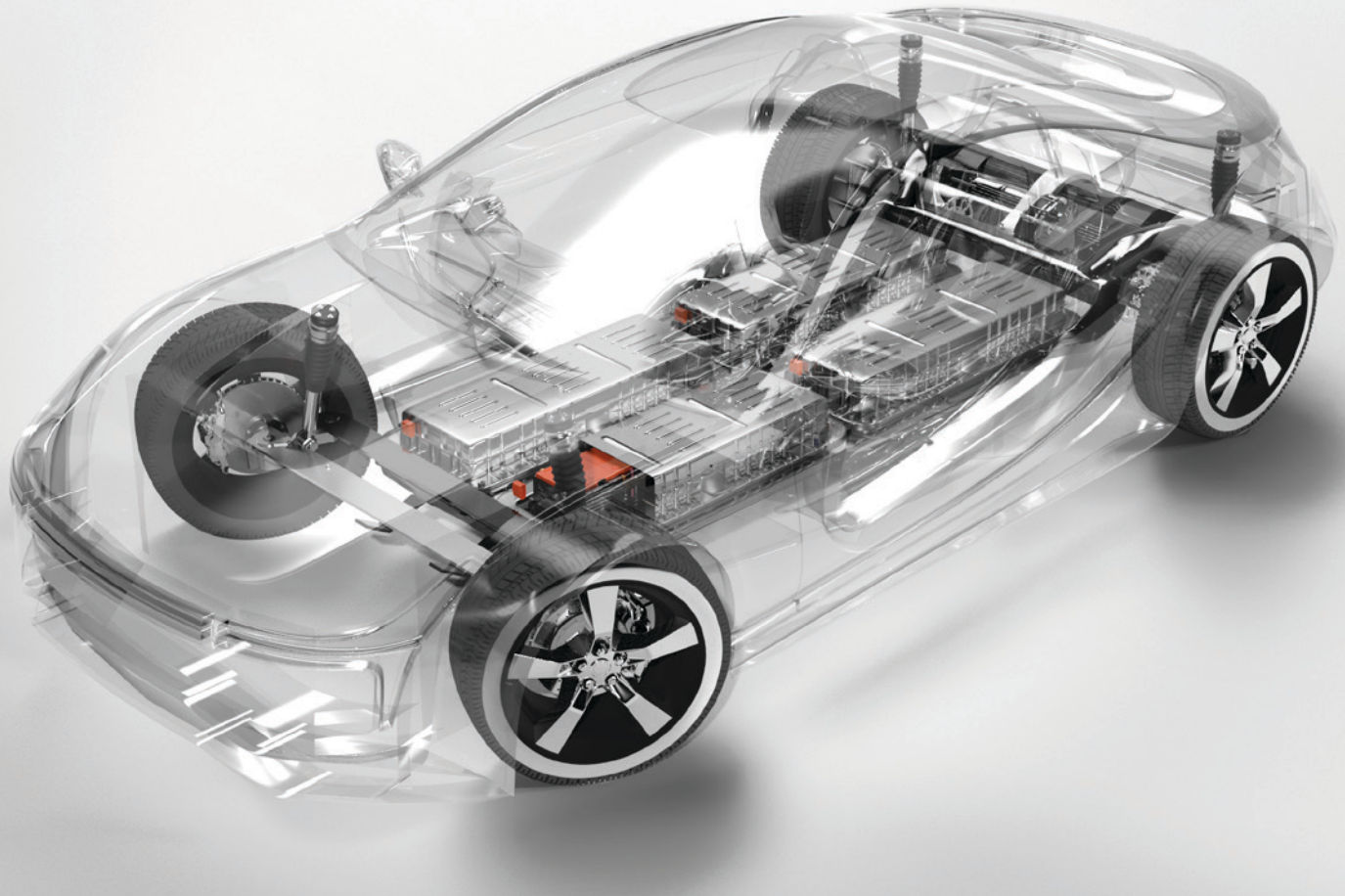
LOCTITE®
TECHNOMELT®

BERGQUIST®

MATERIALS FOR POWER STORAGE SYSTEMS

ELECTRIC AND HYBRID VEHICLE SOLUTIONS



Henkel

CONTENTS

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.

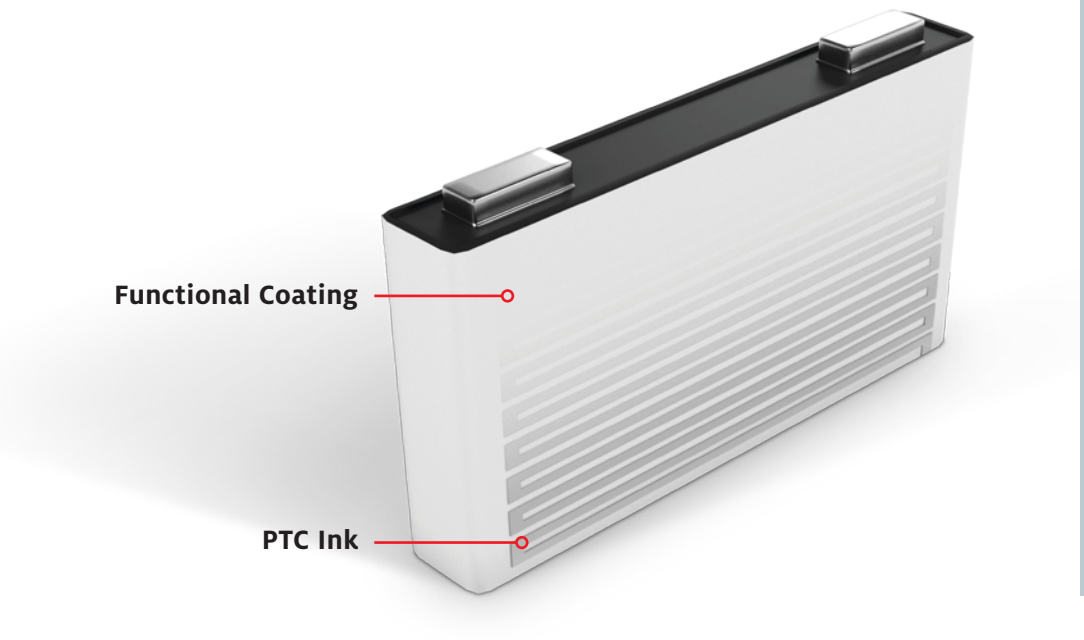
Performance Enablers

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

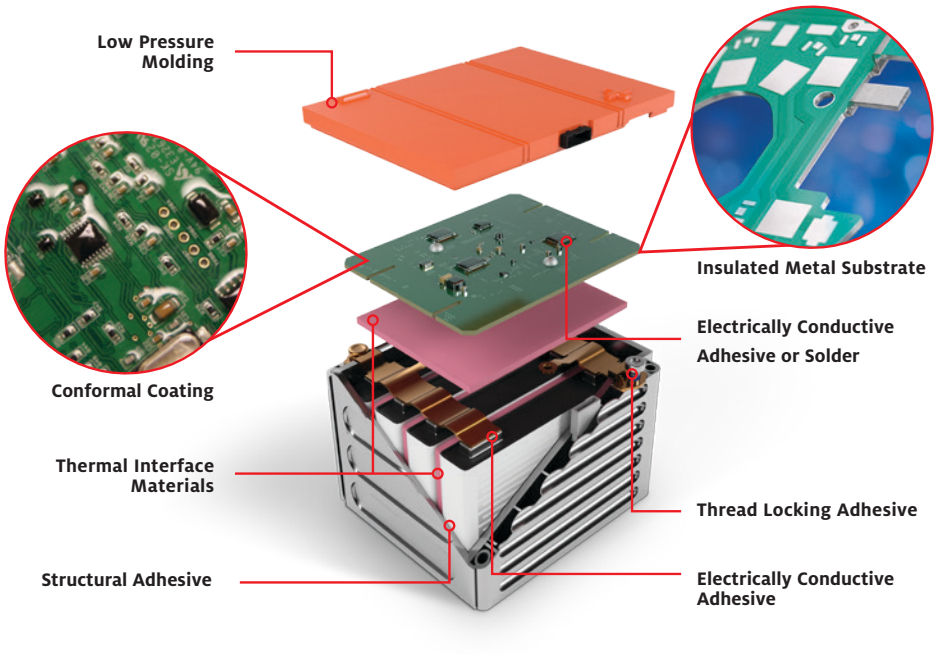
- Pre-treatment coating of anodes and cathodes enhances bonding for improved conductivity.
- Extend battery life and reduce weight with Henkel's novel battery heating PTC inks. Temperature is known to have a significant impact on battery performance, safety and cycle lifetime; Henkel's positive temperature 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	
	Potting	
Thermal	Insulated Metal Substrate	
	Thermal Interface Materials	

Battery Modules

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

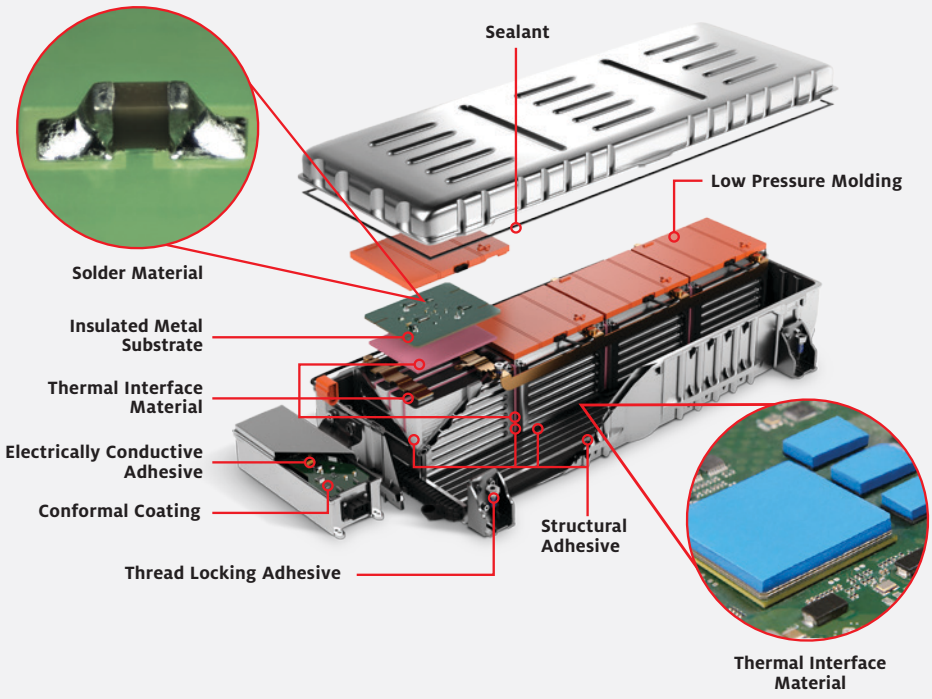


Module and Pack Benefits

- 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.



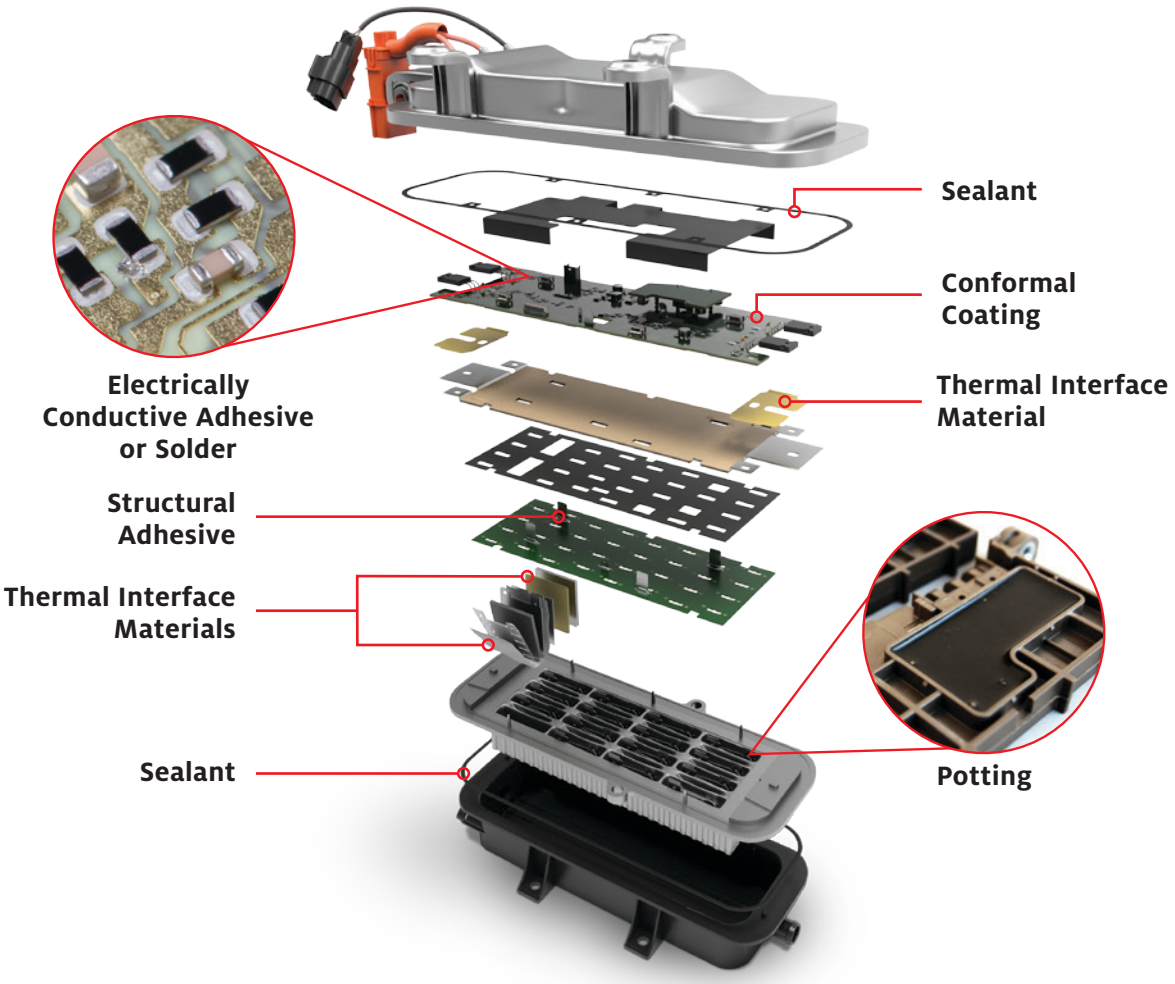
Module Level Product Portfolio

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	✓	✓

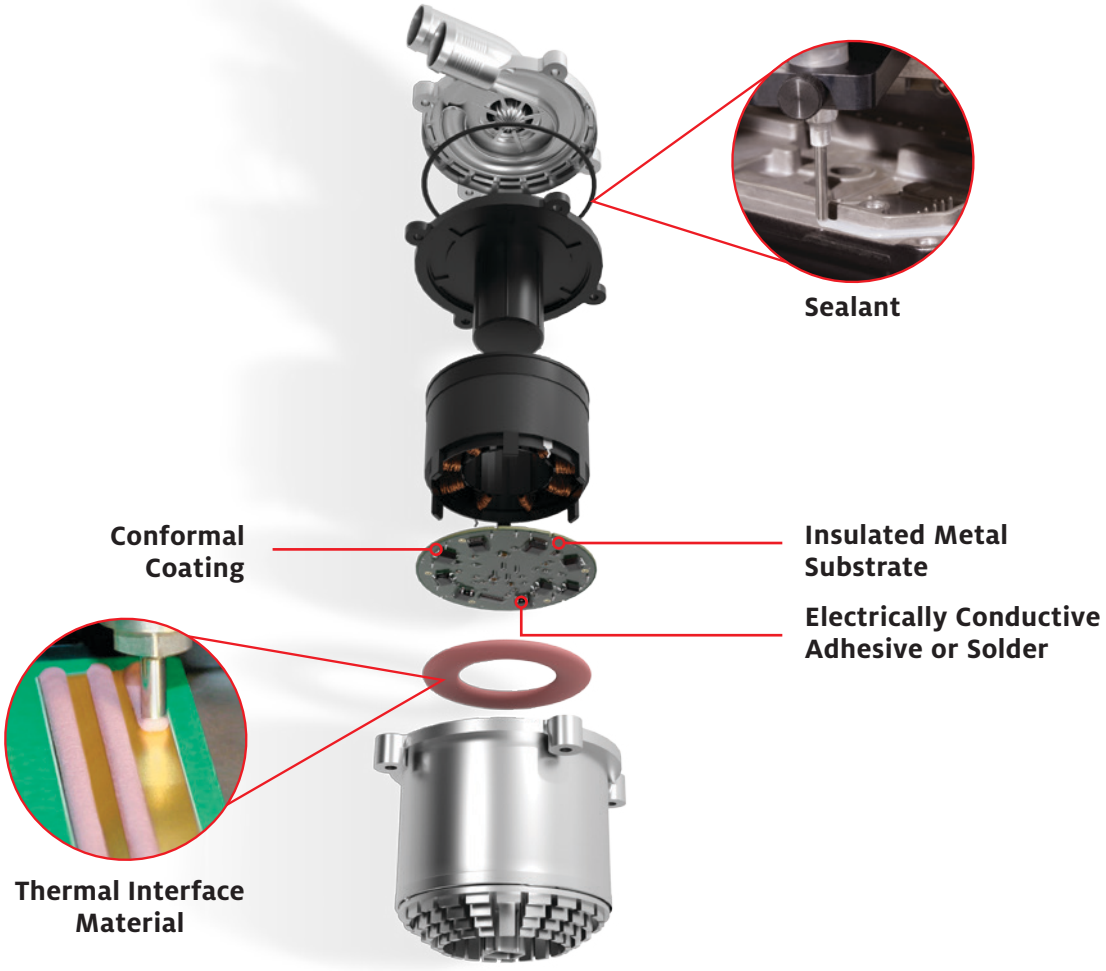
Battery Packs (Continued): Electric Heating Systems



Pack Level Product Portfolio (Continued)

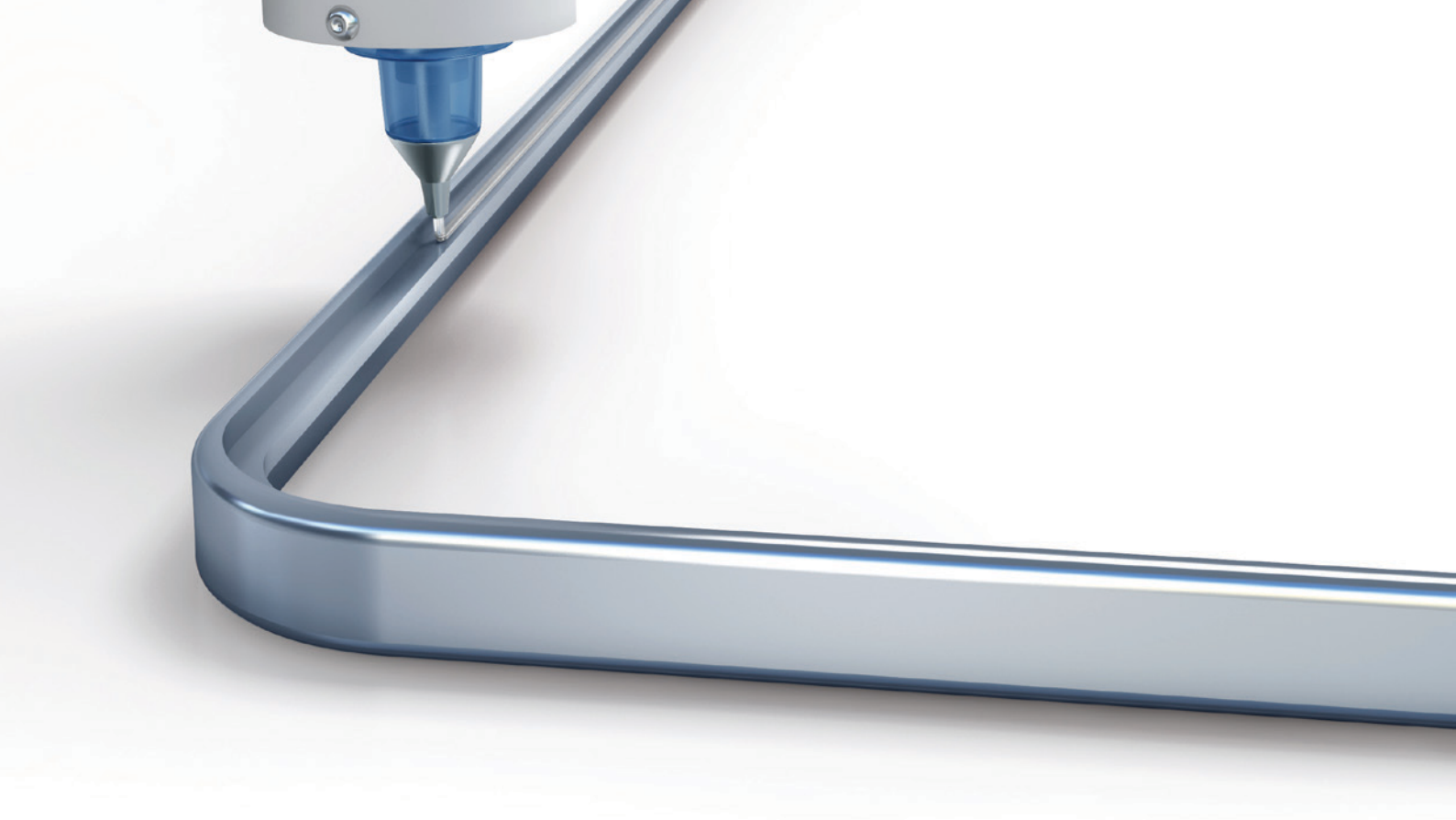
Application	Technology	Pack Level (Continued)
		Electric Heating Systems
Bonding	Structural Adhesives	✓
	Thread Locking Adhesives	
Connecting	Electrically Conductive Adhesives	✓
	Printed Inks	✓
	Solder Materials	✓
Protecting	Conformal Coatings	✓
	Encapsulants	
	Functional Coatings	
	Low Pressure Molding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

Battery Packs (Continued): Coolant Pumps



Pack Level Product Portfolio (Continued)

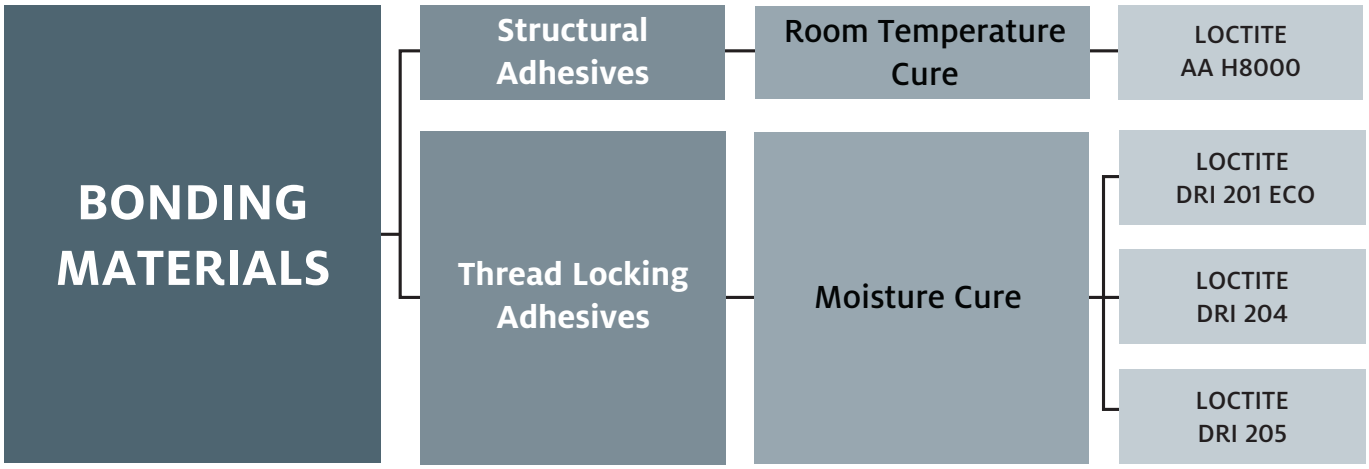
Application	Technology	Pack Level (Continued)
		Coolant Pumps
Bonding	Structural Adhesives	
	Thread Locking Adhesives	
Connecting	Electrically Conductive Adhesives	✓
	Printed Inks	
	Solder Materials	✓
Protecting	Conformal Coatings	✓
	Encapsulants	✓
	Functional Coatings	
	Low Pressure Molding	
	Sealants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

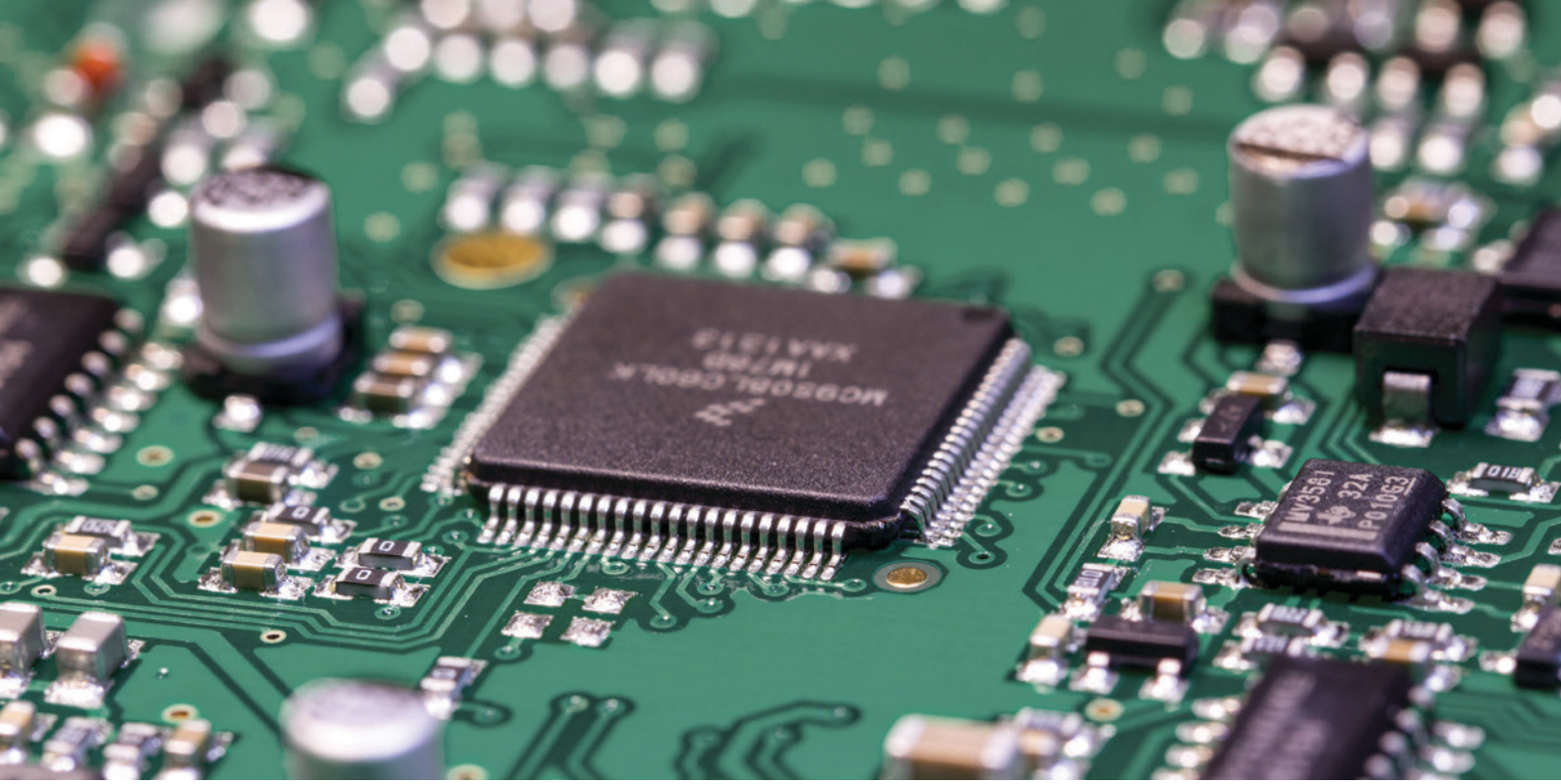


MATERIALS FOR LITHIUM ION BATTERIES

Lasting Bonds

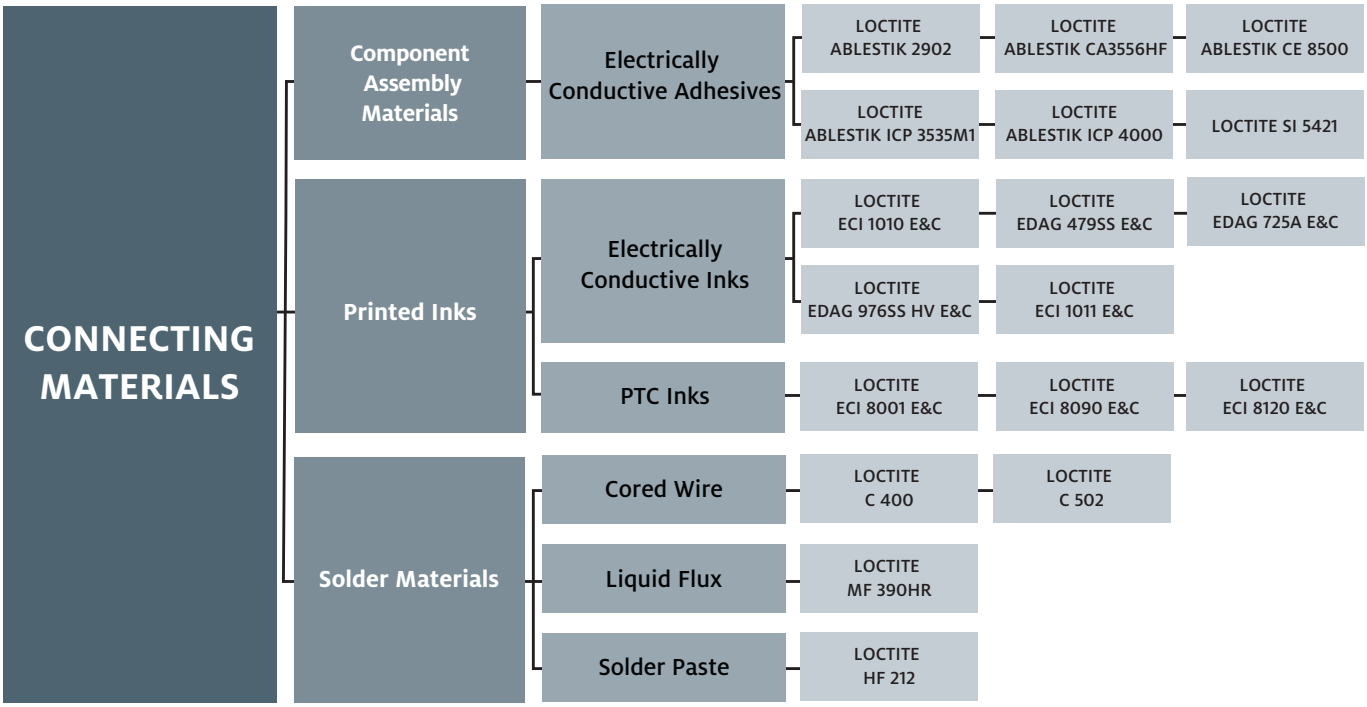
A strong, cohesive structure for all of the components of a battery pack is integral to long-term function and durability. Today's Li-Ion batteries must withstand tremendous in-use vibration and maintain structural integrity even within these conditions. As the global leader in adhesives development, 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.

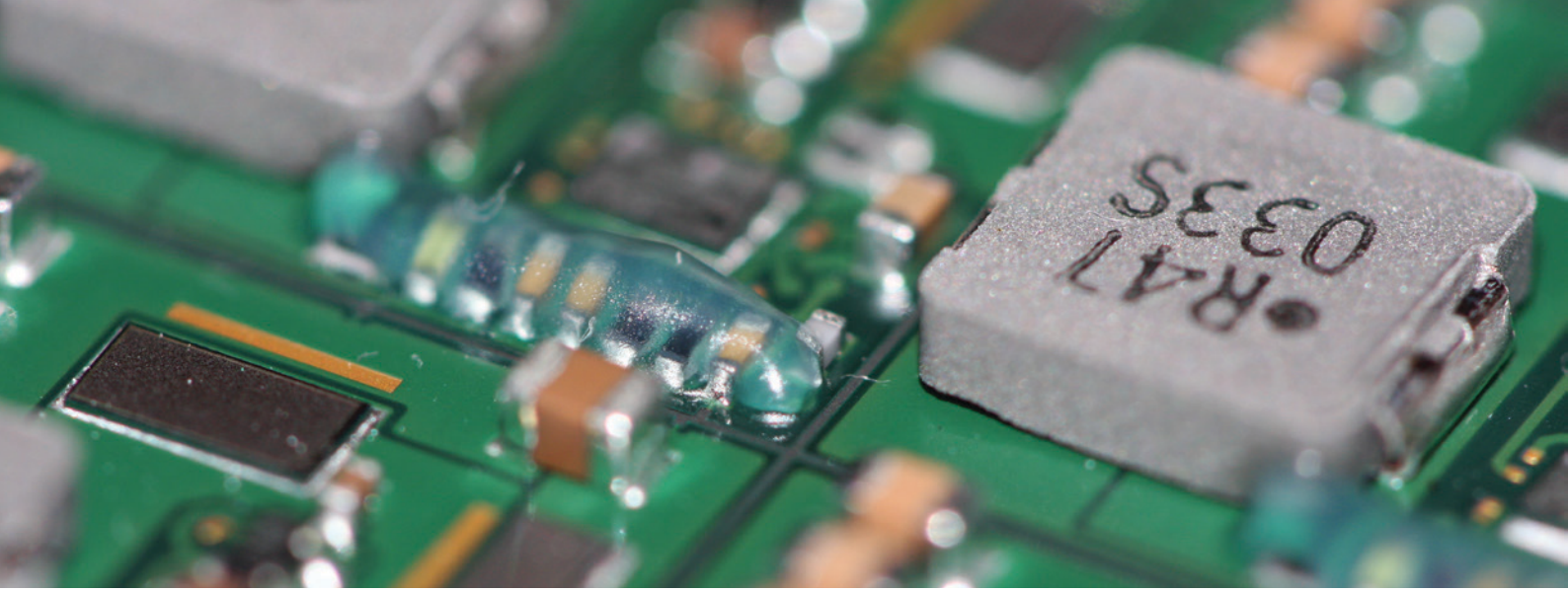




Strong Connections

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.





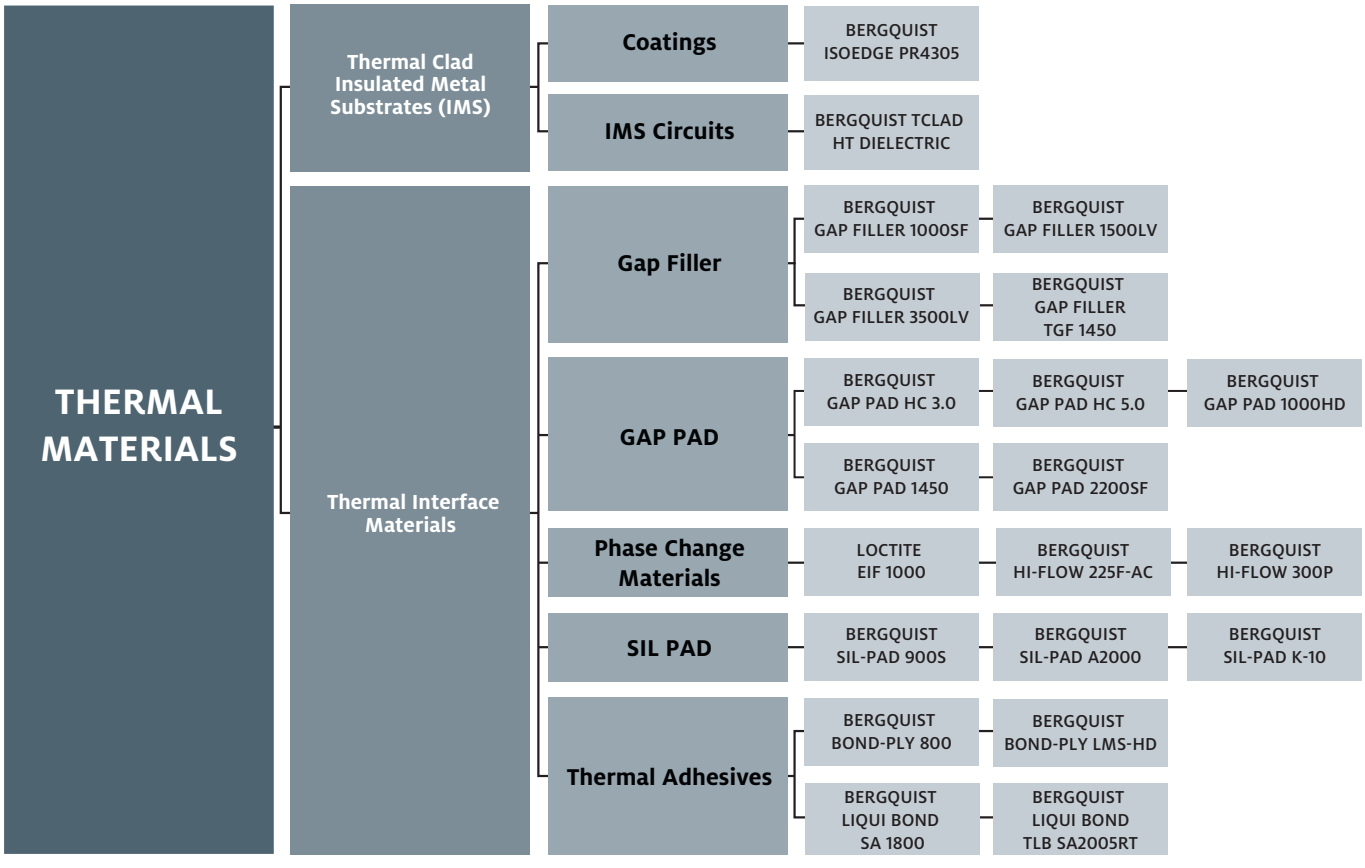
Amplified Protection

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	Epoxy	LOCTITE ECCOBOND E01072	LOCTITE ECCOBOND FP4450	LOCTITE ECCOBOND FP4451TD
	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	

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.



LOCTITE®
TECHNOMELT®

BERGQUIST®

AMERICAS

HEADQUARTERS:
UNITED STATES
Henkel Corporation
14000 Jamboree Road
Irvine, CA 92606
USA
Tel: +1.888.943.6535
Fax: +1.714.368.2265

Henkel Corporation
20021 Susana Road
Rancho Dominguez, CA 90221
USA
Tel: +1.310.764.4600
Fax: +1.310.605.2274

Henkel Corporation
18930 W. 78th Street
Chanhassen, MN 55317
USA
Tel: +1.952.835.2322
Tel: +1.800.347.4572
Fax: +1.952.835.0430

BRAZIL
Henkel Brazil
Av. Prof. Vernon Krieble, 91
06690-070 Itapevi,
Sao Paulo, Brazil
Tel: +55.11.3205.7001
Fax: +55.11.3205.7100

ASIA-PACIFIC

CHINA
No. 332 Meigui South Road
WaiGaoQiao Free Trade Zone, Pu Dong
Shanghai 200131, P.R. China
Tel: +86.21.3898.4800
Fax: +86.21.5048.4169

JAPAN
Henkel Japan Ltd.
27-7, Shin Isogo-cho
Isogo-ku Yokohama, 235-0017
Japan
Tel: +81.45.286.0161
Email: jp.ae-csdesk@henkel.com

KOREA
Henkel Korea Co.,Ltd
18th floor of tower B, BYC High City Bldg
Gasan Digital 1-ro, Geumcheon-gu, Seoul,
08506, South Korea
Tel : +82.2.6150.3000
Fax: +82.2.6947.5203

Henkel Korea Co.,Ltd
806, Daeryung Techno Town II, 33-33,
Gasan Digital 1-ro, Geumcheon-gu, Seoul,
08594, Korea
Tel : +82.2.6675.8000
Fax: +82.2.6675.8191

SINGAPORE
Henkel Singapore Pte Ltd.
401, Commonwealth Drive
#03-01/02 Haw Par Technocentre,
Singapore 149598
Tel: +65.6266.0100
Fax: +65.6472.8738 / +65.6266.1161

EUROPE

BELGIUM
Henkel Electronics Materials (Belgium)
N.V. Nijverheidsstraat 7
B-2260 Westerlo
Belgium
Tel: +32.1457.5611
Fax: +32.1458.5530

UNITED KINGDOM
Henkel Ltd.
Adhesives Limited Technologies House
Wood Lane End
Hemel Hempstead
Hertfordshire HP2 4RQ
Tel: +44.1442.278000
Fax: +44.1442.278071

Across the Board,
Around the Globe.

henkel-adhesives.com/electronics
henkel-adhesives.com/thermal