> <li>Good adhesion to liquid crystal polymer (LCP) substrates</li> <li>Designed for image sensor module assemblies and temperature sensitive electronics components</li> </ul>	90	45	156	54,000	4,500	2 sec. at 100 mW/cm <sup>2</sup> + 30 min. at 80°C
LOCTITE ABLESTIK NCA 2280LV	Acrylated epoxy adhesive	<ul style="list-style-type: none"> <li>One component</li> <li>High thixotropic index</li> <li>Fast cure at low temperatures</li> <li>Low transmittance</li> <li>Good adhesion to liquid crystal polymer (LCP) substrates</li> <li>Black in color to prevent light penetration</li> <li>Designed for image sensor module assemblies and temperature sensitive electronics components</li> </ul>	75	54	160	32,800	3,000	2 sec. at 100 mW/cm <sup>2</sup> + 30 min. at 80°C

## THREAD LOCKING ADHESIVES

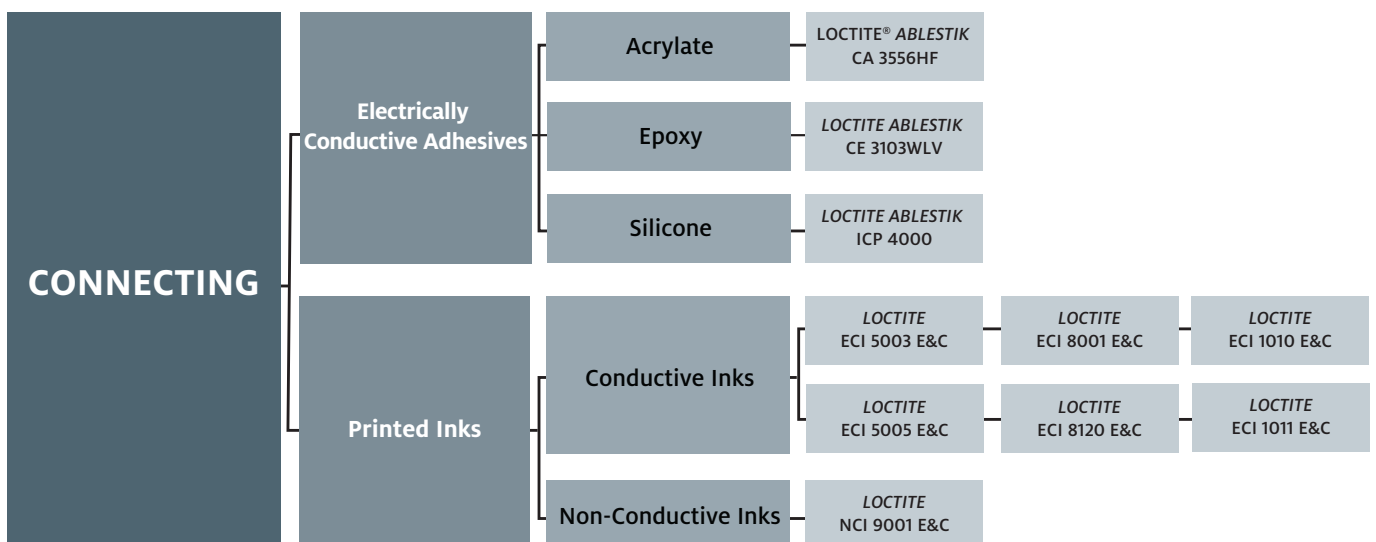
Product Name	Description	Key Attributes	Color	Viscosity at 25°C (cP)	Operating Temperature (°C)	Fixture Time at 25°C	Recommended Cure
Moisture Cure							
LOCTITE 4031	Cyanoacrylate thread locking adhesive	<ul style="list-style-type: none"> <li>One component</li> <li>Low odor for applications where vapor control is vital</li> <li>Low bloom for cosmetic applications</li> <li>Suitable for metals, plastics and elastomers</li> </ul>	Transparent, colorless to pale yellow	1,650	-50 – 70	5 – 180 sec. depending on substrate	24 hr. at 22°C
LOCTITE 4601	Cyanoacrylate thread locking adhesive	<ul style="list-style-type: none"> <li>One component</li> <li>Low odor for applications where vapor control is vital</li> <li>Low bloom for cosmetic applications</li> <li>Suitable for metals, plastics and elastomers</li> <li>Low viscosity</li> </ul>	Transparent, colorless to pale yellow	30 – 60	-50 – 70	5 – 180 sec. depending on substrate	24 hr. at 22°C

# CONNECTING MATERIALS FOR ADAS CAMERAS



## OUTSTANDING INTERCONNECTION

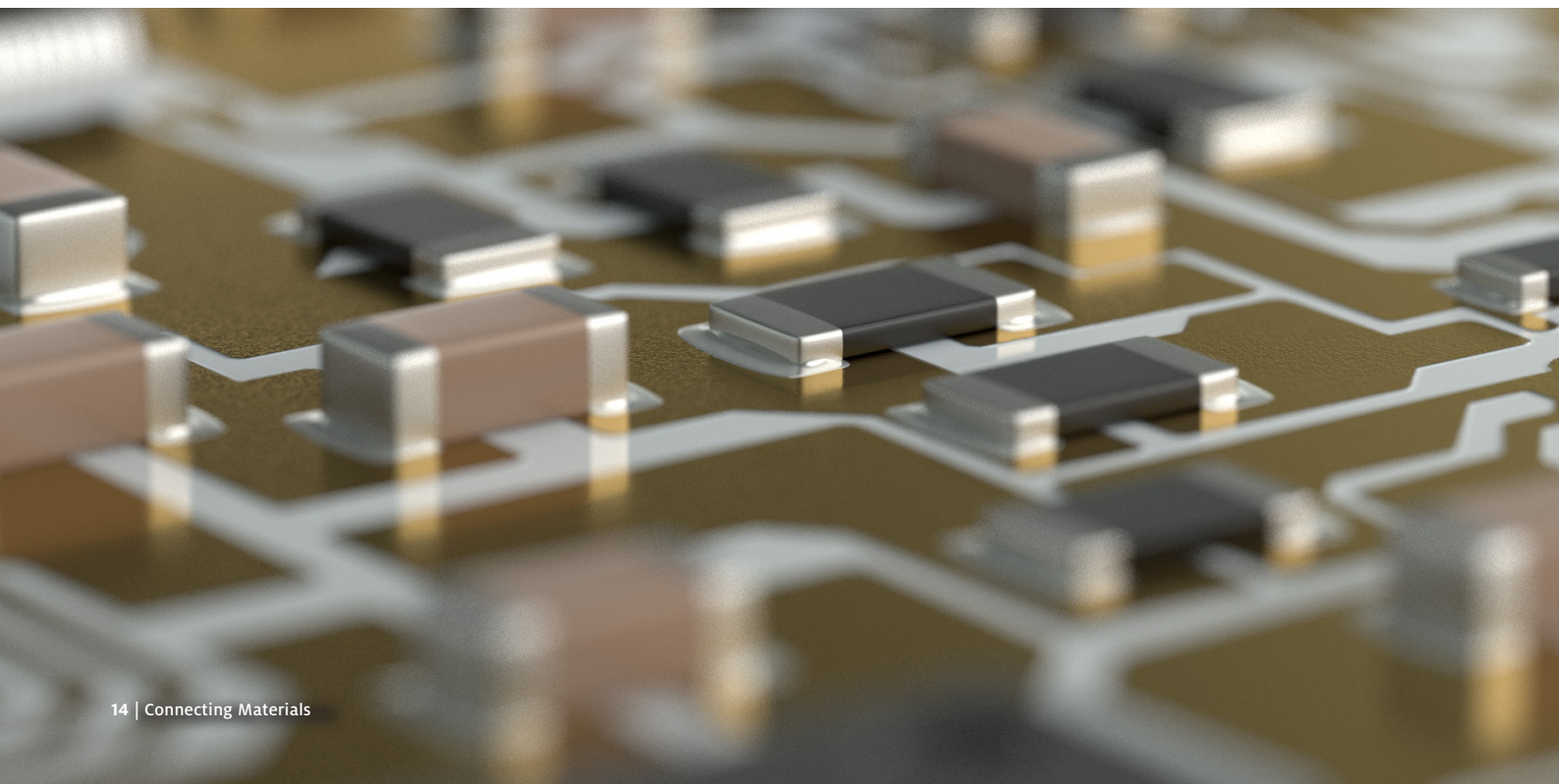
At the board level, reliable electrical interconnection is the foundation of camera function. A history of innovative connecting formulations and market firsts, Henkel continues to deliver the performance that electronics specialists require for today's demanding assemblies. As the leading global supplier of electronics assembly materials, Henkel is uniquely capable of delivering a holistic materials approach for reliable electronic performance. Electrically conductive adhesives, and innovative printed inks offer strong component and PCB interconnect for on-demand, long-term, reliable performance.



# CONNECTING MATERIALS FOR ADAS CAMERAS

## ELECTRICALLY CONDUCTIVE ADHESIVES

Product Name	Description	Key Attributes	Volume Resistivity ( $\Omega \cdot \text{cm}$ )	Glass Transition Temperature, $T_g$ ( $^{\circ}\text{C}$ )	Coefficient of Thermal Expansion, CTE (ppm/ $^{\circ}\text{C}$ )		Modulus at 25 $^{\circ}\text{C}$ (MPa)	Recommended Cure
					Below $T_g$	Above $T_g$		
Acrylate								
LOCTITE® ABLESTIK CA 3556HF	Acrylate electrically conductive adhesive	<ul style="list-style-type: none"> <li>• One component</li> <li>• Fast, low-temperature cure</li> <li>• Excellent flexibility</li> <li>• Good adhesion</li> <li>• Low contact resistance</li> </ul>	$2.5 \times 10^{-3}$	-30	95	278	650	2 min. at 110 $^{\circ}\text{C}$
Epoxy								
LOCTITE ABLESTIK CE 3103WLV	Epoxy electrically conductive adhesive	<ul style="list-style-type: none"> <li>• Pb-free alternative to solder</li> <li>• Low-temperature cure</li> <li>• Stable contact resistance</li> </ul>	$8 \times 10^{-4}$	114	45	225	4,500	10 min. at 120 $^{\circ}\text{C}$
Silicone								
LOCTITE ABLESTIK ICP 4000	Silicone electrically conductive adhesive	<ul style="list-style-type: none"> <li>• One component</li> <li>• High flexibility</li> <li>• Excellent electrical conductivity</li> <li>• High-temperature performance</li> <li>• Pb-free alternative to solder</li> <li>• High electrical current carrying capability</li> <li>• Low-temperature cure</li> <li>• Outstanding elongation performance</li> <li>• Low outgassing</li> </ul>	$6 \times 10^{-5}$	-45	N/A	330	101	1 hr. at 130 $^{\circ}\text{C}$



# PRINTED INKS

## Conductive Inks

Product Name	Description	Key Attributes	Coverage at 10 $\mu\text{m}$ ( $\text{m}^2/\text{kg}$ )	Sheet Resistance ( $\Omega/\text{sq}/25 \mu\text{m}$ )	Processing	Substrates	Recommended Cure
<b>Transparent Inks</b>							
LOCTITE ECI 5003 E&C	Conductive printable ink	<ul style="list-style-type: none"> <li>Low temperature cure</li> <li>No need for laser etching</li> </ul>	2.6	< 100	• Screenprint	• PET*	3 min. at 85°C + 5 min. at 140°C
LOCTITE ECI 5005 E&C	Conductive printable ink	<ul style="list-style-type: none"> <li>Low temperature cure</li> <li>ITO replacement</li> </ul>	2.6	< 100	• Screenprint	• PET*	3 min. at 85°C + 5 min. at 140°C
<b>PTC Carbon Inks</b>							
LOCTITE ECI 8001 E&C	Positive temperature coefficient (PTC) printable ink	<ul style="list-style-type: none"> <li>Flexible</li> <li>Printable on most common substrates</li> <li>Self-regulating heater with PTC temperature of 65°C</li> </ul>	48	1,700	• Screenprint	<ul style="list-style-type: none"> <li>Polyester</li> <li>PEN**</li> <li>Polyimide film</li> <li>PET*</li> </ul>	10 min. at 120°C
LOCTITE ECI 8120 E&C	Positive temperature coefficient (PTC) printable ink	<ul style="list-style-type: none"> <li>Flexible</li> <li>Printable on most common substrates</li> <li>Self-regulating heater with PTC temperature of 120°C</li> </ul>	43	1,700	• Screenprint	<ul style="list-style-type: none"> <li>Polyester</li> <li>PEN**</li> <li>Polyimide film</li> <li>PET*</li> </ul>	10 min. at 140°C
<b>Silver Inks</b>							
LOCTITE ECI 1010 E&C	Conductive printable ink	<ul style="list-style-type: none"> <li>Flexible</li> <li>Good adhesion</li> <li>High conductivity with optimum mechanical performance</li> <li>Compatible with LOCTITE EDAG 440A E&amp;C, LOCTITE EDAG 440B E&amp;C and LOCTITE EDAG PF 455B E&amp;C</li> </ul>	10.6	0.007	• Screenprint	<ul style="list-style-type: none"> <li>Polyimide film</li> <li>PET*</li> </ul>	15 min. at 120°C
LOCTITE ECI 1011 E&C	Flexography and conductive printable ink	<ul style="list-style-type: none"> <li>High conductivity</li> <li>Small particle size</li> <li>Excellent adhesion</li> <li>Excellent printability with flexography</li> <li>Flexible</li> </ul>	8.3	< 0.005	<ul style="list-style-type: none"> <li>Screenprint</li> <li>Flexographic</li> <li>Rotogravure</li> </ul>	<ul style="list-style-type: none"> <li>Paper</li> <li>PET*</li> <li>Polyimide film</li> <li>ITO film***</li> </ul>	10 min. at 150°C

## Non-Conductive Inks

Product Name	Description	Key Attributes	Coverage at 10 $\mu\text{m}$ ( $\text{m}^2/\text{kg}$ )	Processing	Substrates	Recommended Cure
<b>Dielectric Inks</b>						
LOCTITE NCI 9001 E&C	Printable dielectric ink	<ul style="list-style-type: none"> <li>Insulating</li> <li>Excellent transparency</li> <li>Good flexibility</li> <li>Minimal dielectric strength</li> <li>Excellent flexibility</li> <li>Resistant to abrasion</li> <li>Primer coat to adhere to difficult substrates</li> </ul>	18.8	<ul style="list-style-type: none"> <li>Screenprint</li> <li>Flexographic</li> </ul>	<ul style="list-style-type: none"> <li>Flexible copper circuits</li> <li>ITO*** sputtered polyester film</li> <li>Metals</li> <li>Glass</li> </ul>	5 min. at 130°C

\*Polyethylene terephthalate (PET)

\*\*Polyethylene naphthalate (PEN)

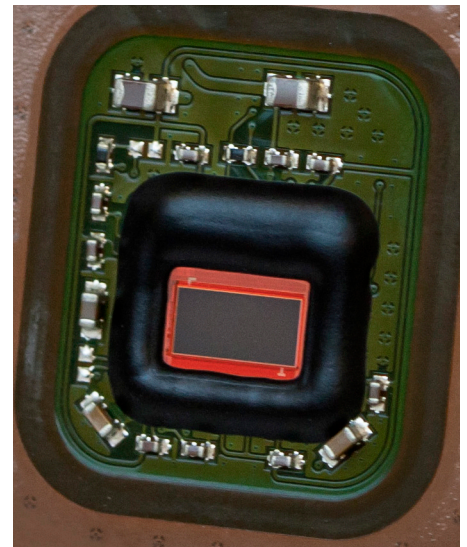
\*\*\*Indium-tin-oxide (ITO)

# PROTECTING MATERIALS FOR ADAS CAMERAS

## RELIABLE CIRCUIT BOARD PROTECTION

Safeguarding all elements of automotive cameras from the effects of moisture, corrosion, adverse environmental conditions, electromagnetic interference, vibration and shock is vital. With many camera technologies now integrated into the vehicle’s exterior bumpers, proper protection against external conditions guarantees dependable function. Henkel’s range of protecting materials is broad, covering everything from conformal coatings for PCB performance longevity to underfills and encapsulants for image sensor reliability, and EMI shielding coatings and sealants for minimized signal noise.

This focus on exceptional protection extends from the inside out – all the way to the camera housing, where Henkel’s TECHNOMELT® low-pressure molding materials offer a fast, cost-effective alternative to traditional plastic injected molding techniques, and our potting materials provide rugged defense for cameras mounted on vehicle exteriors. With Henkel materials protecting them, automotive cameras are fail-safe.



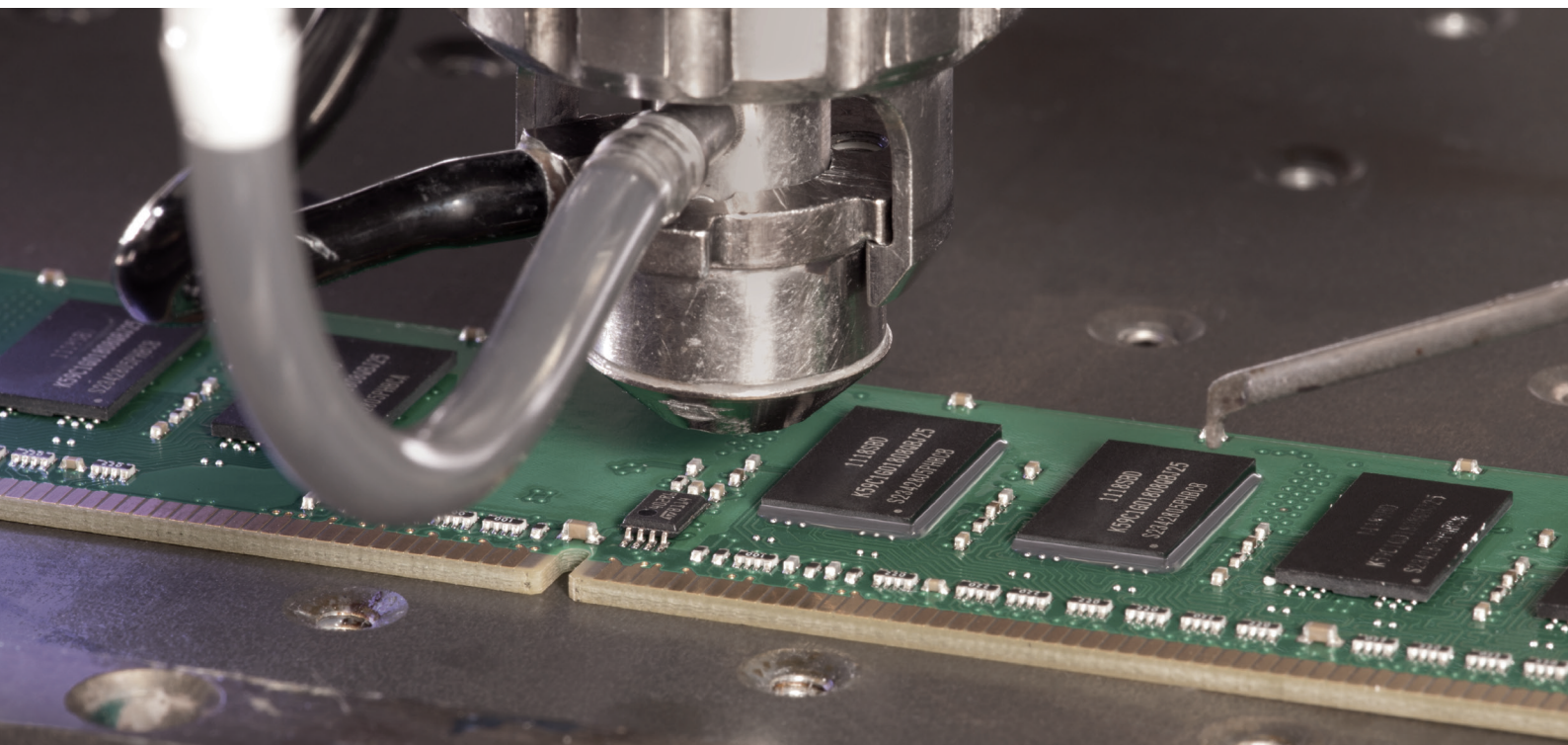
<b>PROTECTING</b>	<b>Board Level Underfills</b>	<b>Capillary</b>	LOCTITE® ECCOBOND E 1172A	LOCTITE ECCOBOND E 1216M	LOCTITE ECCOBOND FP4531	
		<b>CORNERBOND</b>	LOCTITE 3508NH			
		<b>EDGEBOND</b>	LOCTITE 3128	LOCTITE 3705		
	<b>Conformal Coatings</b>	<b>UV + Moisture Cure</b>	LOCTITE SI 5290	LOCTITE SI 5293	LOCTITE STYCAST PC 40-UMF	LOCTITE STYCAST UV 7993
	<b>EMI Shielding Materials</b>	<b>Assembly-Level EMI Shielding Coatings</b>	LOCTITE EDAG 437 E&C	LOCTITE EDAG 440 AS E&C	LOCTITE EDAG 1415M E&C	
		<b>Assembly-Level EMI Shielding Gasketing</b>	LOCTITE ABLESTIK SI 5421			
		<b>Package-Level EMI Shielding Coatings</b>	LOCTITE EMI 8660S	LOCTITE EMI 8880S		
	<b>Encapsulants</b>	<b>Dam</b>	LOCTITE ECCOBOND FP4451TD			
		<b>Fill</b>	LOCTITE ECCOBOND FP4450			
		<b>Glob Top</b>	LOCTITE ECCOBOND E01072			
	<b>Low Pressure Molding</b>	<b>High-Temperature Resistant</b>	TECHNOMELT® PA 673	TECHNOMELT PA 678	TECHNOMELT PA 682	TECHNOMELT PA 687
		<b>Increased Hardness</b>	TECHNOMELT PA 641	TECHNOMELT PA 646		
	<b>Potting</b>	<b>Two-Component</b>	LOCTITE UK U-09FL			



## BOARD LEVEL UNDERFILLS

### Capillary Underfills

Product Name	Description	Key Attributes	Modulus at 25°C (MPa)	Glass Transition Temperature, T <sub>g</sub> (°C)	Coefficient of Thermal Expansion, CTE (ppm/°C)		Pot Life	Recommended Cure
					Below T <sub>g</sub>	Above T <sub>g</sub>		
LOCTITE® ECCOBOND E 1172 A	Non-reworkable, capillary flow, epoxy underfill	<ul style="list-style-type: none"> <li>• Snap curable</li> <li>• Fast cure at low temperatures</li> <li>• One component</li> <li>• Non-anhydride curing chemistry</li> <li>• Void-free</li> </ul>	10,000	135	27	85	48 hr. at 25°C	6 min. at 135°C
LOCTITE E 1216M	Non-reworkable capillary flow underfill	<ul style="list-style-type: none"> <li>• Snap or inline cure</li> <li>• Fast, void-free underfill of area array devices</li> <li>• Excellent stability during shipping, storage and use</li> <li>• Excellent adhesion and strength</li> <li>• Non-anhydride curing chemistry</li> </ul>	2,970	125	35	131	5 days at 25°C	3 min. at 165°C
LOCTITE ECCOBOND FP4531	Capillary flow underfill	<ul style="list-style-type: none"> <li>• Snap curable</li> <li>• Fast flow</li> <li>• High adhesion strength</li> <li>• Proven workability at high temperatures</li> <li>• Qualified in automotive reliability conditions</li> </ul>	7,600	161	28	104	24 hr. at 25°C	7 min. at 160°C

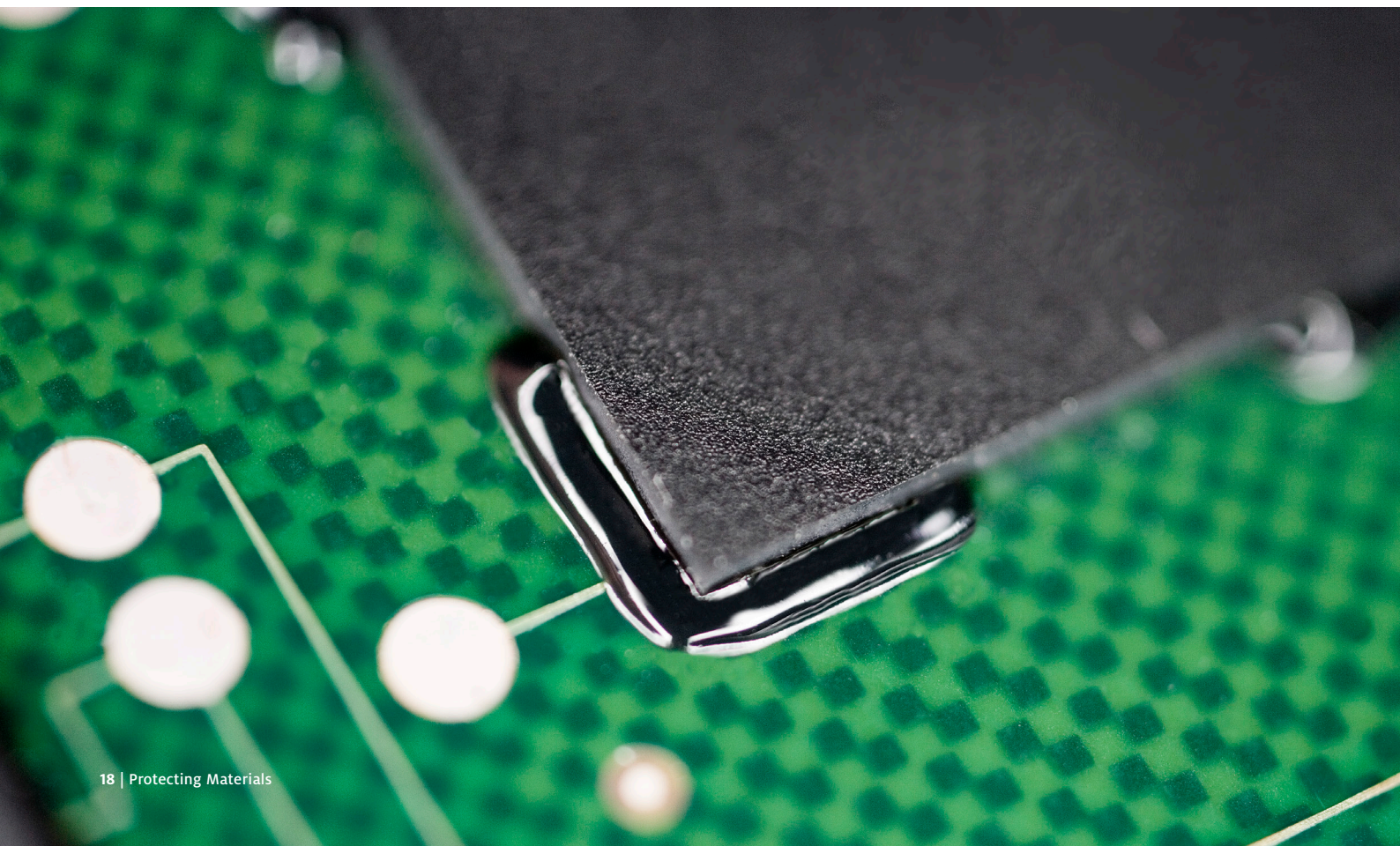


# PROTECTING MATERIALS FOR ADAS CAMERAS

## BOARD LEVEL UNDERFILLS – CONTINUED

### CORNERBOND @ EDGEBOND Underfills

Product Name	Description	Key Attributes	Viscosity at 25°C (cP)	Glass Transition Temperature, T <sub>g</sub> (°C)	Coefficient of Thermal Expansion, CTE (ppm/°C)		Pot Life	Recommended Cure
					Below T <sub>g</sub>	Above T <sub>g</sub>		
<i>CORNERBOND</i>								
LOCTITE 3508NH	Reworkable epoxy underfill	<ul style="list-style-type: none"> <li>• One component</li> <li>• Reflow curable</li> <li>• Eliminates post-reflow dispense and cure steps</li> <li>• Reworkable</li> <li>• Halogen-free</li> </ul>	70,000	118	65	175	30 days at 25°C	Cure during Pb-free solder reflow profile at 245°C
<i>EDGEBOND</i>								
LOCTITE 3128	Epoxy underfill	<ul style="list-style-type: none"> <li>• One component</li> <li>• Low temperature cure</li> <li>• Excellent adhesion to a wide range of materials</li> </ul>	22,000	45	40	130	3 weeks at 25°C	20 min. at 80°C bondline temperature
LOCTITE 3705	Acrylate underfill	<ul style="list-style-type: none"> <li>• One component</li> <li>• Thixotropic</li> <li>• Medium viscosity</li> <li>• Fast UV cure</li> <li>• No post cure required</li> <li>• Good adhesion to a variety of substrates</li> </ul>	44,000	-39 (T <sub>g</sub> 1) 77 (T <sub>g</sub> 2)	66	151	30 days at 25°C	80 sec. at 30 mW/cm <sup>2</sup>



## CONFORMAL COATINGS

Product Name	Description	Key Attributes	Viscosity at 25°C (cP)	Operating Temperature (°C)	Volume Resistivity ( $\Omega \cdot \text{cm}$ )	Color	Recommended Cure
<b>UV + Moisture Cure</b>							
LOCTITE SI 5290	Silicone conformal coating	<ul style="list-style-type: none"> <li>One component</li> <li>Designed for severe temperature environments and high-reliability automotive applications</li> <li>Solvent-free</li> </ul>	100 – 350	-53 – 200	$2 \times 10^{14}$	Transparent amber to yellow	20 – 40 sec. at 70 mW/cm <sup>2</sup> + 72 hr. at 50% relative humidity
LOCTITE SI 5293	Silicone conformal coating	<ul style="list-style-type: none"> <li>One component</li> <li>Exhibits positive fluorescence under UV light</li> <li>Repairable</li> <li>Solvent-free</li> <li>Designed for severe temperature environments and high-reliability automotive applications</li> </ul>	400 – 800	-40 – 200	$1 \times 10^{14}$	Transparent amber to yellow	20 – 40 sec. per side at 70 mW/cm <sup>2</sup> + 72 hr. at 50% relative humidity
LOCTITE STYCAST PC 40-UMF	Urethane acrylate conformal coating	<ul style="list-style-type: none"> <li>One component</li> <li>VOC-free</li> <li>Conforms to IPC-CC-830 requirements</li> </ul>	250	-40 – 135	$3.5 \times 10^{16}$	Clear	10 sec. at 300 – 600 mW/cm <sup>2</sup> + 2 – 3 days at atmospheric moisture
LOCTITE STYCAST UV 7993	Urethane conformal coating	<ul style="list-style-type: none"> <li>One component</li> <li>Solvent-free</li> <li>Good moisture resistance</li> <li>Excellent chemical resistance</li> </ul>	120	-40 – 130	$2.2 \times 10^{16}$	Translucent yellow	5 sec. at 400 – 700 mW/cm <sup>2</sup> + 100 hr. at 50% relative humidity

## EMI SHIELDING MATERIALS

### Assembly-Level EMI Shielding Coatings

Product Name	Description	Key Attributes	Attenuation	Sheet Resistance ( $\Omega/\text{sq}/25 \mu\text{m}$ )	Surfaces	Coverage at 10 $\mu\text{m}$ (m <sup>2</sup> /kg)	Recommended Cure
LOCTITE EDAG 437 E&C	Cu-filled, thermoplastic EMI shielding coating	<ul style="list-style-type: none"> <li>Burnish resistant</li> <li>Excellent environmental resistance</li> <li>Stable electrical properties after heat cycling</li> <li>Excellent shielding against radiated electromagnetic interference (EMI) and protection against electrostatic discharge (ESD)</li> <li>Room temperature cure</li> </ul>	50 – 70 dB at 50 $\mu\text{m}$	< 0.5	Plastic	23	30 min. at 25°C
LOCTITE EDAG 440 AS E&C	Ni-filled, thermoplastic EMI shielding coating	<ul style="list-style-type: none"> <li>Excellent shielding against radiated electromagnetic interference (EMI)</li> <li>Protection against electrostatic discharge (ESD)</li> <li>Stable in difficult environmental conditions such as high humidity or heat</li> <li>Room temperature or heat cure</li> </ul>	50 – 70 dB at 50 $\mu\text{m}$	< 0.5	Plastic	17	20 min. at 70°C
LOCTITE EDAG 1415M E&C	Ag-filled, thermoplastic EMI shielding coating	<ul style="list-style-type: none"> <li>Excellent shielding against radiated electromagnetic interference (EMI)</li> <li>Maintains low resistance after exposure to heat, cold, humidity and salt spray</li> <li>Air drying system that requires no primer or top coat</li> <li>Room temperature or heat cure</li> </ul>	60 dB at 25 $\mu\text{m}$	< 0.015	Plastic	9	30 min. at 70°C

# PROTECTING MATERIALS FOR ADAS CAMERAS

## EMI SHIELDING MATERIALS – CONTINUED

### Assembly-Level EMI Shielding Gasketing

Product Name	Description	Key Attributes	Attenuation	Shore A Hardness	Volume Resistivity ( $\Omega\cdot\text{cm}$ )	Tensile Lap Show Strength, N/m <sup>2</sup> (TLSS)	Recommended Cure
LOCTITE SI 5421	Ag-filled, silicone gasketing material	<ul style="list-style-type: none"> <li>Room temperature cure</li> <li>Low stress</li> <li>High flexibility</li> </ul>	<ul style="list-style-type: none"> <li>80 dB at 10 MHz</li> <li>110 dB at 100 MHz</li> <li>100 dB at 10 GHz</li> </ul>	50 – 65	$< 1 \times 10^{-2}$	0.7	24 hr. at 25°C

### Package-Level EMI Shielding Coatings

Product Name	Description	Key Attributes	Attenuation	Volume Resistivity ( $\Omega\cdot\text{cm}$ )	Surfaces	Coating Thickness ( $\mu\text{m}$ )	Recommended Cure
LOCTITE ABLESTIK EMI 8660S	Package-level, conformal EMI shielding coating	<ul style="list-style-type: none"> <li>Thinly spray-coated material provides uniform coverage on top and sidewalls of package</li> <li>Excellent adhesion to mold compound</li> <li>Excellent EMI shielding performance at &gt; 100 MHz</li> </ul>	90 dB at 3 $\mu\text{m}$	$1.5 \times 10^{-5}$	<ul style="list-style-type: none"> <li>Epoxy mold compound</li> <li>Copper</li> </ul>	3 – 5	1 hr. at 175°C in air
LOCTITE ABLESTIK EMI 8880S	Package-level, conformal EMI shielding coating	<ul style="list-style-type: none"> <li>Thinly spray-coated material provides uniform coverage on top and sidewalls of package</li> <li>Excellent adhesion to mold compound</li> <li>Excellent EMI shielding performance at &gt; 10 MHz</li> </ul>	90 dB at 3 $\mu\text{m}$	$7.9 \times 10^{-6}$	<ul style="list-style-type: none"> <li>Epoxy mold compound</li> <li>Copper</li> </ul>	3 – 5	1 hr. at 175°C in air

## ENCAPSULANTS

Product Name	Description	Key Attributes	Viscosity at 25°C (cP)	Glass Transition Temperature, T <sub>g</sub> (°C)	Coefficient of Thermal Expansion, CTE (ppm/°C)		Modulus at 25°C (MPa)	Recommended Cure
					Below T <sub>g</sub>	Above T <sub>g</sub>		
<b>Dam</b>								
LOCTITE ECCOBOND FP4451TD	Epoxy dam encapsulant	<ul style="list-style-type: none"> <li>Excellent chemical resistance and thermal stability</li> <li>High thixotropy with high height-to-width aspect ratio (0.7)</li> <li>Designed for use with fill encapsulant LOCTITE ECCOBOND FP4450</li> </ul>	300,000	150	21	65	14,300	30 min. at 125°C + 90 min. at 165°C
<b>Fill</b>								
LOCTITE ECCOBOND FP4450	Epoxy fill encapsulant	<ul style="list-style-type: none"> <li>Low stress</li> <li>Good moisture resistance and excellent chemical resistance</li> <li>Exhibits relatively high flow</li> <li>Excellent pressure pot performance on live devices up to 500 hr.</li> </ul>	43,900	155	22	80	13,500	30 min. at 125°C + 90 min. at 165°C
<b>Glob Top</b>								
LOCTITE ECCOBOND E01072	Epoxy glob top encapsulant	<ul style="list-style-type: none"> <li>High T<sub>g</sub></li> <li>Low extractable ionics</li> <li>High performance</li> <li>Long shelf life</li> <li>Fast curing</li> <li>One component</li> </ul>	80,000	135	43	123	6,700	5 min. at 140°C – 150°C

## LOW PRESSURE MOLDING

Product Name	Description	Key Attributes	Color	Operating Temperature (°C)	Shore Hardness	Flammability Rating	Glass Transition Temperature, T <sub>g</sub> (°C)
Increased Hardness							
TECHNOMELT® PA 641	Moldable polyamide	<ul style="list-style-type: none"> <li>• Ideal for applications where strength and hardness are needed</li> <li>• Good adhesion for high-temperature applications</li> </ul>	Amber	-40 – 125	92A	UL 94 V-0	-30
TECHNOMELT PA 646			Black				
High-Temperature Resistant							
TECHNOMELT PA 673	Moldable polyamide	<ul style="list-style-type: none"> <li>• Good adhesion to a variety of substrates</li> <li>• Excellent moisture resistance</li> <li>• Excellent environmental resistance</li> <li>• Good adhesion for high-temperature applications</li> </ul>	Amber	-40 – 140	88A	UL 94 V-0	-45
TECHNOMELT PA 678			Black				
TECHNOMELT PA 682	Moldable polyamide	<ul style="list-style-type: none"> <li>• Suitable for high-humidity applications</li> <li>• Formulated for very low water vapor transmission</li> </ul>	Amber	-40 – 150	88A	UL 94 V-0	-40
TECHNOMELT PA 687			Black				

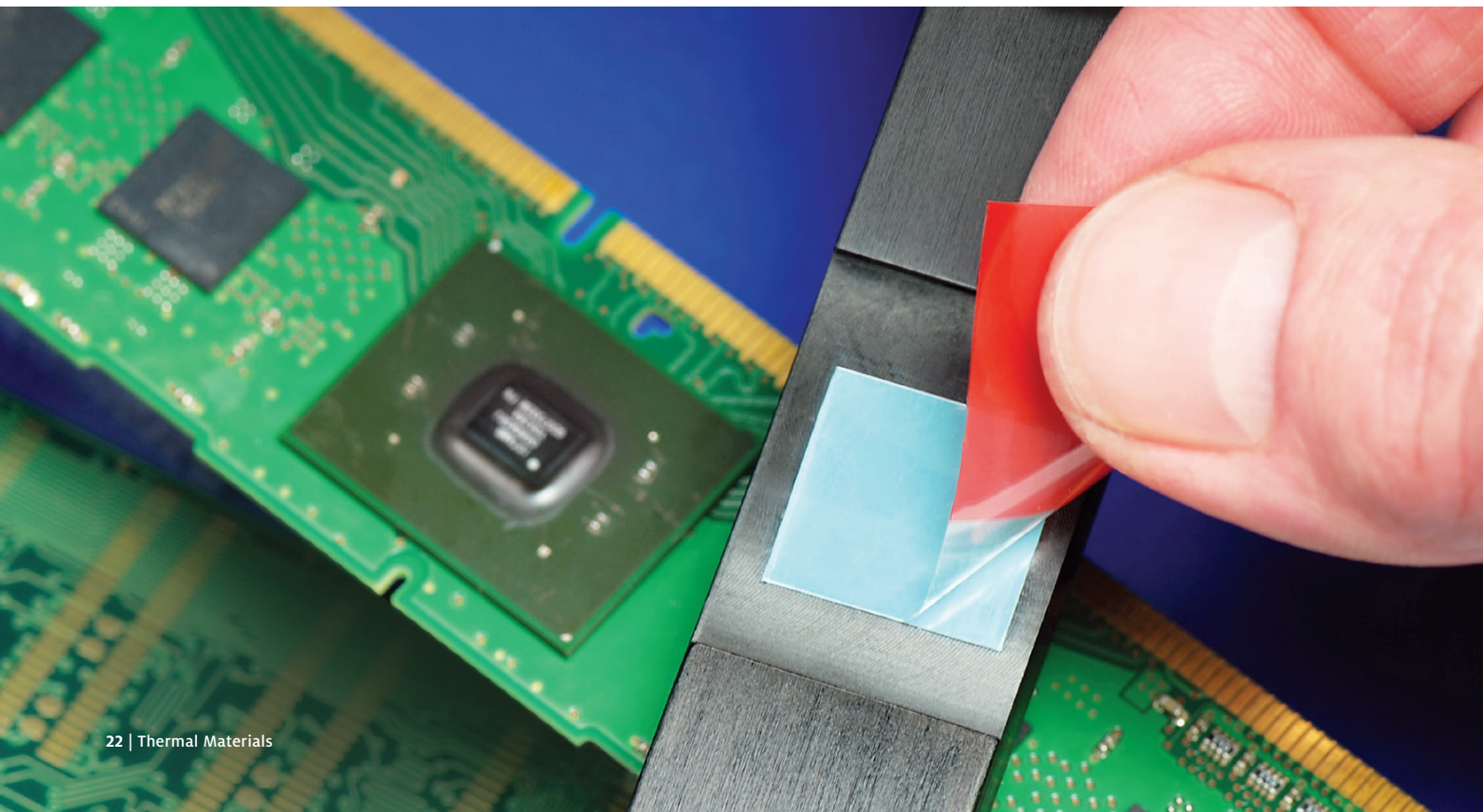
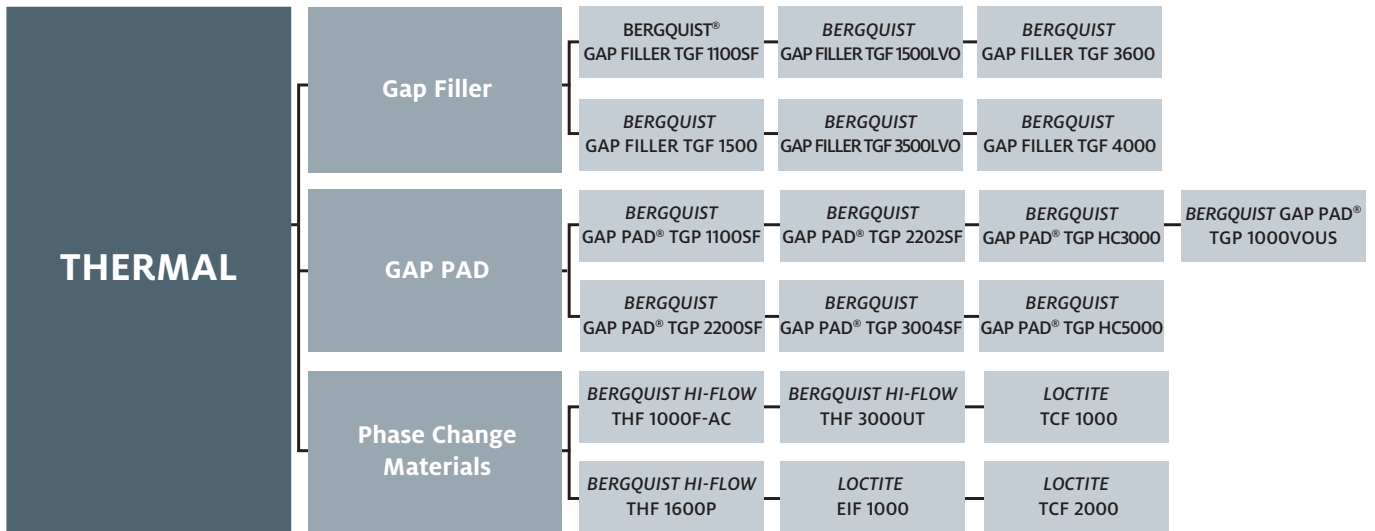
## POTTING

Product Name	Description	Key Attributes	Color	Viscosity at 25°C (cP)		Glass Transition Temperature, T <sub>g</sub> (°C)	Shore Hardness	Recommended Cure
				Part 1	Part 2			
Two Component								
LOCTITE UK U-09FL	Industrial-grade urethane adhesive	<ul style="list-style-type: none"> <li>• Excellent peel strength</li> <li>• Ideal for bonding glass, metal, polycarbonate and other plastics</li> <li>• Provides an ultra-clear, highly flexible bond line that does not yellow</li> </ul>	Transparent	7,800	1,100	25.8	45D	5 days at 25°C

# THERMAL MATERIALS FOR ADAS CAMERAS

## HIGH-PERFORMANCE THERMAL MANAGEMENT

Thermal management is one of the most pressing issues in electronics today. As board densities increase and higher-functioning, smaller form factor components become the norm, managing the heat has become challenging. The CMOS sensor and the logic chip within an automotive camera assembly are prime examples; massive image processing equates to power increases and the need to effectively dissipate the resulting thermal load. As the market leader in thermal management materials, Henkel delivers high-performance BERGQUIST® brand thermal interface materials (TIMs) spanning a wide range of mediums and thermal conductivities to accommodate various heat dissipation requirements and manufacturing preferences. Printable phase change TIMs, custom die-cut GAP PAD® materials and liquid dispensable gap fillers offer the conformity, low stress and thermal conductivity required to move heat away from critical components so that automotive cameras maintain their cool to offer safety-enhancing performance.



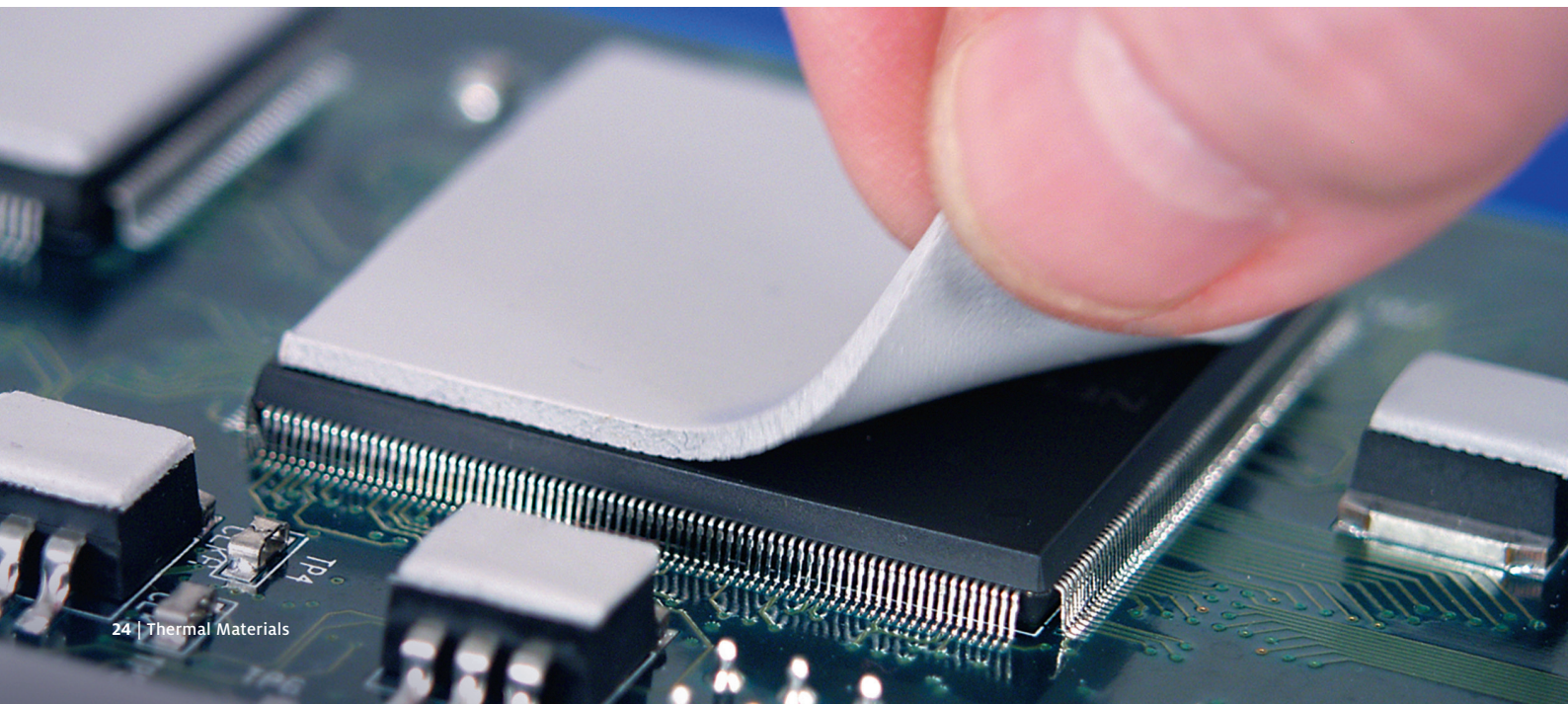
## GAP FILLER

Product Name	Description	Key Attributes	Thermal Conductivity (W/m•K)	Viscosity at 25°C (cP)	Dielectric Strength (V/25 µm)	Flammability Rating	Recommended Cure
BERGQUIST® GAP FILLER TGF 1100SF	Silicone-free, thermally conductive liquid gap filling material	<ul style="list-style-type: none"> <li>No silicone outgassing or extraction</li> <li>Ultra-conforming material designed for fragile and low-stress applications</li> <li>Ambient and accelerated cure schedules</li> <li>100% solids – no cure by-products</li> </ul>	1.1	450,000	400	UL 94 V-0	24 hr. at 25°C
BERGQUIST GAP FILLER TGF 1500	Thermally conductive liquid gap filling material	<ul style="list-style-type: none"> <li>Optimized shear thinning characteristics for ease of dispensing</li> <li>Excellent slump resistance</li> <li>Ultra-conforming with excellent wet-out for low-stress interface applications</li> <li>100% solids – no cure by-products</li> <li>Excellent low- and high-temperature mechanical and chemical stability</li> <li>Ambient and accelerated cure schedules</li> </ul>	1.8	25,000	400	UL 94 V-0	5 hr. at 25°C
BERGQUIST GAP FILLER TGF 1500LVO	Thermally conductive liquid gap filling material	<ul style="list-style-type: none"> <li>Low volatility for silicone sensitive applications</li> <li>Ultra-conforming with excellent wet-out</li> <li>100% solids – no cure by-products</li> <li>Excellent low- and high-temperature, chemical and mechanical stability</li> <li>Ambient or accelerated cure schedules</li> </ul>	1.8	20,000	400	UL 94 V-0	8 hr. at 25°C
BERGQUIST GAP FILLER TGF 3500LVO	Thermally conductive liquid gap filling material	<ul style="list-style-type: none"> <li>Low volatility for outgassing sensitive applications</li> <li>Ultra-conforming with excellent wet-out for low-stress interfaces on applications</li> <li>100% solids – no cure by-products</li> <li>Ambient or accelerated cure schedules</li> </ul>	3.5	45,000	275	UL 94 V-0	24 hr. at 25°C
BERGQUIST GAP FILLER TGF 3600	Thermally conductive liquid gap filling material	<ul style="list-style-type: none"> <li>High thermal performance</li> <li>Thixotropic nature makes it easy to dispense</li> <li>Ultra-conforming material designed for fragile and low-stress applications</li> <li>Ambient or accelerated cure schedules</li> </ul>	3.6	150,000	275	UL 94 V-0	15 hr. at 25°C
BERGQUIST GAP FILLER TGF 4000	Thermally conductive liquid gap filling material	<ul style="list-style-type: none"> <li>High thermal performance</li> <li>Extended working time for manufacturing flexibility</li> <li>Ultra-conforming with excellent wet-out</li> <li>100% solids – no cure by-products</li> <li>Excellent low- and high-temperature, chemical and mechanical stability</li> <li>Ambient or accelerated cure schedules</li> </ul>	4.0	50,000	450	UL 94 V-0	24 hr. at 25°C

# THERMAL MATERIALS FOR ADAS CAMERAS

## GAP PAD®

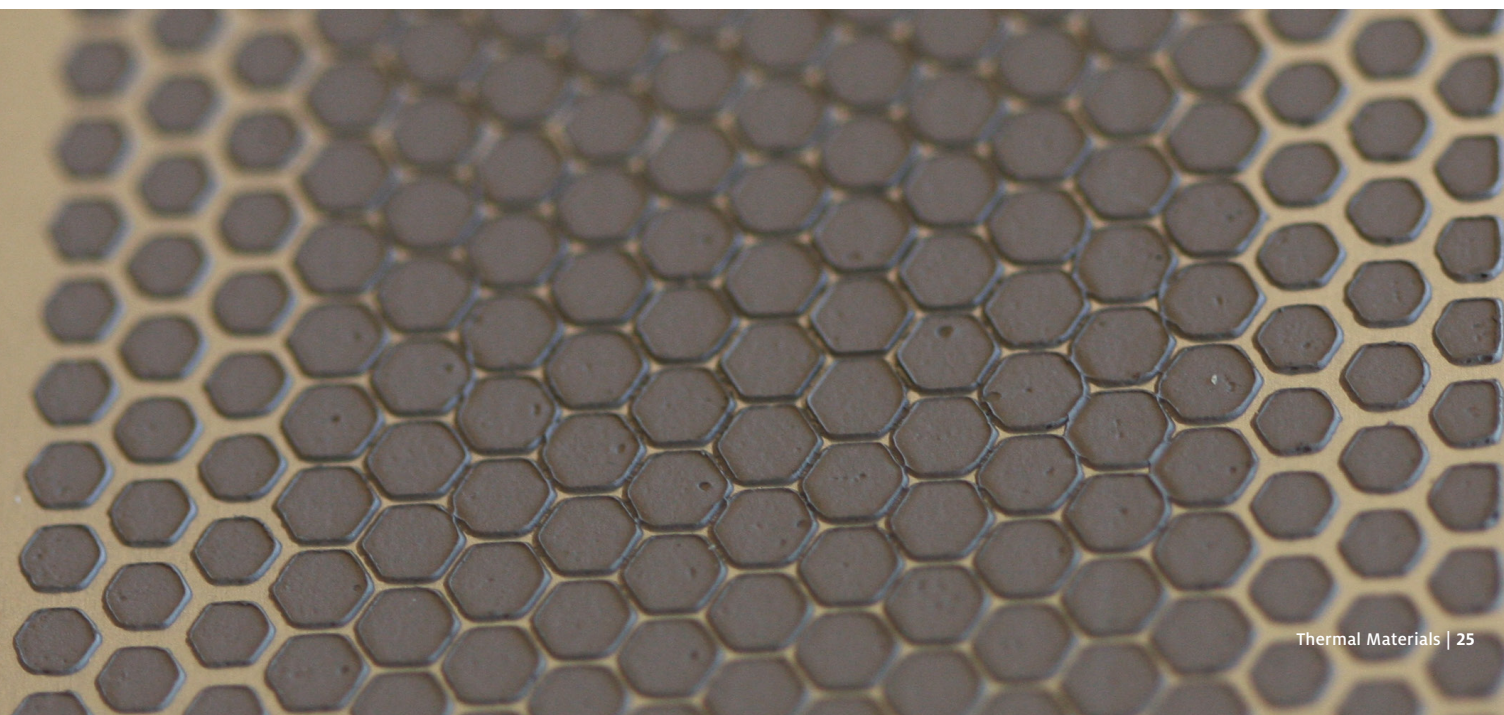
Product Name	Description	Key Attributes	Thermal Conductivity (W/m•K)	Modulus at 25°C (kPa)	Dielectric Breakdown Voltage	Thickness (mm)	Flammability Rating
<i>BERGQUIST</i> GAP PAD® TGP 1100SF	Silicone-free, thermally conductive gap filling material	<ul style="list-style-type: none"> <li>No silicone outgassing</li> <li>No silicone extraction</li> <li>Reduced tack on one side to aid in application assembly</li> <li>Electrically isolating</li> </ul>	0.9	234	6,000 V at 250 µm	• 0.254 – 3.175	UL 94 V-1
<i>BERGQUIST</i> GAP PAD® TGP 2200SF	Silicone-free, thermally conductive gap filling material	<ul style="list-style-type: none"> <li>Medium compliance with easy handling</li> <li>Electrically isolating</li> </ul>	2	228	5,000 V at 250 µm	• 0.254 – 3.175	UL 94 V-0
<i>BERGQUIST</i> GAP PAD® TGP 2202SF	Silicone-free, high performance, thermally conductive gap filling material	<ul style="list-style-type: none"> <li>Minimal compression set</li> <li>12.7 µm film provides tack-free surface</li> <li>Tacky side allows for ease of handling and placement</li> </ul>	2	1,500	5,000 V at 250 µm	• 0.254 – 3.175	UL 94 V-0
<i>BERGQUIST</i> GAP PAD® TGP 3004SF	Silicone-free, high performance, thermally conductive gap filling material	<ul style="list-style-type: none"> <li>Excellent thermal performance</li> <li>6.4 µm polyethylene terephthalate (PET) provides easy disassembly, leaving no residue</li> <li>Tacky side allows for ease of handling and placement</li> </ul>	3	2,450	6,000 V at 250 µm	• 0.254 – 3.175	UL 94 V-0
<i>BERGQUIST</i> GAP PAD® TGP HC3000	Thermally conductive gap filling material	<ul style="list-style-type: none"> <li>High-compliance, low compression stress</li> <li>Fiberglass reinforced for shear and tear resistance</li> <li>Low modulus</li> </ul>	3	110	5,000 V at 500 µm	• 0.508 – 3.175	UL 94 V-0
<i>BERGQUIST</i> GAP PAD® TGP HC5000	Thermally conductive gap filling material	<ul style="list-style-type: none"> <li>Highly conformable</li> <li>Exceptional thermal performance</li> <li>High-compliance, low compression stress</li> <li>Fiberglass reinforced for shear and tear resistance</li> <li>Low modulus</li> </ul>	5	121	5,000 V at 500 µm	• 0.508 – 3.175	UL 94 V-0
<i>BERGQUIST</i> GAP PAD® TGP 1000VOUS	Thermally conductive gap filling material	<ul style="list-style-type: none"> <li>Highly conformable, low hardness</li> <li>“Gel-like” modulus</li> <li>Decreased strain</li> <li>Puncture, shear and tear resistant</li> <li>Electrically isolating</li> </ul>	1	55	6,000 V at 500 µm	• 0.508 – 6.350	UL 94 V-0





## PHASE CHANGE MATERIALS

Product Name	Description	Key Attributes	Thermal Conductivity (W/m•K)	Phase Change Temperature (°C)	Dielectric Strength (V/25 µm)	Thickness (mm)	Flammability Rating
<b>Aluminum Carrier</b>							
<i>BERGQUIST</i> HI-FLOW THF 1000F-AC	Phase change thermal interface material	<ul style="list-style-type: none"> <li>• Low thermal impedance</li> <li>• Can be manually or automatically applied to the surfaces of room-temperature heat sinks</li> <li>• Foil reinforced, adhesive coated</li> <li>• Soft phase change compound</li> </ul>	1	55	N/A	• 0.102	UL 94 V-0
<i>LOCTITE</i> TCF 1000	Non-insulating, phase change thermal interface material	<ul style="list-style-type: none"> <li>• Low thermal impedance</li> <li>• Coated on aluminum foil</li> <li>• Used between any non-isolated heat dissipating component and a heat sink or chassis</li> </ul>	1	60	N/A	• 0.06 – 0.2	None
<i>LOCTITE</i> TCF 2000	Non-insulating, phase change thermal interface material	<ul style="list-style-type: none"> <li>• Used between any non-isolated heat dissipating component and a heat sink or chassis</li> <li>• High thermal conductivity</li> </ul>	3	51	N/A	• 0.076	UL 94 V-0
<b>Polyimide Carrier</b>							
<i>LOCTITE</i> EIF 1000	High-performance, phase change thermal Interface material	<ul style="list-style-type: none"> <li>• High dielectric strength</li> <li>• Excellent cut-through resistance</li> </ul>	0.45	60	> 5,000	• 0.05 – 0.2	UL 94 V-0
<i>BERGQUIST</i> HI-FLOW THF 1600P	High-performance, phase change thermal interface material	<ul style="list-style-type: none"> <li>• Field-proven polyimide film</li> <li>• Excellent dielectric performance</li> <li>• Excellent cut-through resistance</li> <li>• Outstanding thermal performance in an insulated pad</li> </ul>	1.6	55	5,000	• 0.102 – 0.127	UL 94 V-0
<b>No Carrier</b>							
<i>BERGQUIST</i> HI-FLOW THF 3000UT	High-performance, phase change thermal interface material	<ul style="list-style-type: none"> <li>• Very low thermal impedance</li> <li>• High thermal conductivity</li> <li>• Naturally tacky</li> <li>• Tabulated for ease of assembly</li> </ul>	3	52	N/A	• 0.127 • 0.254	UL 94 V-0



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