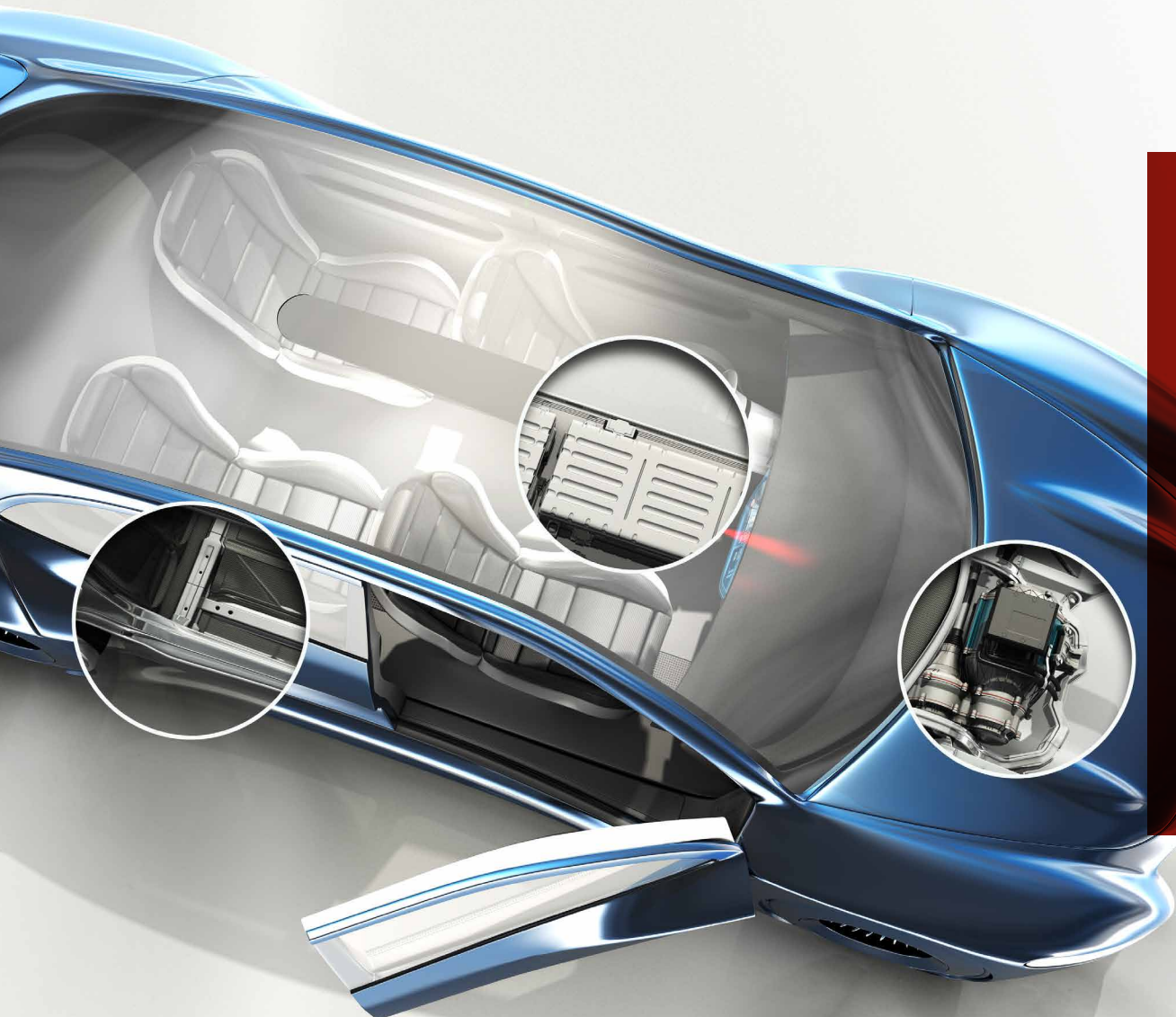


LOCTITE

TECHNOMELT

TEROSON

BERGQUIST



Henkel Solutions for e-Mobility

BATTERY SYSTEMS,
POWER CONVERSION
SYSTEMS AND
E-DRIVE SYSTEMS

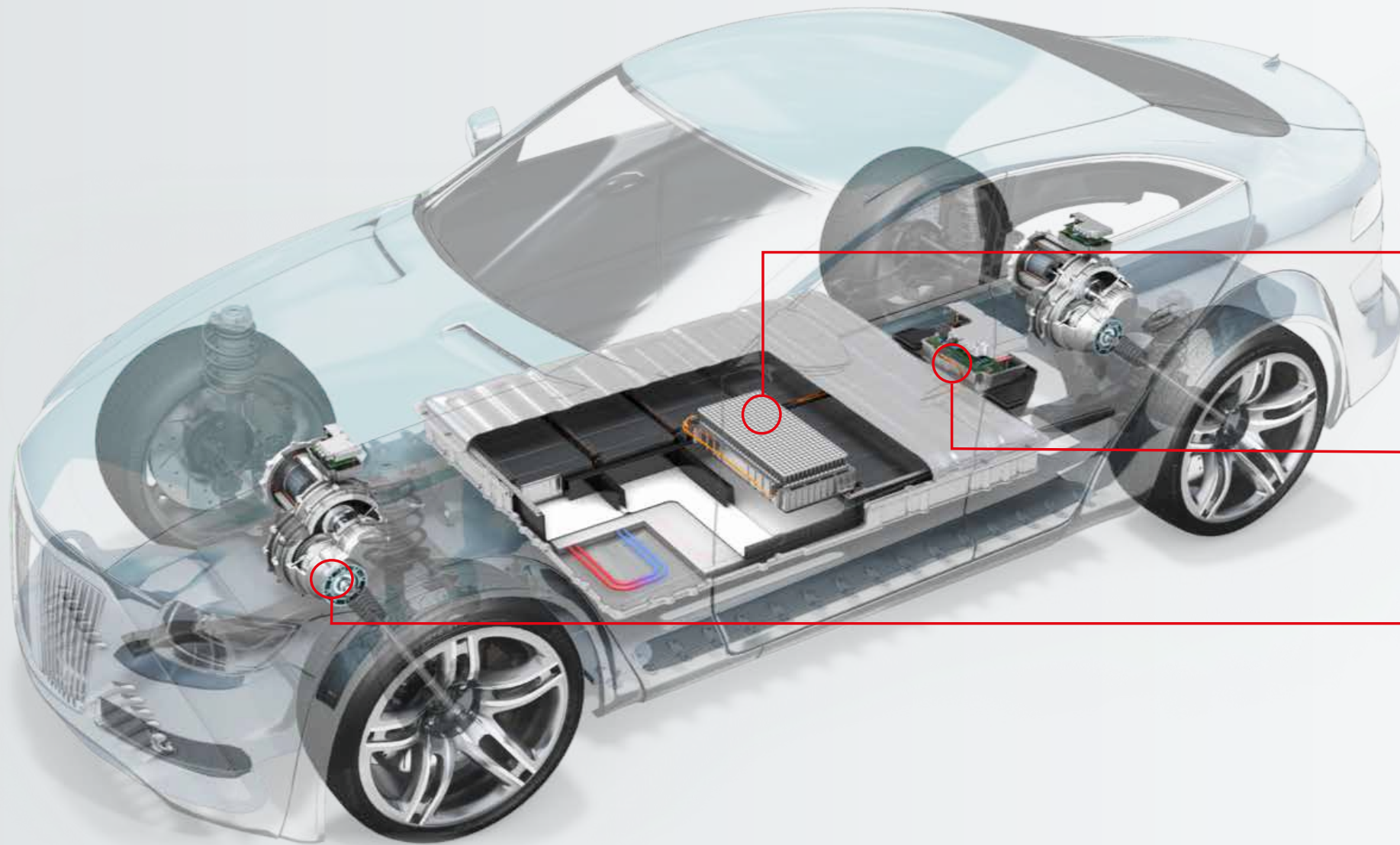


Henkel, a **trusted Solutions Partner**

“DRIVING
E-MOBILITY,
TOGETHER.”

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Our aim is to thoroughly understand **our customers' challenges and needs ...**

1. BATTERY SYSTEMS

Battery systems are the most critical component of an electrical vehicle, accounting for approximately 20 percent of the car by weight and 50 percent by cost. Cost efficiency, passenger safety, vehicle reliability and lightweighting are all important considerations for battery design, making efficient and secure component assembly as well as thermal management a priority.

2. POWER CONVERSION SYSTEMS

Power conversion systems are complex components that have to handle very high voltages as well as both DC and AC, while subjected to harsh electrical and environmental factors. Efficient sealing, electrical insulation and thermal management are essential for optimal performance of these components.

3. E-DRIVE SYSTEMS

Electric motors are subjected to the harshest vibrations and environmental conditions. It is one of the key systems in the EV architecture that has moving components, making structural integrity, sealing and thermal management key for reliable and optimal performance.



... and to respond accordingly
with a full solution package.

We are committed to solving the engineering and commercial challenges through a combination of:

1. BROAD TECHNOLOGY PORTFOLIO

We have a market leading position in thermal interface materials, adhesives, sealants and functional coatings. In addition, we support our customers overcome engineering challenges by leveraging our strong R&D competences to develop customized solutions.

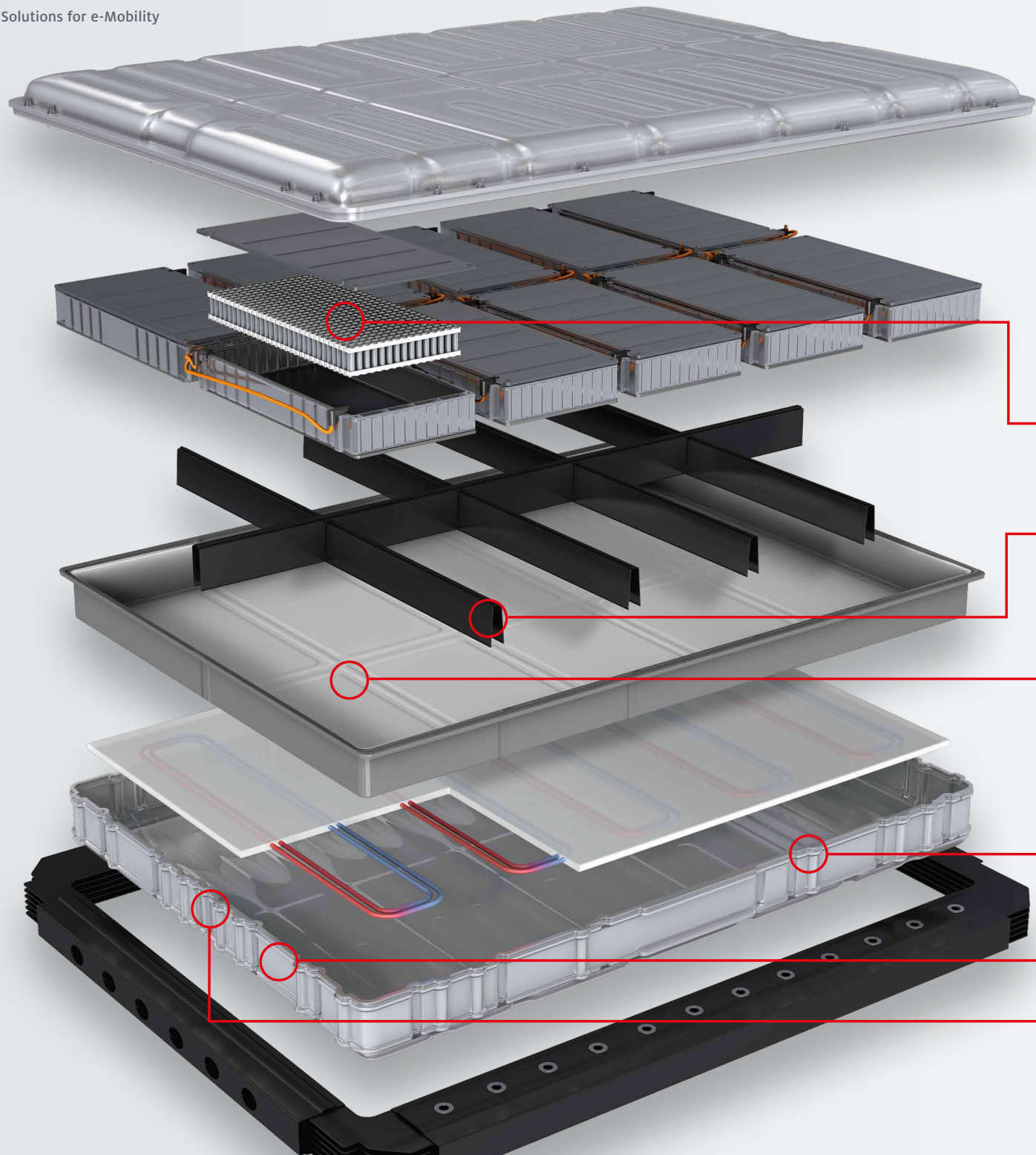
2. PROCESS EXPERTISE

With over 60 years of experience in the automotive industry, our global team of solution engineers has an unparalleled application and process understanding. Our team offers dedicated support to co-develop sustainable production processes that meet large-scale manufacturing requirements.

3. EQUIPMENT SUPPORT

Our portfolio also contains dispensing and curing equipment. In addition, we partner with a large network of leading equipment suppliers. We also have the capabilities and equipment available for modelling, simulation and mechanical validation.

WE ONLY HAVE ONE AIM: DRIVING E-MOBILITY, TOGETHER.



HENKEL SOLUTIONS FOR EV BATTERY SYSTEMS

1. BATTERY ASSEMBLY ADHESIVES

Cell-to-Cell or Cell-to-Carrier

page 10

2. STRUCTURAL BONDING

Module Structure to Module Tray

page 10

3. THERMAL INTERFACE MATERIALS

Battery Module to Cooling Plate

page 12

4. GASKETING

Top Cover to Lower Tray

page 13

5. METAL PRETREATMENT

Battery Pack Housing

page 14

6. IMPREGNATION SERVICE

Aluminum Casted Top Cover

page 28

OUR AMBITION

Henkel technology solutions are designed to optimize the safety, reliability and efficient assembly of EV battery systems.

DISCOVER OUR PORTFOLIO FOR EV BATTERY SYSTEMS

BATTERY ASSEMBLY & STRUCTURAL ADHESIVES				
Product	Chemistry	Curing / Initial Strength	Bond Strength / Shear Strength (psi)	Key properties
TEROSON MS 9399 ¹	Silane-modified polymer	RTV after mixing / 10 min @ 60 °C Handling time: 2 hrs @ RTV	290	Non-silicone, NCO-free, solvent-free, good adhesion to multiple substrates, high elasticity
LOCTITE AA 3963 ¹	Acrylic	UV / Visible light / ≤ 10 sec	3,336	Quick cure, high strength, flexible open time
TEROSON EP 5065 ¹	Epoxy	RTV / 15 min @ 80 °C Handling time: 8 hrs @ 23 °C	3,625	Adhesion to to multiple substrates, crash resistance
Technomelt PS 1573E ¹	Synthetic-rubber	RTV / fast cure, sec to min	52	Pressure-sensitive adhesive
LOCTITE AA 3525	Acrylic	UV / Visible light / < 30 sec	1,420	Quick cure, easy to handle, flexible open time
LOCTITE AA H8000 ³	Acrylic	RTV / 30 min	3,140	Flexible open time, good adhesion to mutliple substrates
TEROSON PU 6700ME/6800 ¹	Polyurethane	RTV / 120 min	1,450	Improves system overall stiffness (e-modulus > 500MPa), compatible with spot welding, Micro-Emission PU (label free)
LOCTITE UK 2015 ⁴	Polyurethane	RTV after mixing / 10 min @ 20 °C	2,900	Provides incremental stiffness, excellent adhesion to non-metallic surfaces



THERMAL INTERFACE MATERIALS				
Product	Chemistry	Curing	Thermal conductivity	Key properties
BERGQUIST TGF 3010 APS	Silane-modified polymer	RTV or heat	3.0 W/mK	Non-silicone gap filler, high flow rate (80 cc/sec), UL94 V-0, compressable (shore OO 75)
BERGQUIST TGF 2200 APS	Silicone	RTV or heat	2.2 W/mK	Low density gap filler, UL94 V-0, compressable (shore OO 55)
BERGQUIST TGP 1350	Silicone	Pre-cured	1.4 W/mK	Gap pad, compressible (shore OO 30), UL94 V-0, high durability
LOCTITE EA 9497 ²	Epoxy	RTV	1.4 W/mK	Thermal adhesive, high stiffness and strength, multi-substrate bonding
BERGQUIST TLB SA2005RT	Silicone	RTV or heat	2.0 W/mK	Thermal adhesive, UL94 V-0, high elongation
BERGQUIST TLB EA1800	Epoxy	RTV	1.8 W/mK	Thermal adhesive, UL94 V-0, high strength

No Number: Available globally | 1: Available only in APAC, EU | 2: Available only in NA, EU | 3: Available only in NA, APAC | 4: Available only in EU

DISCOVER OUR PORTFOLIO FOR EV BATTERY SYSTEMS

GASKETING					
Product	Chemistry	Curing	Serviceability	Flame retardency (UL94 V0)	Key properties
LOCTITE SI 5486 ¹	Silicone foam	FIPFG	Yes	Yes	Low compression set with excellent sealing and aging performance, exceeds UL94 V-0
TEROSON MS 939 FR	Silane-modified polymer	RTV / FIPG	Yes*	No	Good moisture barrier, good elongation
LOCTITE ESB 5100	Butyl	Non-reactive	Yes	No	Non-curing, permanent tacky, pumpable
TEROSON MS 9320 SF	Silane-modified polymer	RTV / FIPG	No	No	Non-silicone, sprayable, low viscosity, weld sealant
TEROSON MS 930	Silane-modified polymer	RTV / FIPG	Yes*	No (only UL94 HB)	High viscosity, weld sealant, non-silicone, paintable
SONDERHOFF FERMAPOR K31 SERIES	Polyurethane foam	RTV / FIPFG	Yes	No	Customizable, compressible, fast-cure, tolerance adaptable, complete system solution with dosing equipment
SONDERHOFF FERMASIL SERIES	Silicone foam	RTV / FIPFG	Yes	No	Customizable, compressible, water-resistant, tolerance adaptable, complete system solution with dosing equipment

No Number: Available globally | 1: Available only in EU

*Tools required



BERGQUIST GAP FILLER® TGF 3010 APS



SONDERHOFF form-in-place foam gasket (FIPFG)



Battery assembly adhesive for cylindrical cells (LOCTITE AA 3963)



Butyl gasket (LOCTITE ESB 5100)

DISCOVER OUR PORTFOLIO FOR EV BATTERY SYSTEMS

SURFACE TREATMENT

To achieve optimal surface conditions for bonding and welding, Henkel offers **a variety of surface treatment solutions:**

- FEATURES & BENEFITS
- » » Etch-passivation of aluminum battery components
 - » » Flexible process for cleaning and Ti-passivation
 - » » Stable surface conditions and resistance for up to 6 months
 - » » Excellent welding and adhesive bonding of components after extended storage period
 - » OEM-approved

KEY PRODUCTS SURFACE TREATMENT				
Product	Process	Temperature	Concentration Range	Key properties
ALKALINE CLEANER BONDERITE C-AK 1563-1	Spray & Immersion	50 – 80 °C	1.0 –5.0 %	Alkaline aluminum cleaner, orate-free, very good cleaning power on aluminum substrates
SURFACTANT PACKAGE BONDERITE C-AD 5003	Spray & Immersion	50 – 80 °C	0.1 –1.0 %	Highly efficient cleaning booster, based on non-ionic surfactants, excellent removal of oil and contaminants from metal surfaces
ETCH-PASSIVATION BONDERITE M-NT 2040	Spray & Immersion	25 – 45 °C	1.0 –2.0 %	Etching and passivation of the Al-surface in one step, prepares surface for welding, adhesive bonding and painting processes



Aluminum battery pack top covers immersed in a treatment bath

CUSTOMER USE CASE

BERGQUIST TGF 3010 APS

SILICONE-FREE, FAST-DISPENSABLE BATTERY THERMAL MANAGEMENT SOLUTION

CUSTOMER CHALLENGES

- » Key automotive OEM required a fast-dispensable thermal gap filler with low squeeze flow in production and low pull off forces for in-line aftermarket repair.
- » To avoid the impact of any potential silicone outgassing, a silicone-free formulation was required.
- » Low equipment abrasion for limited maintenance was essential.

RECOMMENDED TECHNOLOGY

- » Henkel developed a two-component, silicone-free, liquid gap filler: BERGQUIST TGF 3010 APS.
- » Material has a dispensing speed of 80 cc/second and is easily compressible.
- » A thermal conductivity of 3.0 W/mK provides ample heat dissipation while balancing filler load and minimizing the effects of dispensing equipment abrasion.

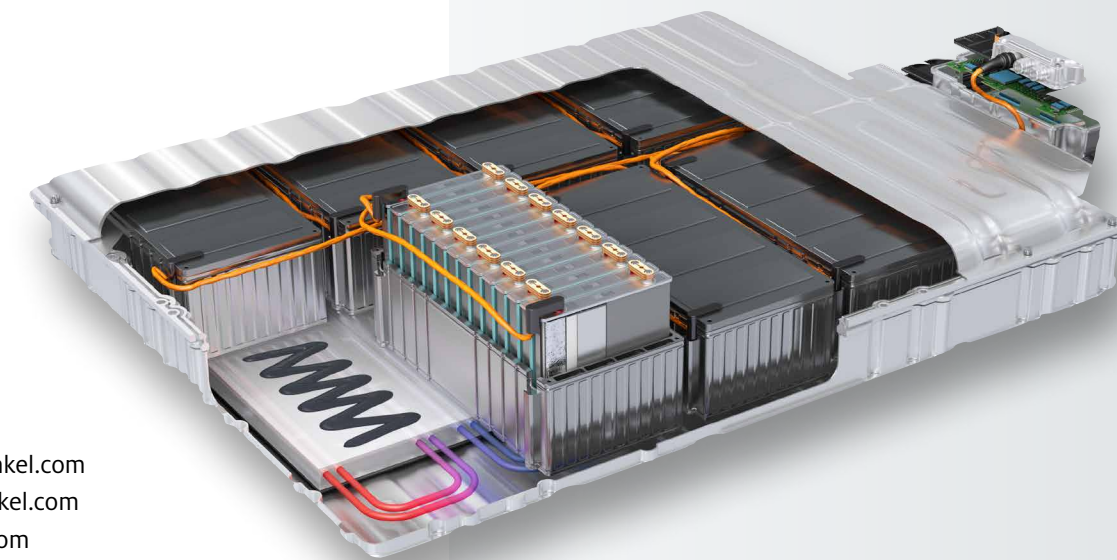


MASS PRODUCTION PROCESS SET-UP

- » Through close collaboration with the dispensing equipment supplier, Henkel engineered a material that met all customer prerequisites.
- » With an application time of < 60 seconds, the OEM has the capability to produce > 500 battery packs a day on one production line.
- » Henkel e-Mobility experts provided close technical and on-site engineering support for validation and scale-up.

CUSTOMER BENEFITS

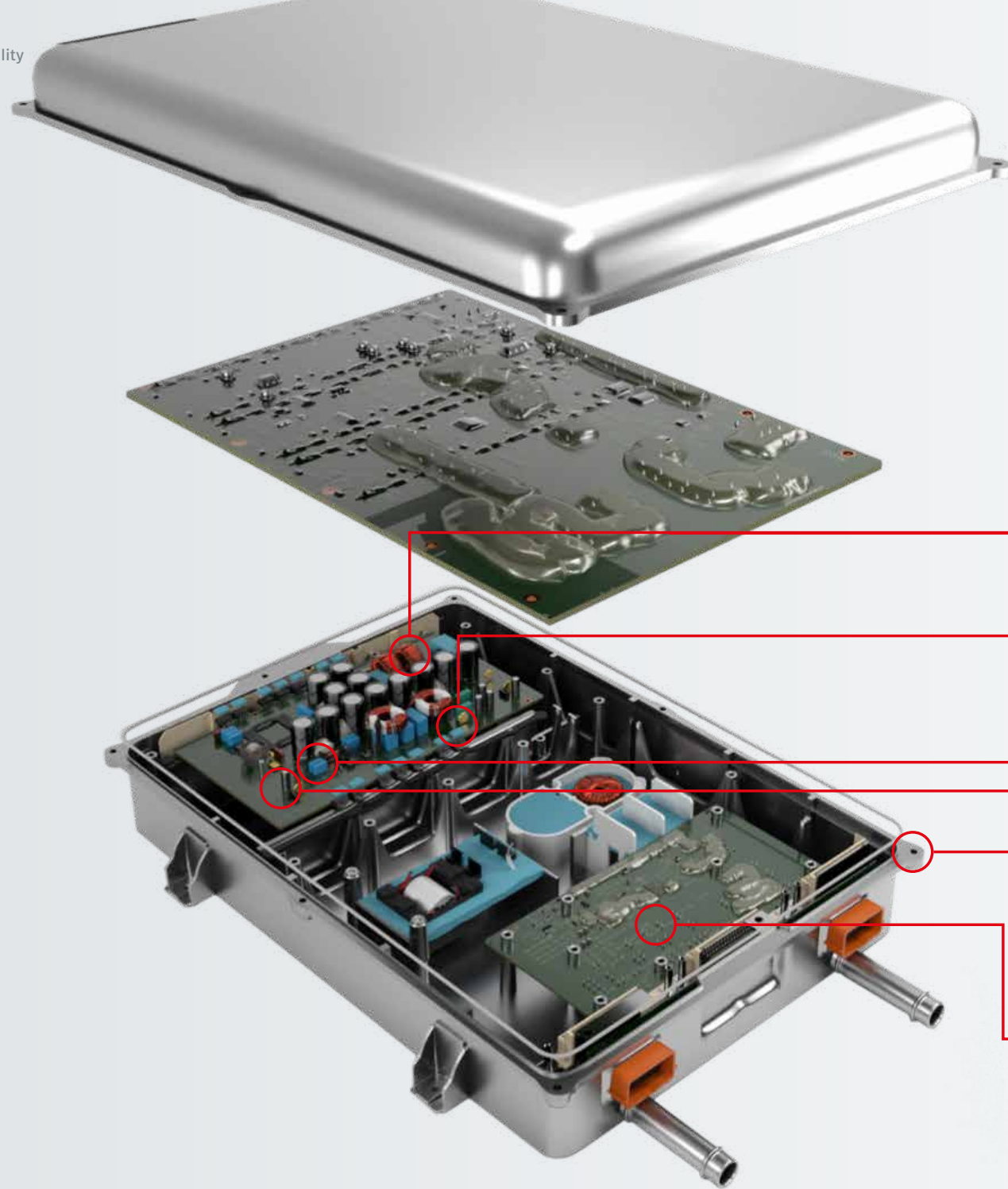
- » High dispense rate of 80 cc/second and application time < 60 seconds
- » Silicone free formulation to avoid impact on optical, electrical contact for surface painting functionality
- » Optimized filler package with low abrasion characteristics



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HENKEL SOLUTIONS FOR POWER CONVERSION SYSTEMS

**1. POTTING MATERIALS**

PCB/Induction Coils

*page 18***1. GAP PAD**

Heat Source or Heat Sink

*page 18***3. GAP FILLER**

Component/PCB to Housing or Heat Sink

*page 19***4. THERMAL CONDUCTIVE ADHESIVES**

Printed Circuit Board

*page 19***5. GASKETING**

Top Cover to Lower Tray

*page 20***6. SOLDER MATERIALS**

Components to PCB

page 21

OUR AMBITION

Henkel technology solutions are designed to optimize the safety, reliability and efficient assembly of power conversion systems.

DISCOVER OUR PORTFOLIO FOR POWER CONVERSION SYSTEMS

POTTING MATERIALS				
Product	Chemistry	Thermal conductivity	Viscosity (mixed)	Key properties
BERGQUIST TGF 1400SL	Silicone	1.4 W/mK	5,000 mPa·s	Self leveling, low volatility
LOCTITE SI 5631 ²	Silicone	1.0 W/mK	5,000 mPa·s	Excellent cavity filling, flexible and robust
LOCTITE EA 9496 ¹	Epoxy	1.7 W/mK	15,000 – 40,000 mPa·s	Room temperature and warm cure, low shrinkage
SONDERHOFF FERMADUR SERIES	Polyurethane	0.2 – 0.9 W/mK	500 – 200,000 mPa·s	Room temperature and warm cure, customizable, UL94 V0, multi-substrate adhesion

GAP PADS [®]				
Product	Thermal conductivity	Dielectric breakdown voltage	Hardness / Young's Modulus	Key properties
BERGQUIST TGP 1000VOUS	1.0 W/mK	6,000 V at 0.5 mm	Shore 00 = 5 / YM = 8 psi	Ultra soft, self-tacky one side
BERGQUIST TGP 3000M	3.0 W/mK	5,000 V at 0.5 mm	Shore 00 = 15 / YM = 16 psi	High compliant, low volatility
BERGQUIST TGP HC5000	5.0 W/mK	5,000 V at 0.5 mm	Shore 00 = 35 / YM = 17.5 psi	Highest compliant, low volatility resin



GAP FILLERS [®]				
Product	Chemistry	Curing	Thermal conductivity	Key properties
BERGQUIST TGF 1500	Silicone	RTV or heat	1.8 W/mK	Low siloxane volatility, high temperature resistance
BERGQUIST TGF 3500LV	Silicone	RTV or heat	3.6 W/mK	Low Young's Modulus, high dielectric isolation
BERGQUIST TGF 3600	Silicone	RTV or heat	3.6 W/mK	High thermal conductivity, Ultra low Young's Modulus
BERGQUIST TGF 7000	Silicone	RTV or heat	7.0 W/mK	Highest thermal conductivity, controlled volatility

THERMALLY CONDUCTIVE ADHESIVES				
Product	Chemistry	Curing	Thermal conductivity	Key properties
BERGQUIST TLB SA3500	Silicone	Heat (125 °C 20 min; 150 °C 10 min)	3.5 W/mK	Good flexibility, UL94 V0
BERGQUIST TLB EA1800	Epoxy	RTV	1.8 W/mK	UL94 V0, high strength, chemical stability

DISCOVER OUR PORTFOLIO FOR POWER CONVERSION SYSTEMS

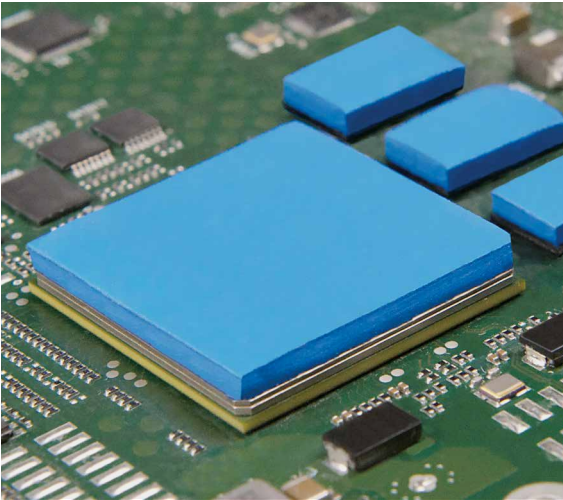
GASKETING				
Product	Chemistry	Curing	Servicability	Key properties
LOCTITE SI 5970	Silicone	RTV / FIPG	Yes*	High temperature stability, good moisture barrier, multi-substrate bonding
LOCTITE SI 5421	Silicone	RTV / FIPG	Yes*	EMI gasketing, high temperature stability, good moisture barrier, multi-substrate bonding
LOCTITE AA 5884	Polyacrylate	UV / CIPG	Yes	Quick cure, durable for heavy duty applications, compressable for good sealing capability, ATF and high temperature resistance, non-silicone
BERGQUIST TLB 400SLT	Silicone	RTV or heat / FIPG	Yes*	Thermally conductive, glycol resistance, high elongation, multi-substrate bonding, compatible with BERGQUIST GAP FILLERS®
LOCTITE AA 5820 ¹	Polyacrylate	RTV / FIPG	Yes*	Durable for heavy duty applications, ATF and high temperature resistance, compatible with BERGQUIST GAP FILLERS®
LOCTITE SI 5039 ³	Silicone	UV + Moisture / CIPG	Yes	Flexible cure mechanism, durable for heavy duty applications, multi-substrate bonding, compressable for good sealing capability, high temperature resistance
SONDERHOFF FERMAPOR K31 SERIES	Polyutherane foam	RTV / FIPFG	Yes	Customizable, compressable, fast-cure, tolerance adaptable, complete system solution with dosing equipment
SONDERHOFF FERMASIL SERIES	Silicone foam	RTV / FIPFG	Yes	Customizable, compressable, water-resistant, tolerance adaptable, complete system solution with dosing equipment

*Tools required



SOLDER PASTE					
Product	Alloy	Particle size distribution	IPC J-STE-004B classification	Optimal shelf-life	Key properties
LOCTITE LF 318 ²	» 90iSC » SAC305 » SAC387	» Type 3 » Type 4	ROLO	6 months at 0 °C – 10 °C	Pb-free, halide-free, no-clean solder paste with pin-testable flux exhibits excellent humidity resistance and able to resist component movement during high-speed placement

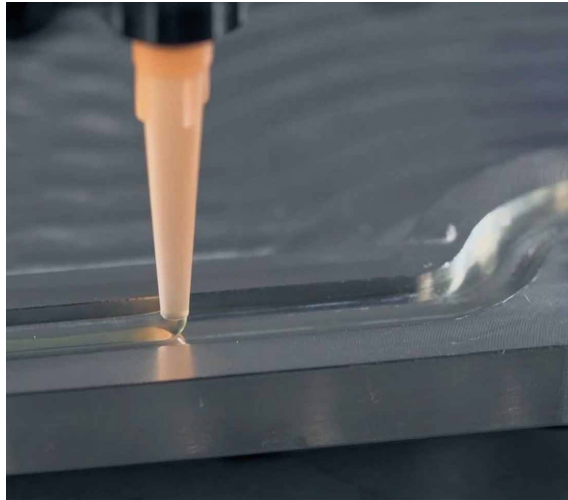
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GAP PAD®



BERGQUIST GAP FILLER® TGF7000



Cured-in-place gasketing material

CUSTOMER USE CASE

LOCTITE SI 5970, BERGQUIST TGF 3600, BERGQUIST TGP 1000VOUS

CUSTOMER REQUIREMENT

- » A Tier 1 automotive supplier designed a new high-voltage EV inverter, which required reliable thermal management for safe and efficient function over lifetime.
- » Due to this nature of the inverter, which was designed to handle very high voltages, the Thermal Interface Materials (TIM) needed to be electrically insulating to avoid electrical hazards.
- » The compatibility of the gasketing and TIM chemistry was important, as multiple chemistries in the same component can cause contamination issues which could lead to curing and operational issues.

RECOMMENDED TECHNOLOGY

- » To fill larger, multi-level gaps, BERGQUIST GAP FILLER® TGF 3600 with 3.6 W/mK and 0.9 to 5.4 g/sec dispense rate was selected, as it was proven to perform reliably for an existing application.
- » Ultra-soft, conformable BERGQUIST GAP PAD® TGP 1000VoUS was chosen as the solution for various components to provide thermal management along with providing high voltage breakdown strength to protect against high voltage surge.
- » LOCTITE SI 5970 was recommended for sealing the inverter, as it is approved by multiple OEMs and Tier 1 Suppliers for its compatibility with other chemistries of gap filler and potting compounds.

PROCESS DESIGN/PRODUCTION SET-UP

- » Leveraging Henkel's partnerships with multiple dispensing equipment suppliers, the customer was able to select the best dispensing equipment for the liquid gap filler.
- » To ensure gap pad integrity, Henkel initiated an additional testing phase with a third-party laboratory to verify material cleanliness and purity in order to exclude any possibility of electrical shorts due to particle contamination.
- » This multi-material solution helped bring one of the EV industry's highest voltage inverters to commercialization, allowing an annual production capacity of > 500,000 inverters.

For more information contact

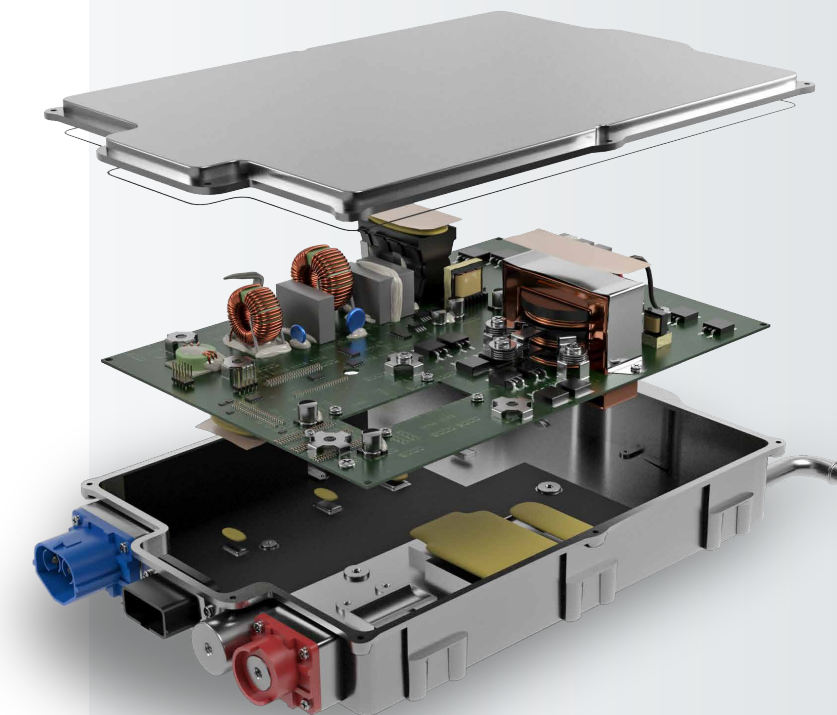
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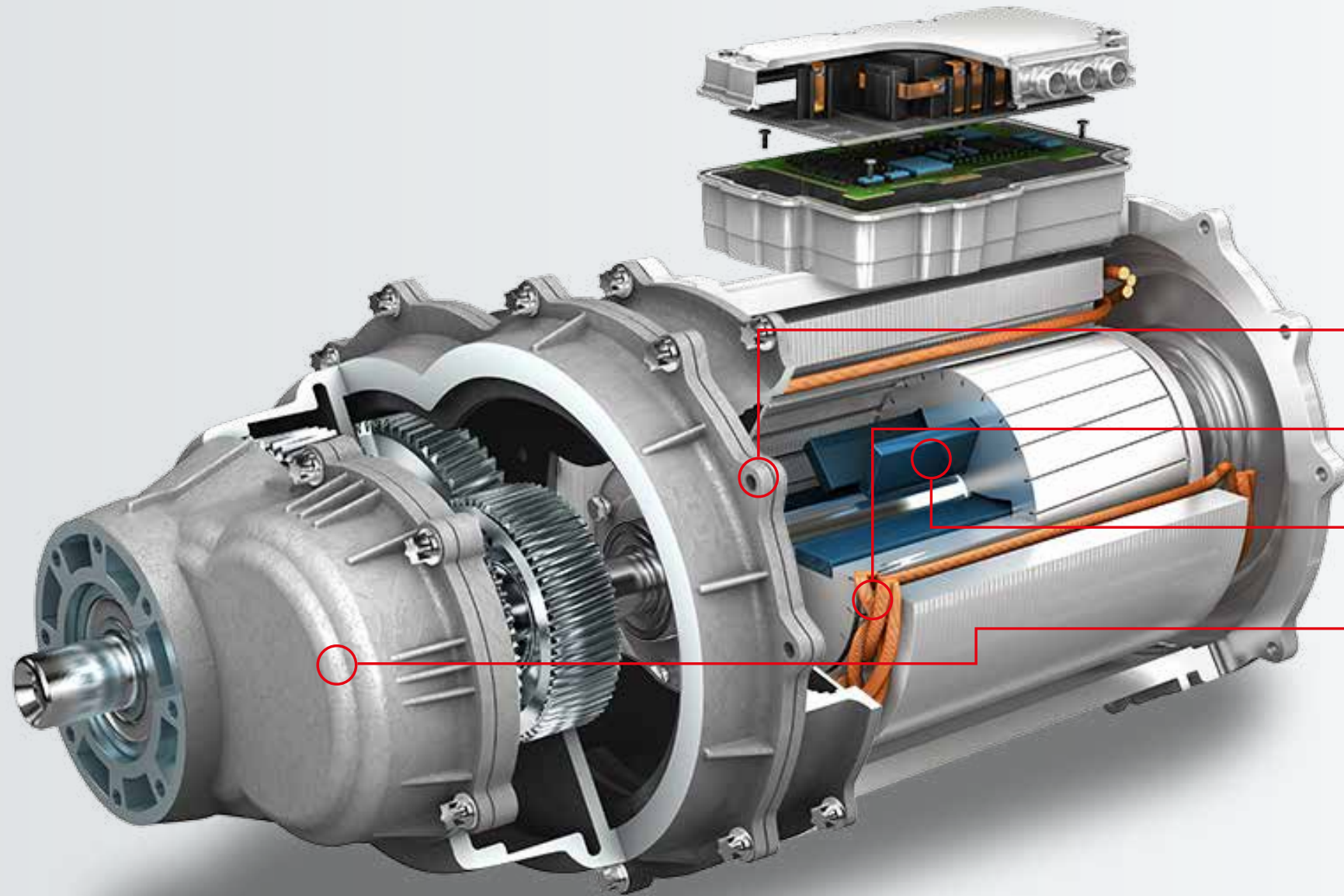
LOCTITE®

BERGQUIST®

CUSTOMER BENEFITS

- » Reliable potting material performance
- » Process optimization by removing need for vacuum de-airing
- » Complete coverage of the coils and filling of all gaps





HENKEL SOLUTIONS FOR E-DRIVE SYSTEMS

- 1. GASKETING**
e-Drive Housing/ ECU Housing
- 2. THERMAL POTTING**
Induction Coil
- 3. MAGNET BONDING**
Magnet to Stator
- 4. IMPREGNATION SERVICE**
Aluminium Casted Housing

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OUR AMBITION

Henkel technology solutions are designed to optimize the safety, reliability and efficient assembly of electric drive systems.

DISCOVER OUR PORTFOLIO FOR E-DRIVE SYSTEMS

GASKETING					
Product	Chemistry	Curing	Servicability	Processing time	Key properties
LOCTITE AA 5820 ¹	Polyacrylate	Humidity / FIPG	No	< 60 min	Durable for heavy duty applications, ATF and high temperature resistance, compatible with BERGQUIST GAP FILLERS®
LOCTITE AA 5884	Polyacrylate	UV / CIPG	Yes	30 sec @ 270 mW/cm²	Durable for heavy duty applications, ATF and high temperature resistance, compatible with BERGQUIST GAP FILLERS®
LOCTITE SI 5970	Silicone	RTV / FIPG	No	< 25 min	High temperature stability, good moisture barrier, multi-substrate bonding
BERGQUIST TLB 400SLT	Silicone	RTV or heat	No	Yes	Thermally conductive, glycol resistance, high elongation, multi-substrate bonding, compatible with BERGQUIST GAP FILLERS®



POTTING MATERIAL				
Product	Chemistry	Thermal value	Viscosity (mixed)	Key properties
LOCTITE PE 1000LV	Epoxy	—	9,500 - 12,500 mPa·s	Excellent oil resistance, good thermal shock resistance, good rheology performance
LOCTITE PE 8083 ²	Epoxy	1.0 W/mK	15,000 - 25,000 mPa·s	High lap shear strength (20 MPa), high decomposition temperature (350 °C)
LOCTITE SI 5631 ²	Silicone	1.0 W/mK	5,000 mPa·s	Low viscosity at room temperature, high elongation rate (> 180 %)
LOCTITE STYCAST 2850FT CAT 27-1	Epoxy	1.1 W/mK	150,000 mPa·s	Small filler size to fill small gaps, good physical and chemical properties at high temperatures

MAGNET BONDING				
Product	Chemistry	Thermal value	Viscosity (mixed)	Key properties
LOCTITE 638	Acrylic	3 min @ 60 °C, then rest @ RTV for 2 min	4,500	ATF resistance, high temperature resistance up to 200 °C, multi-substrate bonding, 4,500 psi
LOCTITE 648	Acrylic	3 min @ 60 °C, then rest @ RTV for 2 min	3,900	ATF resistance, high temperature resistance up to 200 °C, multi-substrate bonding, 3,900 psi
LOCTITE Stycast A316-48	Epoxy	30 min @ 100 °C, or 5 min @ 120 °C	2,500	ATF resistance, high temperature resistance up to 180 °C, good gap filling performance, high viscosity (50,000 mPa·s)

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DISCOVER OUR PORTFOLIO FOR E-DRIVE SYSTEMS

HENKEL IMPREGNATION SERVICE

To impregnate porosities in aluminum casted components, Henkel offers **two main service solutions**:

1. ON-SITE IMPREGNATION

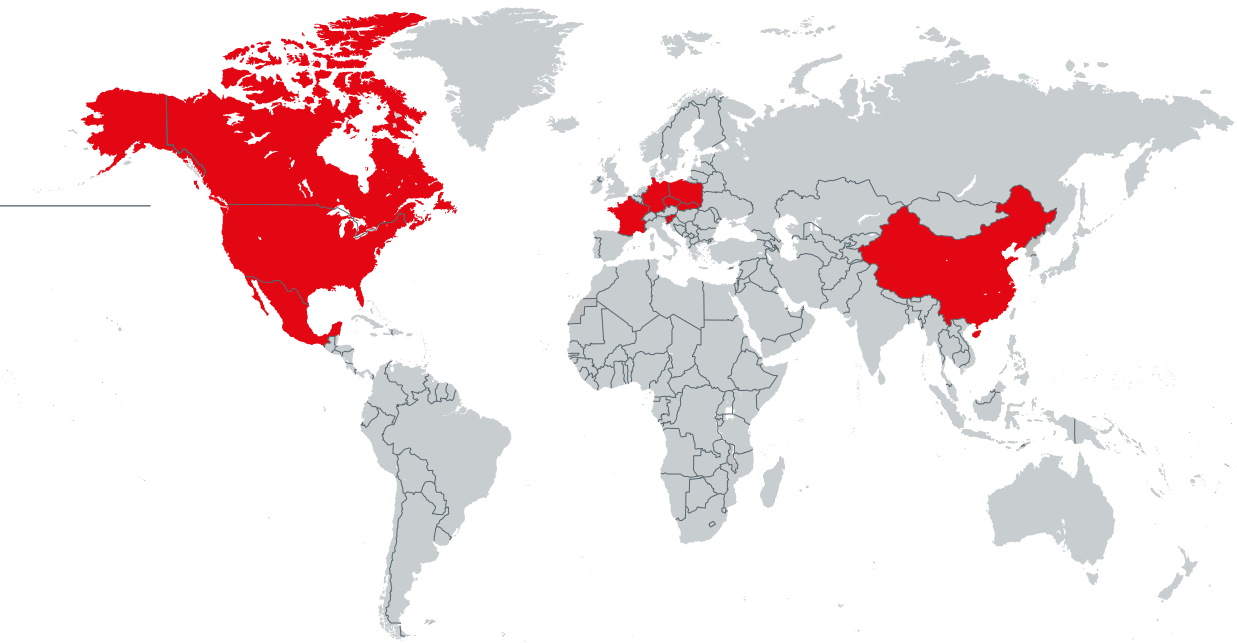
Temporary installation of a small but customized impregnation service center.

2. CLOSE-BY IMPREGNATION

Enjoy the advantages of our sealing solutions from an external impregnation service center located close-by your manufacturing plant.

LOCATIONS WORLDWIDE

- » Canada
- » China
- » Czech Republic
- » France
- » Germany
- » Mexico
- » Poland
- » Slovakia
- » Slovenia
- » USA

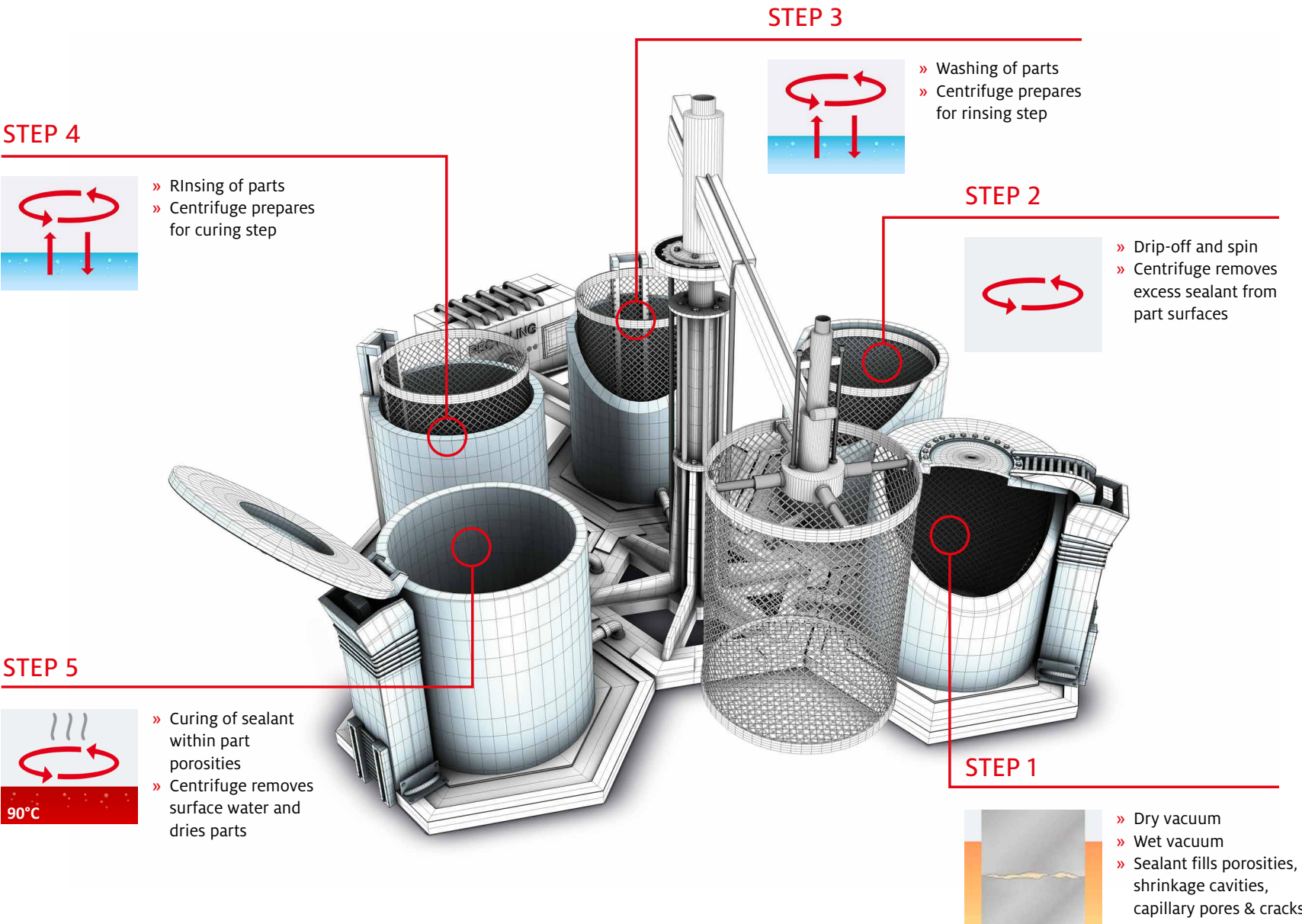


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TECHNOMELT®

TEROSON®

BERGQUIST®



CUSTOMER USE CASE

LOCTITE PE 1000LV

E-MOTOR CONNECTOR RING POTTING PROTECTION AND STREAMLINED PRODUCTION

CUSTOMER CHALLENGES

- » A leading automotive supplier required a reliable potting solution for the stator of its new hybrid electric motor.
- » The material had to protect the ring's internal coils from physical damage, electrical shorts, moisture, automotive fluids and thermal shock.
- » The application process had to be optimized by removing the need for vacuum de-airing before dispensing and curing.

RECOMMENDED TECHNOLOGY

- » Henkel developed a new potting formulation, LOCTITE PE 1000LV, which passed thermal shock testing without any cracks, exhibits excellent resistance to automatic transmission fluids and provides robust vibration endurance.
- » The rheology of the potting material strikes the right balance between self-levelling and thixotropic behavior.
- » As a result, it provides optimized filling of all spaces with deep penetration of the coils without any voids.

MASS PRODUCTION PROCESS SET-UP

- » Henkel formulated LOCTITE PE 1000LV with significantly less bubbles, eliminating the need for vacuum de-airing before dispensing.
- » This new optimized application process allows to save approximately 40 minutes to one hour per shift.
- » The material allowed the Tier 1 supplier to increase the yield and successfully produce > 100,000 electric motors annually.

CUSTOMER BENEFITS

- » Component protection against environmental factors
- » Complete coverage of the coils and filling of all gaps
- » Process optimization by removing need for vacuum de-airing

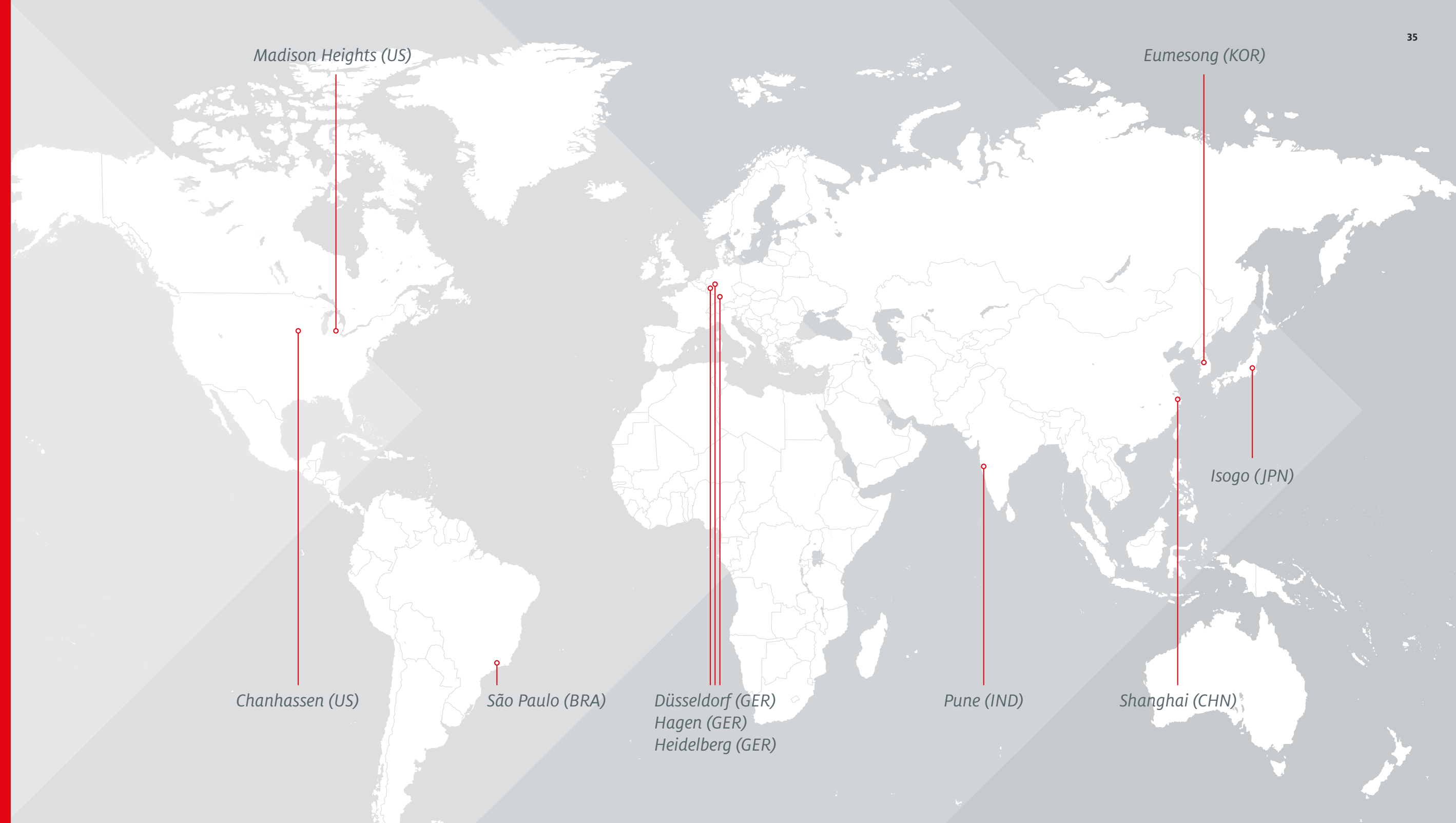
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Get in Touch with our Global Team of Solution Engineers

Driving e-Mobility, together.



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TECHNOMELT®
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