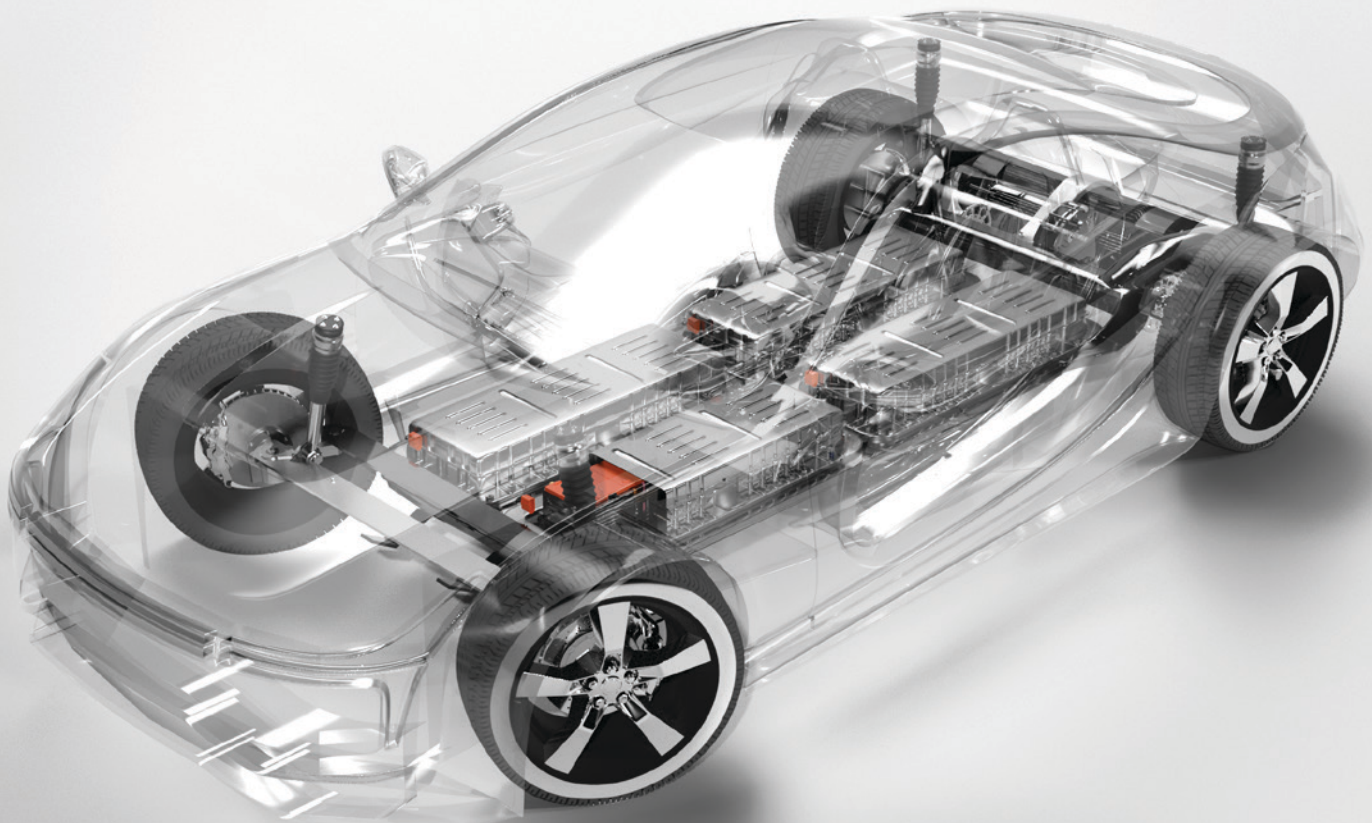


LOCTITE®
TECHNOMELT®

BERGQUIST®

MATERIALS FOR POWER STORAGE SYSTEMS

ELECTRIC AND HYBRID VEHICLE SOLUTIONS



Henkel

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INTRODUCTION

Electric and Hybrid Vehicles Charging Ahead

Henkel's comprehensive portfolio of materials for electric and hybrid vehicles and power storage systems is driving unprecedented levels of performance, efficiency, reliability and safety.

Our latest automotive electronic material innovations facilitate the manufacture of high-energy density, lightweight Lithium-Ion (Li-Ion) batteries and their related sub-systems, which are key to enabling the longer ranges and speed expectations of today's plug-in hybrid electric and electric vehicles. Henkel's bonding, connecting, protecting and thermal formulations deliver advantages at the individual cell level all the way through to the battery pack, power conversion systems and control units.

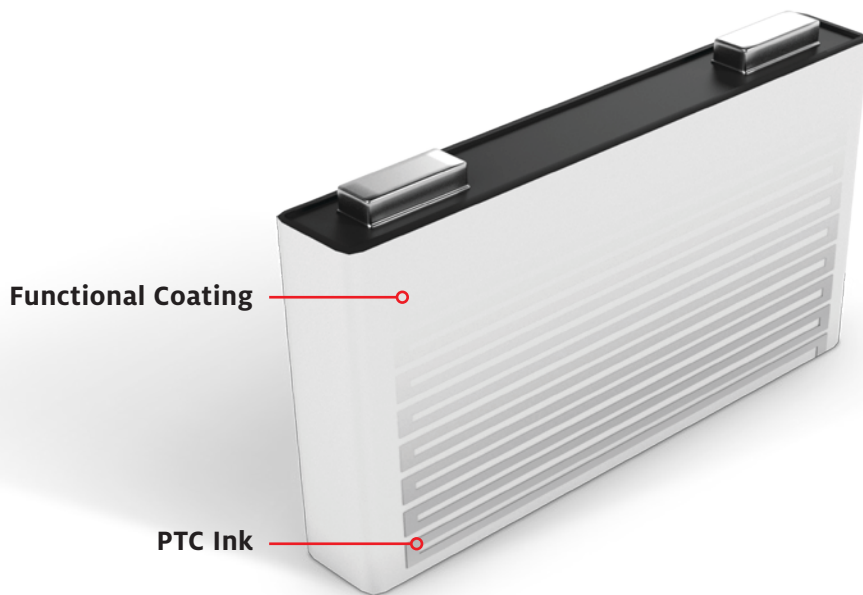
Performance Enablers

Beneath the cool, quiet exterior of modern electric vehicles are powerful Li-Ion battery packs working in concert to facilitate the entire driving experience. Within each pack are a series of modules, which house the individual battery cells. At every level of the battery structure – and even outside the battery in the power inverter and engine control unit (ECU) – Henkel electronic materials are accelerating efficiency, reliability, battery life and, ultimately, safety. Bonding materials secure housings and lead frames for rugged conditions, while high-performance solders, adhesives and inks deliver reliable and responsive interconnects. Between each of the battery components, award-winning BERGQUIST brand thermal management materials are dissipating the heat generated by charging and discharging these workhorses. Safeguarding the entire battery system from top to bottom are Henkel protection materials to defend against exposure to fluids, harsh conditions, vibration and thermal shock.

MULTIPLE LEVELS OF BATTERY SOLUTIONS

Battery Cells

At the cell level, Henkel’s functional coatings pre-treat anodes and cathodes for better conductivity, while unique PTC inks elevate cell temperature in freezing conditions for optimal performance and longer battery life.



+ Cell Benefits

- Pre-treatment coating of anodes and cathodes enhances bonding for improved conductivity.
- Extend battery life and reduce weight with Henkel’s novel battery heating PTC inks. Temperature is known to have a significant impact on battery performance, safety and cycle lifetime; Henkel’s positive temperature coefficient (PTC) self-regulating printed inks provide a thin, light solution for heating in freezing conditions.

Cell Level Product Portfolio

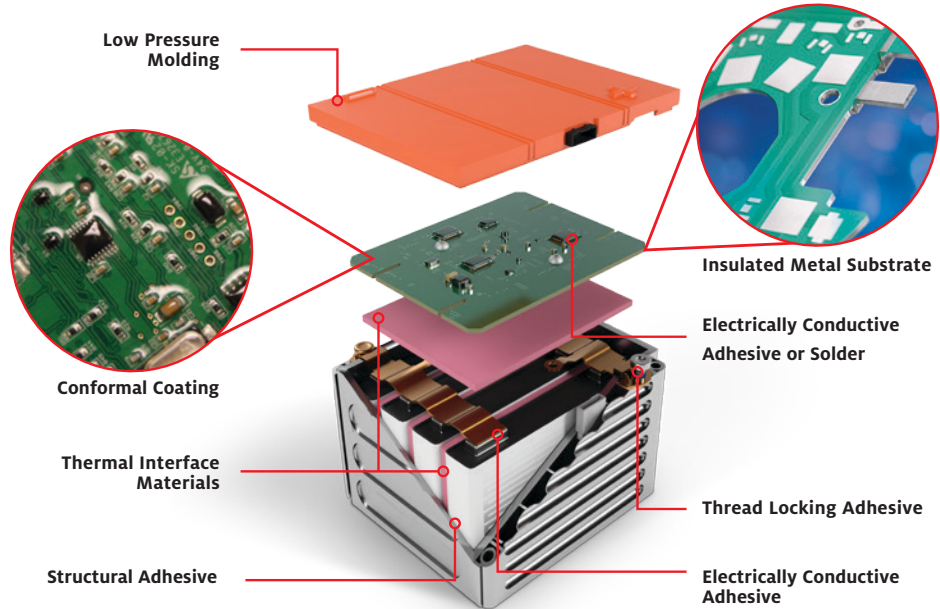
Application	Technology	Cell Level
Bonding	Structural Adhesives	
	Thread Locking Adhesives	
Connecting	Electrically Conductive Adhesives	
	Printed Inks	✓
	Solder Materials	
Protecting	Conformal Coatings	
	Encapsulants	
	Functional Coatings	✓
	Low Pressure Molding	
	Sealants	
Thermal	Potting	
	Insulated Metal Substrate	
	Thermal Interface Materials	

Battery Modules

Multiple Henkel materials work in collaboration within the battery module for rugged, reliable and responsive function.

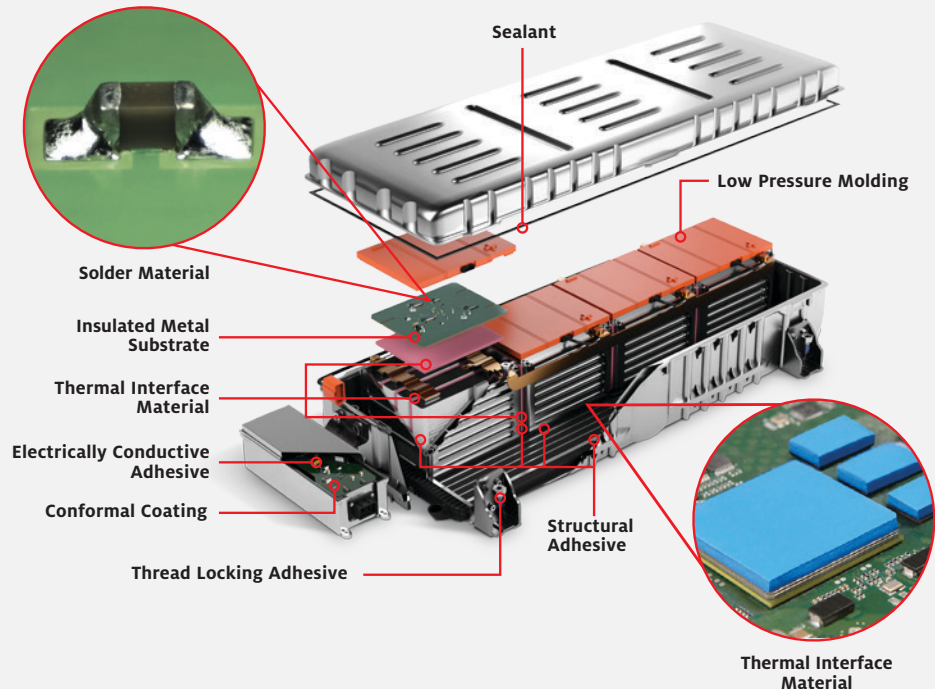
+ Module and Pack Benefits

- Protect sensitive components within the battery module through a simple, three-step solution. Low pressure molding can replace metal and plastic housings, circuit board protection, sealing and thermal management.
- Enable ruggedness and durability with robust structural adhesives and sealants.
- High-performance electrical function is enabled through award-winning electrically conductive adhesives and solder materials.
- Manage high power densities and extreme heat generation with BERGQUIST brand thermal interface materials in a range of formats and conductivities.



Battery Packs

Henkel innovations seal, protect, connect and cool multiple components in battery packs, providing drivers with on-demand power and on-the-road reliability.



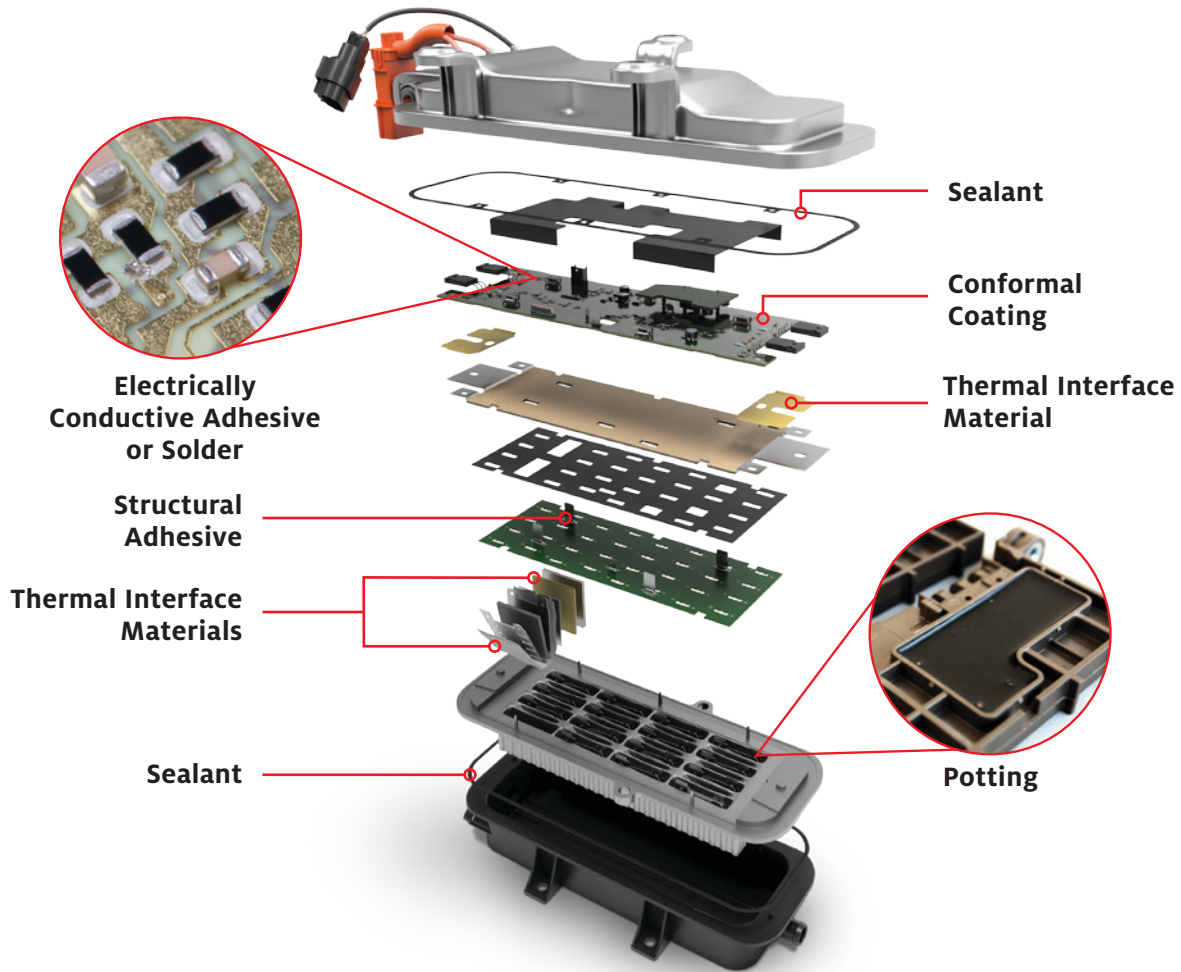
Module Level Product Portfolio

Application	Technology	Module Level	
		Battery Control Module	Module Housing & Assembly
Bonding	Structural Adhesives		✓
	Thread Locking Adhesives		✓
Connecting	Electrically Conductive Adhesives	✓	✓
	Printed Inks		✓
	Solder Materials	✓	
Protecting	Conformal Coatings	✓	
	Encapsulants	✓	
	Functional Coatings		
	Low Pressure Molding		✓
	Sealants	✓	✓
	Potting		✓
Thermal	Insulated Metal Substrate	✓	
	Thermal Interface Materials	✓	✓

Pack Level Product Portfolio

Application	Technology	Pack Level	
		Master Control Module	Pack Housing & Assembly
Bonding	Structural Adhesives		✓
	Thread Locking Adhesives		✓
Connecting	Electrically Conductive Adhesives	✓	✓
	Printed Inks		
	Solder Materials	✓	
Protecting	Conformal Coatings	✓	
	Encapsulants	✓	
	Functional Coatings		
	Low Pressure Molding	✓	✓
	Sealants	✓	✓
	Potting		✓
Thermal	Insulated Metal Substrate	✓	
	Thermal Interface Materials	✓	✓

Battery Packs (Continued): Electric Heating Systems



Pack Level Product Portfolio (Continued)

Application	Technology	Pack Level (Continued)
		Electric Heating Systems
Bonding	Structural Adhesives	✓
	Thread Locking Adhesives	
Connecting	Electrically Conductive Adhesives	✓
	Printed Inks	✓
	Solder Materials	✓
Protecting	Conformal Coatings	✓
	Encapsulants	
	Functional Coatings	
	Low Pressure Molding	
	Sealants	✓
	Potting	✓
Thermal	Insulated Metal Substrate	
	Thermal Interface Materials	✓

Battery Packs (Continued): Coolant Pumps



Pack Level Product Portfolio (Continued)

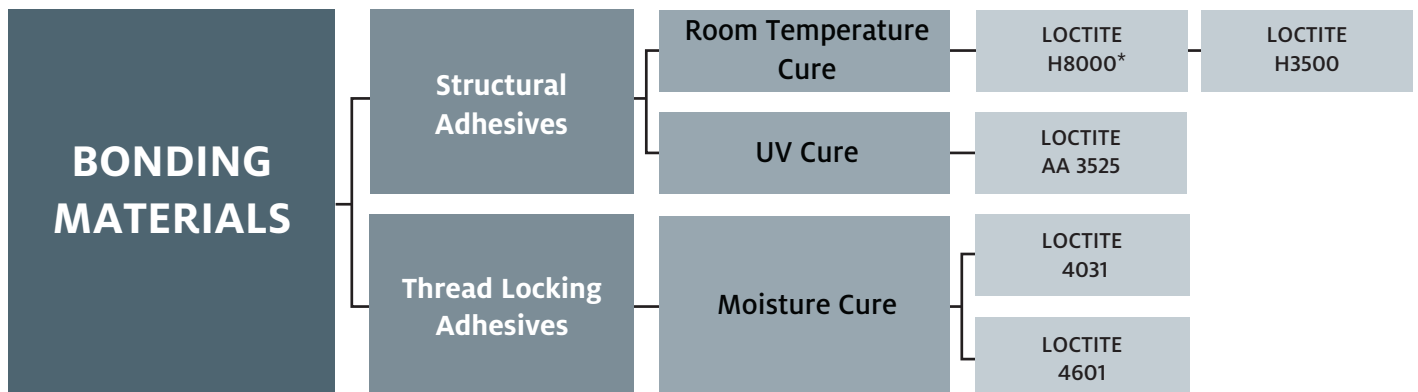
Application	Technology	Pack Level (Continued)
		Coolant Pumps
Bonding	Structural Adhesives	
	Thread Locking Adhesives	
Connecting	Electrically Conductive Adhesives	✓
	Printed Inks	
	Solder Materials	✓
Protecting	Conformal Coatings	✓
	Encapsulants	✓
	Functional Coatings	
	Low Pressure Molding	
	Sealants	✓
	Potting	✓
Thermal	Insulated Metal Substrate	✓
	Thermal Interface Materials	✓



MATERIALS FOR LITHIUM ION BATTERIES

Lasting Bonds

A strong, cohesive structure for all of the components of a battery pack is integral to long-term function and durability. Today's Li-Ion batteries must withstand tremendous in-use vibration and maintain structural integrity even within these conditions. As the global leader in adhesives development, Henkel's award-winning LOCTITE formulations deliver uncompromising structural reliability for Li-Ion battery modules and battery packs. Within the module, rugged cell to cell and cell to module bonding are achieved with proven structural adhesives developed specifically for battery applications. These materials also ensure that the battery pack housing is securely attached and sealed, keeping fluids, dust and moisture out. LOCTITE brand adhesive strength is found in the battery's mechanically attached components as well. While screws and fasteners are designed to hold parts together, road vibration can loosen the threads and risk separation of copper lead frames or housings. LOCTITE thread locking adhesives eliminate this risk, securing mechanical parts for battery endurance.



* Product not available in Europe

STRUCTURAL ADHESIVES

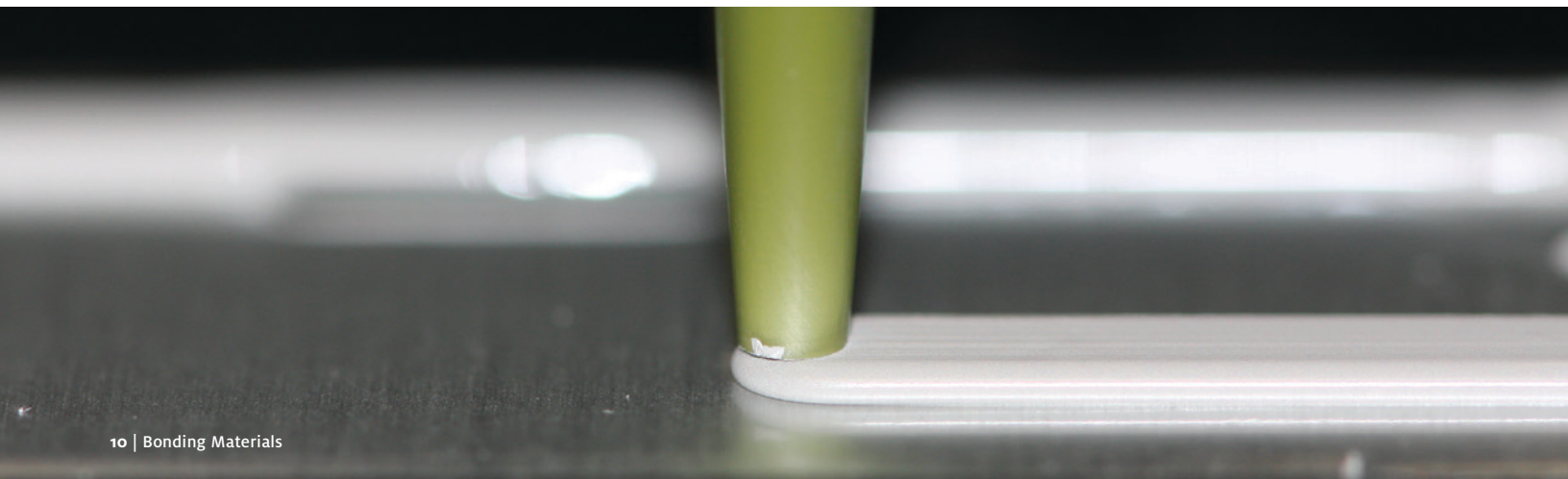
Product Name	Description	Key Attributes	Color	Viscosity (cP)	Cure Time	Operating Temperature (°C)	Fixture time
Room Temperature Cure							
LOCTITE H8000*	Two component, room temperature curing methacrylate adhesive system	<ul style="list-style-type: none"> Superior impact and peel strength Little or no surface preparation Rapid room temperature cure Excellent environmental resistance 	Part A: Yellow Part B: Blue Mix: Green	Part A at 25°C: 160,000 – 250,000 Part B at 25°C: 20,000 – 50,000	24 hr. at 22 °C	-50°C – 120°C	25 – 30 min. at 25°C
LOCTITE H3500	Two component, room temperature curing methacrylate adhesive system	<ul style="list-style-type: none"> High strength, durable bonds on various metals and plastics High impact strength and maintains strength over a wide temperature range 	Part A: White Part B: Yellow Mix: Light Yellow	Part A: 29,000 Part B: 18,000	24 hr. at 22 °C	-50°C – 120°C	18 – 20 min. at 21°C
UV Cure							
LOCTITE AA 3525	One component, UV curing acrylic adhesive	<ul style="list-style-type: none"> Fast cure Excellent flexibility, toughness and durability to moisture exposure when cured Bonds to glass, metals and plastics for industrial applications 	Clear, colorless bonds	9,500 to 21,000 at 25°C	Per TDS	-50°C – 120°C	Less than 5 sec. with black light, 6 mW/cm ²

* Product not available in Europe

THREAD LOCKING ADHESIVES

Moisture Cure

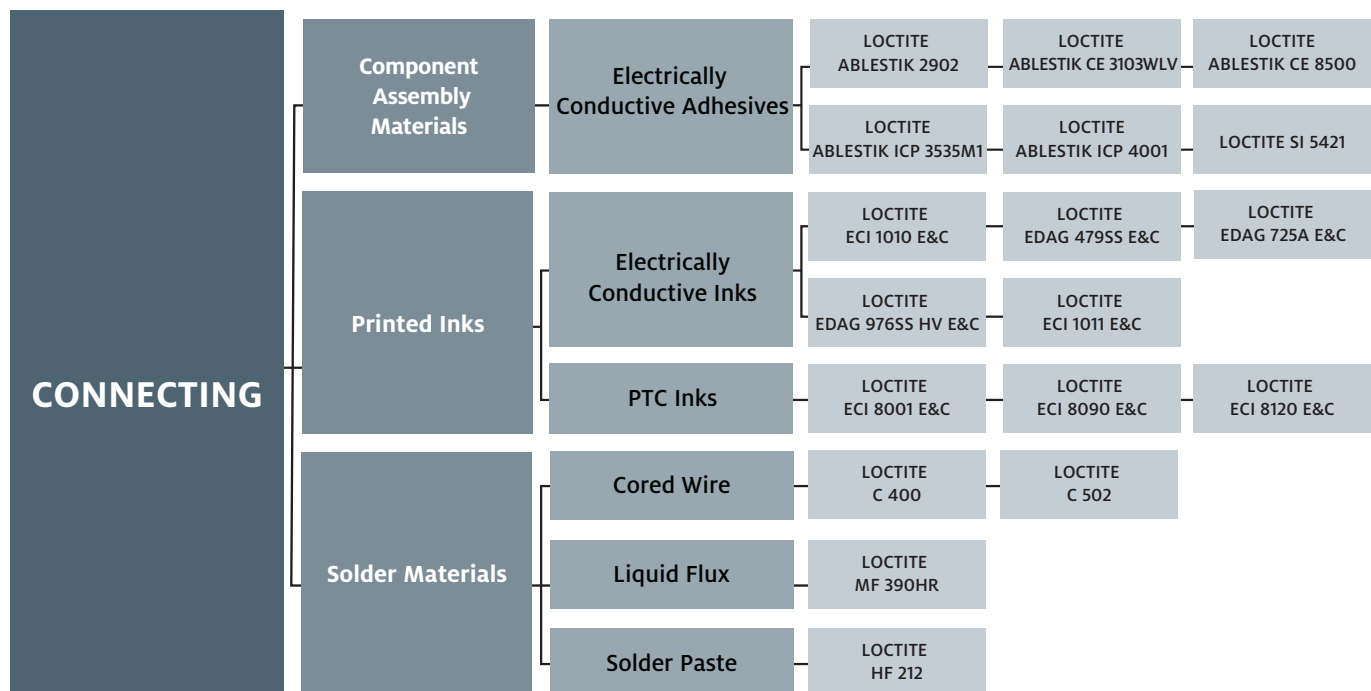
Product Name	Description	Key Attributes	Color	Viscosity at 25°C (cP)	Cure Time	Operating Temperature (°C)	Fixture Time at 25°C
Moisture Cure							
LOCTITE 4031	Cyanoacrylate thread locking adhesive	<ul style="list-style-type: none"> One component Low odor for applications where vapor control is vital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





Strong Connections

Printed circuit boards (PCBs) within each Li-Ion battery module feed information about cell temperature, charging/discharging speed and overall module stress and performance to the master battery pack control module PCB, which manages battery pack operation. At the board level, Henkel's proven interconnect solutions deliver reliable and responsive electronic function to drive and monitor battery performance. Advanced materials such as high-reliability solder alloys, temperature stable LOCTITE solder pastes and electrically conductive adhesives provide superior interconnection of components to substrates. Connection versatility is further enhanced with Henkel's printed inks, which deliver electrical performance in space-constrained areas and also enable battery performance through printed temperature sensors for use in heating applications.



COMPONENT ASSEMBLY MATERIALS

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)		Modulus at 25 $^{\circ}\text{C}$ (MPa)	Recommended Cure
					Below T_g	Above T_g		
Epoxy								
LOCTITE ABLESTIK 2902	Epoxy electrically conductive adhesive	<ul style="list-style-type: none"> Two component, solvent-free Room temperature cure Good adhesion to variety of substrates 	0.0006	52	49	N/A	N/A	24 hr. at 25 $^{\circ}\text{C}$ or 1 – 4 hr. at 65 $^{\circ}\text{C}$
LOCTITE ABLESTIK CE 3103WLV	Epoxy electrically conductive adhesive	<ul style="list-style-type: none"> Pb-free alternative to solder Low-temperature cure Stable contact resistance 	0.0008	114	45	225	4,500	10 min. at 120 $^{\circ}\text{C}$
LOCTITE ABLESTIK ICP 3535M1	Epoxy electrically conductive adhesive	<ul style="list-style-type: none"> One component, Pb-free alternative to solder, Sn Compatible Low-temperature cure Stable contact resistance 	0.004	102	36	141	2.6	1 hr. at 150 $^{\circ}\text{C}$ or 10 min. at 175 $^{\circ}\text{C}$
Hybrid								
LOCTITE ABLESTIK CE 8500	Epoxy hybrid electrically conductive adhesive	<ul style="list-style-type: none"> One component Low stress Flexible for bonding mismatched adherends 	0.0002	24	55	380	2.5	90 min. at 120 $^{\circ}\text{C}$ or 40 min. at 150 $^{\circ}\text{C}$ or 15 min. at 175 $^{\circ}\text{C}$
Silicone								
LOCTITE ABLESTIK ICP 4001	Silicone electrically conductive adhesive	<ul style="list-style-type: none"> One component High flexibility Excellent electrical conductivity High temperature performance Pb-free alternative to solder Outstanding elongation performance Low outgassing 	4×10^{-4}	-50	N/A	370	101	1 hr. at 130 $^{\circ}\text{C}$

Electrically Conductive Adhesives

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

PRINTED INKS

Product Name	Description	Key Attributes	Coverage at 10 μm (m^2/kg)	Sheet Resistance ($\Omega/\text{sq}/25 \mu\text{m}$)	Processing	Substrates	Recommended Cure
PTC Carbon Inks							
LOCTITE ECI 8120 E&C	Positive temperature coefficient (PTC) printable ink	<ul style="list-style-type: none"> Flexible Printable on most common substrates Self-regulating heater with PTC temperature of 120°C 	43	1,700	• Screenprint	<ul style="list-style-type: none"> Polyester PEN** Polyimide film PET* 	10 min. at 140°C
LOCTITE ECI 8090 E&C	Positive temperature coefficient (PTC) printable ink	<ul style="list-style-type: none"> Flexible Printable on most common substrates Self-regulating heater with PTC temperature of 90°C 	38	1,000	• Screenprint	<ul style="list-style-type: none"> Polyester PEN** Polyimide film PET* 	10 min. at 120°C or 140°C
LOCTITE ECI 8001 E&C	Positive temperature coefficient (PTC) printable ink	<ul style="list-style-type: none"> Flexible Printable on most common substrates Self-regulating heater with PTC temperature of 65°C 	48	1,700	• Screenprint	<ul style="list-style-type: none"> Polyester PEN** Polyimide film PET* 	10 min. at 120°C
Silver Inks							
LOCTITE ECI 1010 E&C	Screen printable, conductive ink	<ul style="list-style-type: none"> Flexible Good adhesion High conductivity with optimum mechanical performance Compatible with LOCTITE EDAG 440A E&C, LOCTITE EDAG 440B E&C and LOCTITE EDAG PF 455B E&C 	10.6	0.007	• Screenprint	<ul style="list-style-type: none"> Polyimide film PET* 	15 min. at 120°C
LOCTITE EDAG 479SS E&C	Screen printable, very fast drying, conductive ink	<ul style="list-style-type: none"> Conductive Fast drying Superior adhesion to polyester film Excellent fine line printing Excellent creasability 	14.6	< 0.02	• Screenprint	<ul style="list-style-type: none"> Membrane switches Flexible circuitry display devices 	15 min. at 100°C
LOCTITE EDAG 725A E&C (6S-54)	Screen printable, easy processing, conductive ink	<ul style="list-style-type: none"> Conductive Process ease Excellent adhesion Good printability and screen residence time Excellent flexibility 	11	< 0.015	• Screenprint	<ul style="list-style-type: none"> PET* Membrane Keyboards Other flexible foils 	15 min. at 120°C
LOCTITE EDAG 976SS HV E&C	Screen printable, thermoset, conductive ink	<ul style="list-style-type: none"> Highly conductive Resistant to wave soldering Excellent adhesion Excellent screen residence time Solvent resistant 	18	< 0.025	• Screenprint	<ul style="list-style-type: none"> Phenolic paper Epoxy paper Glass epoxy Copper laminated substrates plain substrates 	Pre-dry 15 min. at 70°C followed by cure of 30 min. at 150 to 160°C
LOCTITE ECI 1011 E&C	Flexography and screen printable conductive ink	<ul style="list-style-type: none"> Highly conductive Small particle size Excellent adhesion Excellent printability with flexography Flexible 	8.3	< 0.005	<ul style="list-style-type: none"> Screenprint Flexographic Rotogravure 	<ul style="list-style-type: none"> Polyester PEN** Polyimide film PET* 	10 min. at 150°C

* Polyethylene Terephthalate

** Polyethylene Naphthalate

*** Indium Tin Oxide

SOLDER MATERIALS

Cored Wire

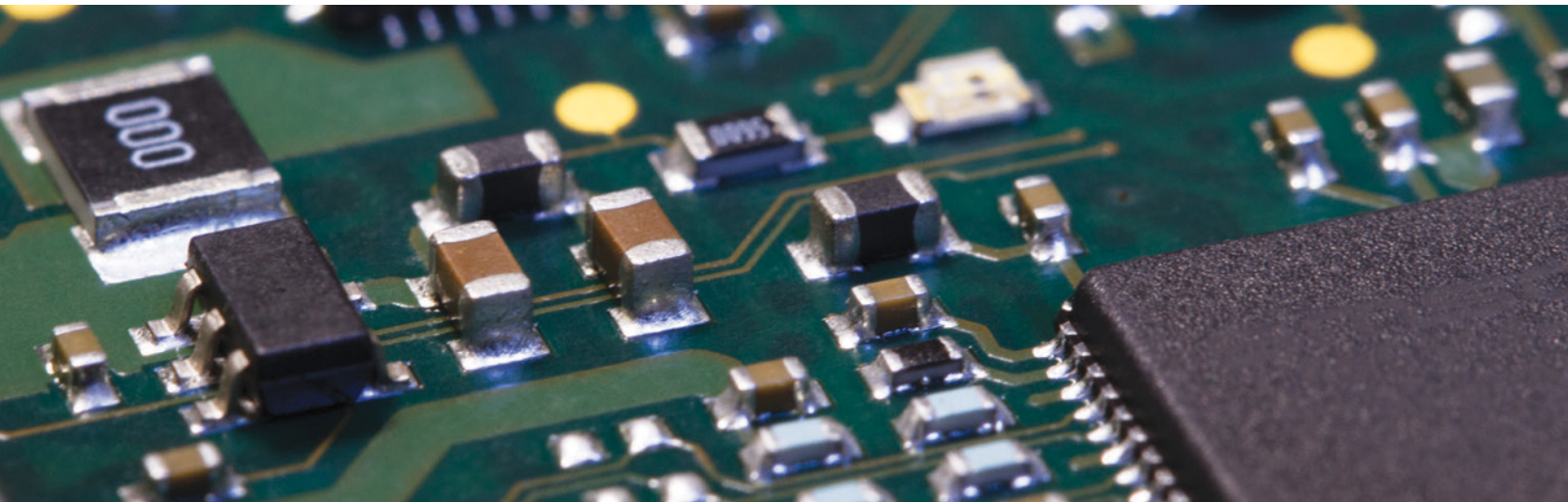
Product Name	Description	Key Attributes	Approximate Flux Content (% by Weight)	Diameter Range (mm)	Pb-Free Alloy	SnPb Alloy	IPC J-STE-004B Classification
Halide-Free, No-Clean							
LOCTITE C 502	Cored solder wire	<ul style="list-style-type: none"> • Clear residue • Good wetting on difficult substrates • Medium activity flux 	2.7	0.25 – 1.63	<ul style="list-style-type: none"> • 96SC (SAC387) • 97SC (SAC305) • 99C (SnCu) 	<ul style="list-style-type: none"> • Sn60 • Sn62 • Sn63 	ROM1
Halogen-Free, No-Clean							
LOCTITE C 400	Cored solder wire	<ul style="list-style-type: none"> • Clear residue • Increased flux content for improved wetting on challenging surfaces • Award-winning multiple flux core technology that ensures consistent distribution of flux throughout the solder wire • Suitable for manual and robotic soldering 	2.2	0.38 – 1.63	<ul style="list-style-type: none"> • 90iSC • 99C • SAC305 • SAC387 	<ul style="list-style-type: none"> • Sn60 • Sn62 • Sn63 	ROLO

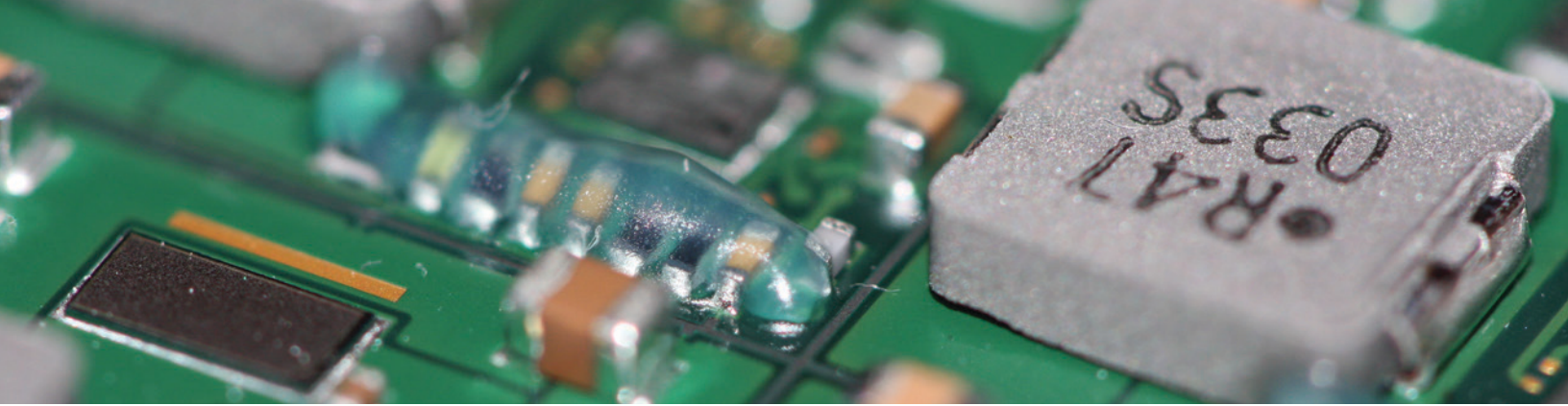
Liquid Flux

Product Name	Description	Key Attributes	Solid Content (% by Weight)	Acid Value (mg KOH/g)	Application	IPC J-STE-004B Classification
Halogen-Free, No-Clean						
LOCTITE MF 390HR	Liquid flux	<ul style="list-style-type: none"> • Exceptional through-hole fill • Recommended for automotive applications and general electrical soldering applications • Compatible with Pb-free and SnPb wave solder processes 	6	20 – 25	Spray/Foam	ROLO

Solder Paste

Product Name	Description	Key Attributes	Alloy	Particle Size Distribution	IPC J-STE-004B Classification	Optimal Shelf Life	Reflow Atmosphere
Halogen-Free, No-Clean							
LOCTITE HF 212	No-clean, halogen free, solder paste	<ul style="list-style-type: none"> • High tack • Low voiding • RoHS-compliant • Excellent fine pitch coalescence • Designed for medium to large boards 	<ul style="list-style-type: none"> • 90iSC • SAC0307 • SAC305 • SAC387 	<ul style="list-style-type: none"> • Type 3 • Type 4 • Type 4.5 (4A) • Type 5 	ROLO	6 months at 0 – 10°C	Air and Nitrogen





Amplified Protection

Once reliable assembly is achieved, multiple areas of power storage systems have to be enhanced with protective materials to fortify the battery ecosystem against moisture, corrosion, automotive fluids, vibration and thermal shock. Henkel conformal coatings, encapsulants and potting materials provide this defense for the PCB, isolating and protecting solder joints and sensitive components from harmful conditions. At the heart of the Li-Ion battery, individual battery cells are augmented with pre-treatment functional coatings of the cathode and anode metal, allowing strengthened bonds for improved conductivity. To keep contaminants out of the battery module and/or battery pack, Henkel TECHNOMELT low pressure molding offers a protective and secure alternative to conventional metal or plastic housings, while Henkel sealants provide an impenetrable barrier for pouches, battery pack housings and coolant systems.

PROTECTING MATERIALS	Conformal Coatings	UV + Moisture Cure	LOCTITE SI 5293	LOCTITE STYCAST PC 40-UMF	LOCTITE STYCAST UV 7993
	Encapsulants	Heat Cure	LOCTITE ECCOBOND EO 1072	LOCTITE ECCOBOND EN 3838T	
		UV + Moisture Cure	LOCTITE ECCOBOND UV 9052		
	Functional Coatings	Protective, Conductive Coatings	BONDERITE L-GP EB 012EU	BONDERITE S-FN 15000	
	Low Pressure Molding	High-Temperature Resistant	TECHNOMELT PA 673	TECHNOMELT PA 678	
		Increased Hardness	TECHNOMELT PA 641	TECHNOMELT PA 646	
		Thermally Conductive	TECHNOMELT TC 50		
	Potting	Epoxy	LOCTITE STYCAST 2651-40 W1 CAT9	LOCTITE STYCAST 2850FT CAT9	LOCTITE STYCAST A 316-48
			LOCTITE STYCAST E 2534 FR CAT9	LOCTITE STYCAST EO 1058	LOCTITE STYCAST EO 7038
			LOCTITE ECCOBOND ES 70205		
Sealants	Silicone	LOCTITE SI 5970	BERGQUIST LIQUI BOND TLB 400 SLT		

CONFORMAL COATINGS

UV + Moisture Cure

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

ENCAPSULANTS

Glob Top – Dam and Fill

Product Name	Description	Key Attributes	Viscosity at 25°C (cP)	Glass Transition Temperature, T _g (°C)	Coefficient of Thermal Expansion (CTE)		Modulus at 25°C (MPa)	Recommended Cure
					Below T _g	Above T _g		
Heat Cure								
LOCTITE ECCOBOND EO 1072	Epoxy encapsulant-dam and fill	<ul style="list-style-type: none"> High T_g Low extractable ionics High performance Good shelf life Fast curing One component 	80,000	135	43	123	6,700	5 min. at 140 – 150°C
LOCTITE ECCOBOND EN 3838T	Epoxy encapsulant	<ul style="list-style-type: none"> One component Fast cure at moderate temperatures Low T_g Low modulus Reworkable Pb-free applications 	6,700	2	57	217	466	8 min. at 130°C
UV + Moisture Cure								
LOCTITE ECCOBOND UV 9052	Acrylate adhesive	<ul style="list-style-type: none"> One component Withstands exposure to ink Cures in shadowed areas No stringing 	6,400	2	49	248	1,987	UV cure 0.5 – 1J for 5 – 10 sec. + moisture cure at ambient humidity

FUNCTIONAL COATINGS

Protective Conductive Coatings

Product Name	Description	Key Attributes	Viscosity at 25°C (cP)	Recommended Cure	Color	Sheet resistance (Ohm/sq/25µm)
BONDERITE L-GP EB 012EU	Water based conductive carbon coating	<ul style="list-style-type: none"> Protective coating onto battery electrodes One component Water based Excellent adhesion to aluminum and copper Good chemical resistant 	50 – 200	24 hr. at room temperature or 3 – 10 min. at 70 – 90°C	Black	< 30
BONDERITE S-FN 15000	Water based conductive carbon coating	<ul style="list-style-type: none"> Protective coating for aluminum electrodes One component Water based thermosetting resin system Superior electrolyte and solvent resistance 	600	1 min. at 110 – 130°C	Black	25

LOW PRESSURE MOLDING

Product Name	Description	Key Attributes	Color	Operating Temperature (°C)	Shore Hardness	Softening Point (°C)
Increased Hardness						
TECHNOMELT PA 641	Moldable polyamide	<ul style="list-style-type: none"> Ideal for applications where strength and hardness are needed Good adhesion for high-temperature applications 	Amber	-40°C – 125°C	92A	175 +/- 5
TECHNOMELT PA 646			Black			
High-Temperature Resistant						
TECHNOMELT PA 673	Moldable polyamide	<ul style="list-style-type: none"> Good adhesion to a variety of substrates Excellent moisture resistance Excellent environmental resistance Good adhesion for high-temperature applications 	Amber	-40 °C – 140 °C	Black	187 +/- 5
TECHNOMELT PA 678			Black			
Thermally conductive						
TECHNOMELT TC 50	Moldable polyamide	<ul style="list-style-type: none"> Thermally conductive – 0.7 W/mK Great adhesion to a variety of substrates Ideal for application where strength and hardness are needed 	Black	-40 °C – 140 °C	60D	187 +/- 5



POTTING

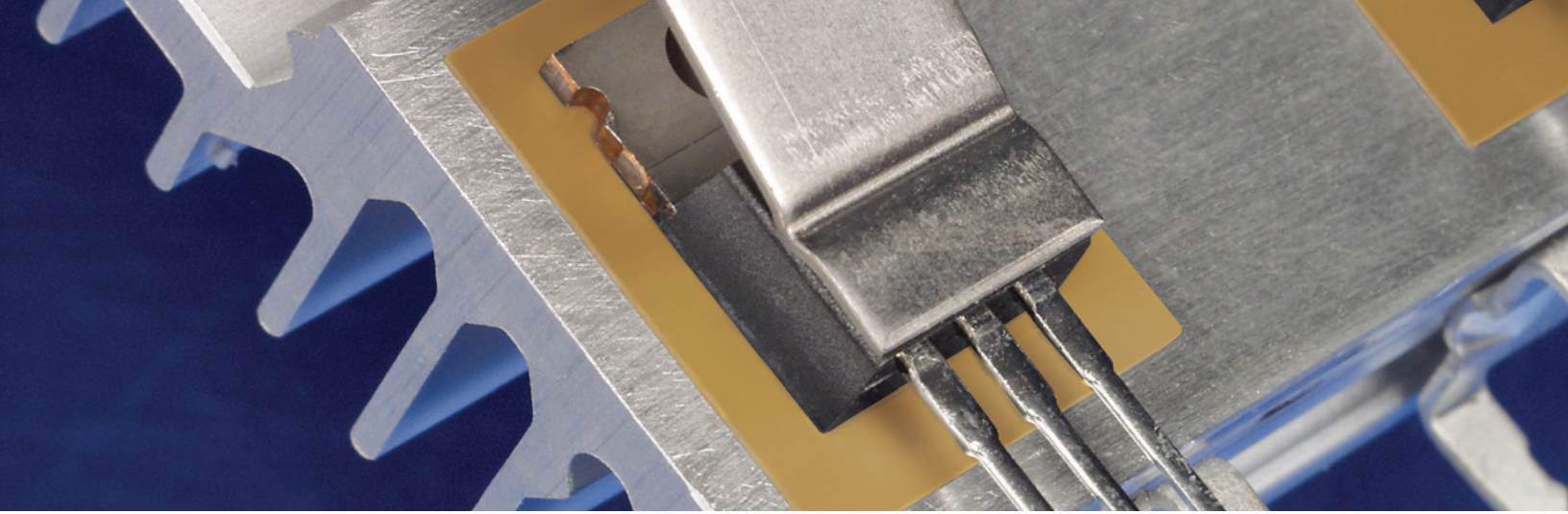
Epoxy

Product Name	Description	Key Attributes	Color	Viscosity at 25°C (cP) - Part 1/Part 2	Glass Transition Temperature, Tg (°C)	Shore Hardness	Recommended Cure
One Component							
LOCTITE STYCAST EO 1058	Epoxy	<ul style="list-style-type: none"> • Excellent chemical resistance • High temperature stability • Good adhesion to variety of substrate • Low CTE 	Black	50,000	140	90	2 hr. at 140°C
LOCTITE STYCAST EO 7038	Epoxy	<ul style="list-style-type: none"> • Good chemical resistance • Good thermal shock resistance 	Black	40,000	140	92	2 hr. at 140°C
LOCTITE STYCAST A 316-48	Epoxy	<ul style="list-style-type: none"> • Fast heat cure • Heat resistant • Exceptional thermal stability • Excellent chemical resistance 	Black	50,000	145	86	30 min. at 100°C
LOCTITE ECCOBOND ES 70205	Epoxy	<ul style="list-style-type: none"> • Low CTE • Good chemical resistance • Good thermal shock resistance • Good adhesion of variety of substrates 	Black	17000	97	90	1 hr. at 120°C
Two Component							
LOCTITE STYCAST 2651-40 W1 CAT9	Epoxy	<ul style="list-style-type: none"> • Low viscosity • Ease of use • Good adhesion to variety of substrate • Room Temperature (RT) or heat cure 	Black	33000 / 95	110	88	24 hr. at RT
LOCTITE STYCAST 2850FT CAT9	Epoxy	<ul style="list-style-type: none"> • Thermally conductive (1W/m.K) • Low CTE • Excellent chemical resistance • Electrically insulating 	Black	250000 / 95	86	96	24 hr. at RT
LOCTITE STYCAST E 2534 FR CAT9	Epoxy	<ul style="list-style-type: none"> • Thermally conductive • Flame retardant (UL 94V-0 rating in 6mm thickness) • Excellent chemical resistance • Halogen Free 	Blue	350000 / 95	76	90	24 hr. at RT

SEALANTS

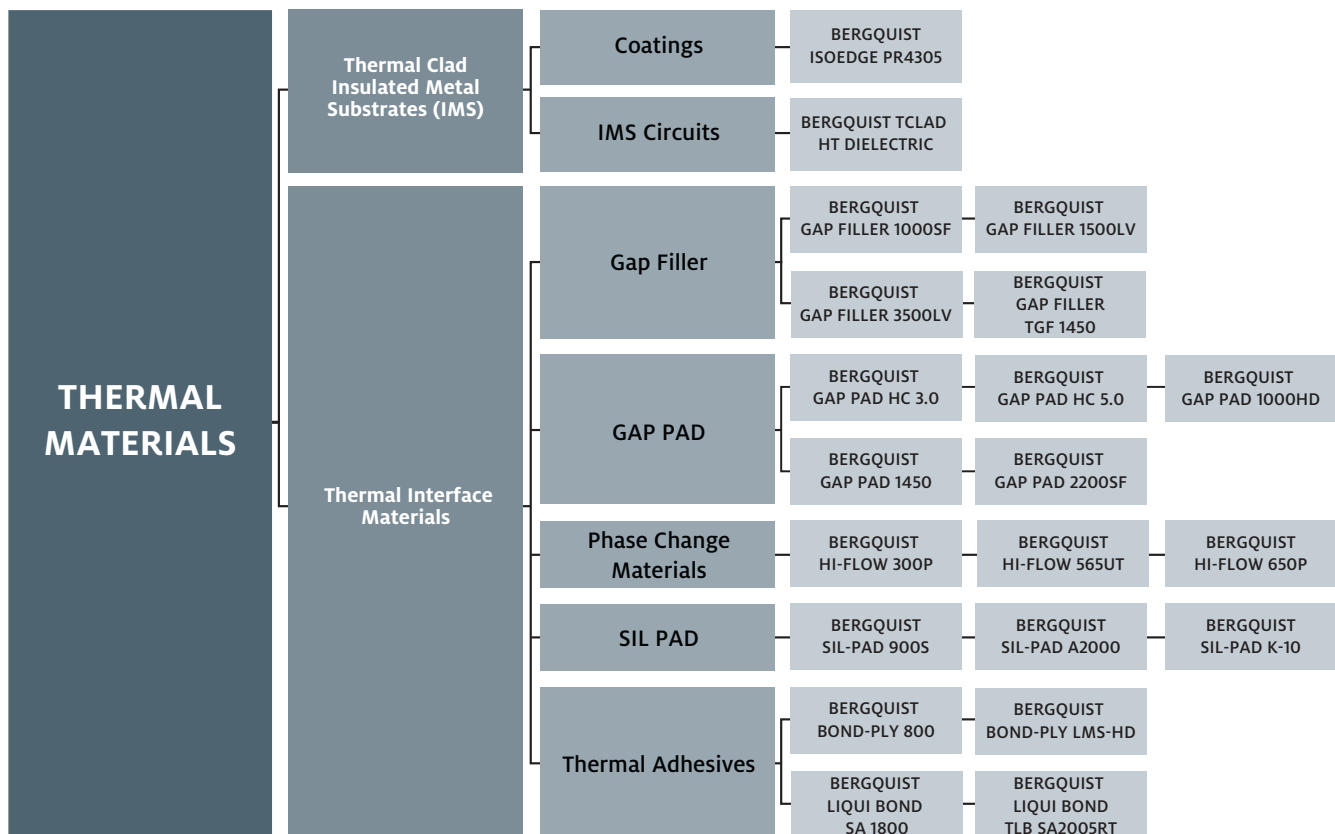
Silicone

Product Name	Description	Key Attributes	Shore A Hardness	Tensile Strength (MPa)	Self-cure time	Recommended Cure
LOCTITE SI 5970	1K, moisture cure silicone sealant to form a tough rubber gasket	<ul style="list-style-type: none"> • 1K, Ideal for use where high vibration or flexing occurs • Can be used with plastic and painted parts • Excellent resistance to automotive engine oils 	44	≥ 1.5	Tack-free after 25 min.	21 days at 23°C
BERGQUIST LIQUI BOND TLB 400 SLT	High performance, two-part, silicone adhesive sealant with an adaptable cure profile	<ul style="list-style-type: none"> • 2K - 1:1 mixing ratio • Fast and adaptable cure (RT or elevated temperature) • Strong and elastic bond • Thixotropic • Designed for automated dispensing as FIPG (Form-In-Place Gasket) • Full compatibility with Gap Filler • Chemical resistance • High adhesion and elongation • Room temperature storage 	40	2.1	12 hr. at 25°C	7 days at 25°C



Running Cool

New Li-Ion batteries now have power and energy densities that are unprecedented, making thorough thermal management of these high-voltage systems non-negotiable for proper operation. If any of the parts overheat – especially those that are flammable – battery work life and, more critically, safety are at risk. As the world’s top thermal management materials innovator, Henkel is partnering with today’s leading automotive companies to deliver flexible and effective heat management solutions for dependable Li-Ion battery function. Thermal management systems are required throughout the entire Li-Ion battery structure – in between the cells, from the battery to module housing and the module to battery pack housing. Henkel’s thermal interface materials – in liquid and pad format – permeate the Li-Ion battery system, providing insulation for safe in-use functionality, and contributing to the reliability of road-ready electric and plug-in hybrid electric vehicles.



THERMAL CLAD INSULATED METAL SUBSTRATES (IMS)

Product Name	Description	Key Attributes	Thermal Conductivity (W/m•K)	Thickness (µm)	Dielectric Strength (VAC/mil)	Flammability Rating	Dielectric Constant
Coatings							
BERGQUIST ISOEDGE PR4305	Thermally conductive, electrically isolating powder coat	<ul style="list-style-type: none"> • Low thermal impedance • Good thermal conductivity • Good dielectric strength • UL certified • Eliminates need for thick gap fillers 	0.6	100 – 250	650	UL 94V-0	6
IMS Circuits							
BERGQUIST TCLAD HT DIELECTRIC	Thermally conductive, electrically isolating dielectric	<ul style="list-style-type: none"> • Very low thermal impedance • High thermal conductivity • Great dielectric strength • UL certified • Eutectic AuSn compatible 	2.2	76	2,000	UL 94V-0	7

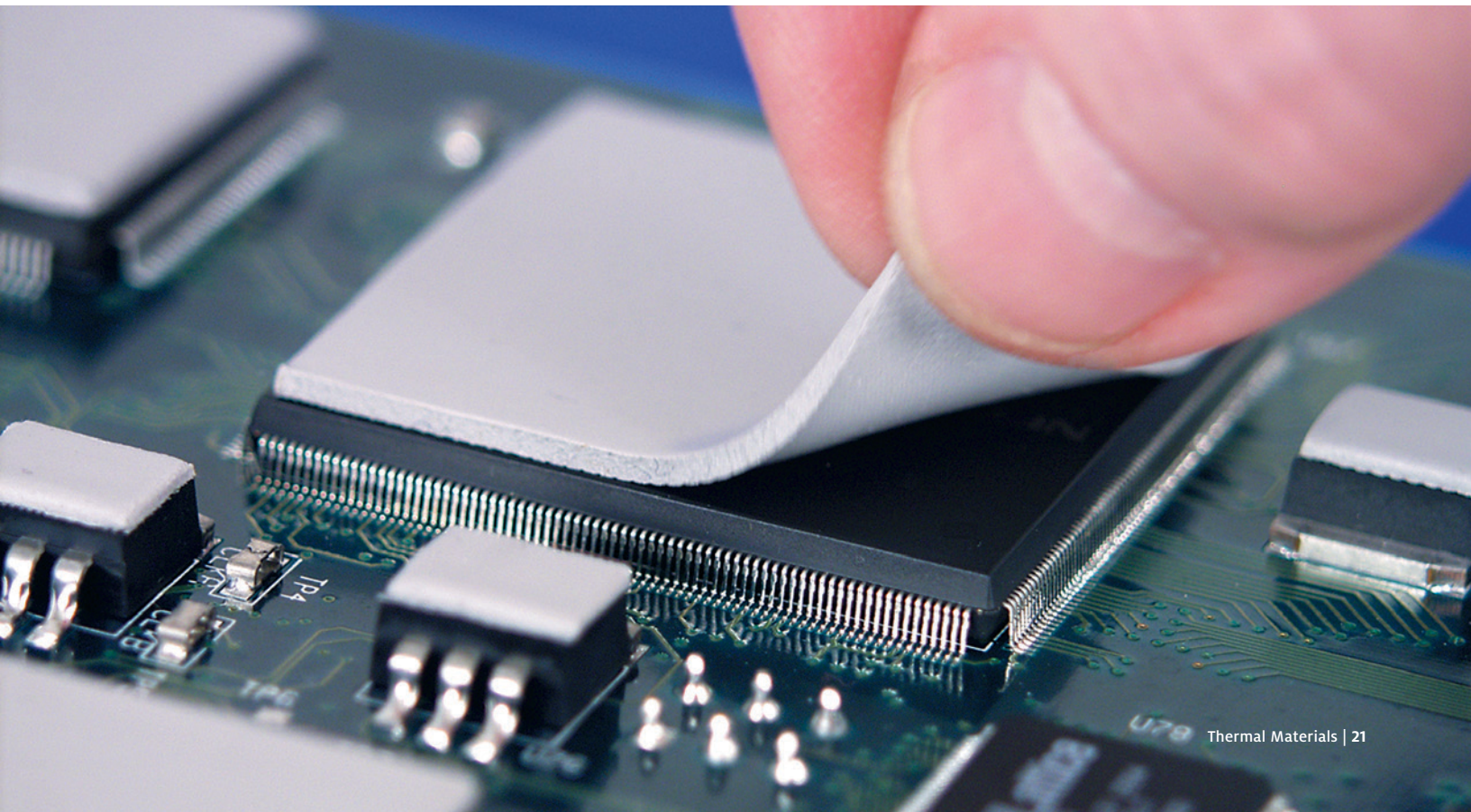
THERMAL INTERFACE MATERIALS

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 1000SR	Two-part, thermally conductive, and slump resistant liquid gap filling material	<ul style="list-style-type: none"> • Excellent slump resistance (stays in place) • Ultra-conforming, with excellent wet-out for low stress interface applications • 100% Solids – no cure by-products • Excellent low and high temperature mechanical and chemical stability 	1	20 Pa-S (ASTM D5099)	500	UL 94V-0	20 min. at 25°C
BERGQUIST GAP FILLER 1450	Two-part, thermally conductive, liquid gap filling material	<ul style="list-style-type: none"> • Ultra-conforming with excellent wet-out for near zero interface stress • No cure by-products • Low density for weight sensitive application • Excellent low and high temperature mechanical and chemical stability • Shear thinning viscosity for ease of dispensing 	1.5	Part A: 30 Pa-S (ASTM D5099) Part B: 200 Pa-S (ASTM D2196)	275	UL 94V-0	5 hr. at 25°C
BERGQUIST GAP FILLER 1500 LV	Thermally conductive liquid gap filling material	<ul style="list-style-type: none"> • Low volatility for silicone sensitive applications • Ultra-conforming, with excellent wet-out • 100% solids — no cure by-products • Excellent low and high temperature, chemical and mechanical stability • Ambient or accelerated cure schedules 	1.8	20,000	400	UL 94V-0	8 hr. at 25°C
BERGQUIST GAP FILLER 3500LV	Thermally conductive, low outgassing, liquid gap filling material	<ul style="list-style-type: none"> • Low volatility for outgassing sensitive applications • Ultra-conforming with excellent wet-out for low stress interfaces on applications • 100% solids - no cure by-products • Ambient or accelerated cure schedules 	3.5	45,000	275	UL 94V-0	24 hr. at 25°C

GAP PAD

Product Name	Description	Key Attributes	Thermal Conductivity (W/m•K)	Modulus at 25°C (KPa)	Dielectric Breakdown Voltage	Thickness (mm)	Flammability Rating
BERGQUIST GAP PAD HC3.0	High-compliance, thermally conductive, low modulus, gap filling material	<ul style="list-style-type: none"> High-compliance, low compression stress Fiberglass reinforced for shear and tear resistance 	3	110	5,000 V (at 500 µm)	• 0.508 – 3.175	UL 94V-0
BERGQUIST GAP PAD HC5.0	High-compliance, thermally conductive, low modulus, gap filling material	<ul style="list-style-type: none"> Exceptional thermal performance High-compliance, low compression stress Fiberglass reinforced for shear and tear resistance 	5	121	5,000 V (at 500 µm)	<ul style="list-style-type: none"> • 0.508 • 1.016 • 1.524 • 2.032 • 2.540 • 3.175 	UL 94V-0
BERGQUIST GAP PAD 1450	Highly compliant gap pad material	<ul style="list-style-type: none"> Permanent liner reinforcement allows easy rework and resistance to puncture and tear resistance Highly conformable/low hardness Designed for and low-stress applications 	1.3	110	6,000 V (at 500 µm)	• 0.508 – 3.175	UL 94V-0
BERGQUIST GAP PAD 1000HD	High durability gap pad	<ul style="list-style-type: none"> Robust Polyimide carrier provides excellent voltage breakdown, puncture and tear resistance Highly conformable Ease of handling and rework in applications 	1	414	10,000 V (at 500 µm)	• 0.508 – 3.175	UL 94V-0
BERGQUIST GAP PAD 2200SF	Thermally conductive, silicone-free gap filling material	<ul style="list-style-type: none"> Medium compliance with easy handling Electrically isolating 	2	228	5,000 V (at 250 µm)	• 0.254 – 3.175	UL 94V-0



Phase Change Materials

Product Name	Description	Key Attributes	Thermal Conductivity (W/m•K)	Phase Change Temperature (°C)	Dielectric Breakdown Voltage	Dielectric Breakdown Voltage	Flammability Rating
Polymide Carrier							
BERGQUIST HI-FLOW 300P	Electrically insulating, thermally conductive phase change material	<ul style="list-style-type: none"> Field-proven polyimide film Excellent dielectric performance Excellent cut-through resistance Outstanding thermal performance in an insulated pad 	1.6	55	5000 V	0.025 – 0.050	94V-0
BERGQUIST HI-FLOW 650P	Electrically insulating, thermally conductive phase change material	<ul style="list-style-type: none"> Thermal impedance: 0.20°C-in²/W (at 25 psi) 150°C high temperature reliability Natural tack one side for ease of assembly Exceptional thermal performance in an insulated pad 	1.5	52	5000 V	0.025 – 0.050	UL 94V-0
No Carrier							
BERGQUIST HI-FLOW 565UT	Tacky, high performance, un-reinforced phase change material	<ul style="list-style-type: none"> Very low thermal impedance High thermal conductivity Naturally tacky Used for applications that do not require electrical insulation Tabulated for ease of assembly 	3	52	N/A	0.127 - 0.254	UL 94V-0

SIL PAD

Product Name	Description	Key Attributes	Thermal Conductivity (W/m•K)	Hardness	Dielectric Breakdown Voltage	Thickness (mm)	Flammability Rating
Polymide Carrier							
BERGQUIST SIL-PAD A2000	A conformable thermally conductive elastomer	<ul style="list-style-type: none"> Thermal impedance: 0.32°C-in² /W (at 50 psi) Optimal heat transfer 	3	90 (Shore A)	4000 V	0.381 to 0.508	UL 94 V-0
BERGQUIST SIL-PAD 900S	Thermally conductive and electrical insulation material	<ul style="list-style-type: none"> Thermal impedance: 0.61°C-in² /W (at 50 psi) Electrically isolating Low mounting pressures Smooth and highly compliant surface General-purpose thermal interface material solution 	1.6	92 (Shore 00)	5500 V	0.229	UL 94 VTM-0
No Carrier							
BERGQUIST SIL-PAD K-10	A high performance insulator to replace ceramic insulators such as Beryllium Oxide, Boron Nitride, and Alumina	<ul style="list-style-type: none"> Thermal impedance: 0.41°C-in² /W (at 50 psi) Tough dielectric barrier against cut-through High performance film Designed to replace ceramic insulators 	1.3	90 (Shore 00)	6000 V	0.152	UL 94 VTM-0

Thermal Adhesives

Product Name	Description	Key Attributes	Thermal Conductivity (W/m•K)	Thickness	Dielectric Strength	Flammability Rating	Lap Shear at RT
Tapes							
BERGQUIST BOND-PLY 800	Thermally conductive, electrically isolation double-sided tape	<ul style="list-style-type: none"> • Thermal impedance: 0.60°C-in²/W (at 50 psi) • High bond strength to most epoxies and metals • Double-sided, pressure sensitive adhesive tape • High performance, thermally conductive acrylic adhesive • More cost-effective than heat-cure adhesive, screw mounting or clip mounting 	0.8	<ul style="list-style-type: none"> • 0.127mm • 0.203mm 	4000 V	UL 94 V-0	150 Psi
BERGQUIST BOND-PLY LMS-HD	Thermally conductive heat curable laminate material	<ul style="list-style-type: none"> • TO-220 Thermal performances: 2.3°C/W, initial pressure only lamination • Exceptional dielectric strength • Very low interfacial resistance • Continuous use of -60 to 180°C • Eliminates mechanical fasteners 	1.4	<ul style="list-style-type: none"> • 0.254mm • 0.457mm 	4000 V	UL 94 V-0	200 Psi

Thermal Adhesives – Continued

Product Name	Description	Key Attributes	Thermal Conductivity (W/m•K)	Viscosity	Dielectric Strength	Flammability Rating	Recommended Cure
Liquids							
BERGQUIST LIQUI BOND TLB SA 1800	High performance, liquid silicone adhesive	<ul style="list-style-type: none"> • Eliminates need for mechanical fasteners • Low viscosity for ease of screening or stenciling • Maintains structural bond in severe-environment applications • Heat cure 	1.8	125,000 cps	250 V/mil	UL 94 V-0	20 min. at 125°C or 10 min. at 150°C
BERGQUIST LIQUI BOND TLB SA2005RT	Two-part, high performance silicone thermal adhesive	<ul style="list-style-type: none"> • Adaptive thermal cure • No cure by-products • Cures and bonds at room temperature • Cure rate is greatly accelerated at elevated temperatures • Room temperature storage 	2	Part A: 70 Pa-S Part B: 70 Pa-S	275 V/mil	UL 94 V-0	7 days at 25°C or 1 hr. at 85°C



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