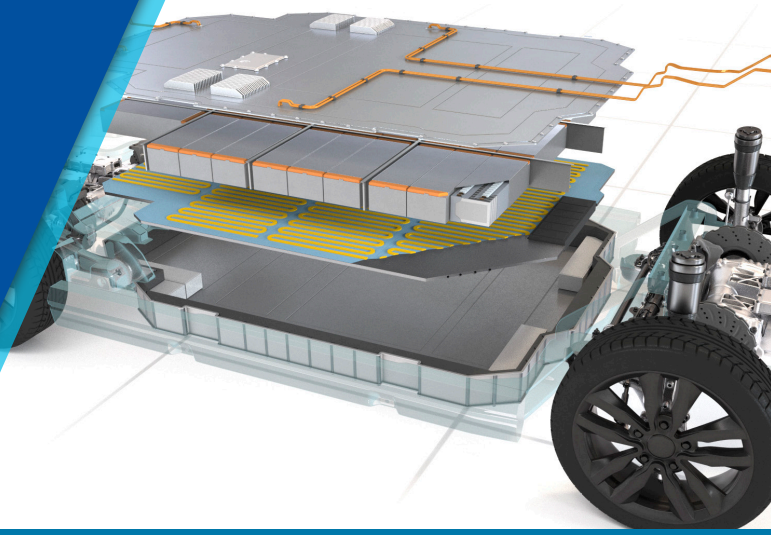


Thermal Management

PPG EV Battery Pack Material Solutions



PPG has developed specific thermal management solutions to support the assembly and thermal performance of EV battery packs. Critical products include thermal gap fillers, thermally conductive adhesive, applied Between cells, cell and module, cell and cooling plate, module and cooling plate. Our solutions offer tailorable attributes including: thermal conductivity, abrasion mitigation, weight (low density), high flexibility, low modulus, electrical conductivity, viscosity, vibration damping, applied cost, and adhesion.

CORATHERM® Thermal Gap Filler

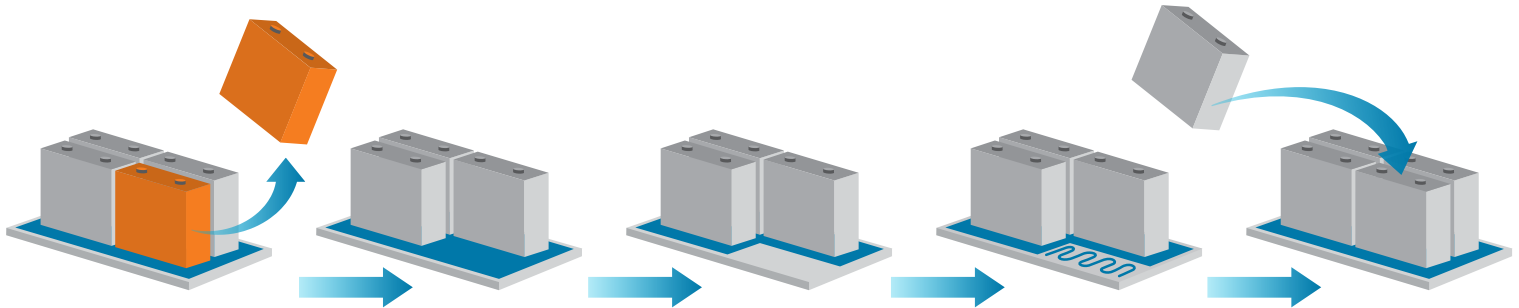
CORATHERM® Thermal Conductive Adhesive

CORATHERM® Resilient Insulation Foam/Pads

Thermal Management Materials Example

Favorable thermal impedance under design use

Excellent Re-Workability For Serviceability



Standard Attributes

- Reduced complexity and risk of maintenance, compared to Thermal Gap Filler with higher adhesive
- Pull out strength <math><0.25\text{ MPa}</math>
- Easy to clean with mechanical removal
- Minimal residue

Easily compressed to bond line target

PPG Value Leveraging Core Competencies

Product/Formulation

GAP FILLERS

- Quickly tailored 1K & 2K solutions
- Lower density
- Advantaged heat removal
- Adj. electrical insulation
- Multi-functionality
- Designed for serviceability
- Silicon-free

CONDUCTIVE ADHESIVES

- 2K silicone-free
- Lower density option
- Bonding strength, to various substrate
- Flexibility & low storage modulus
- Low press-in force
- Electrical insulation

Application

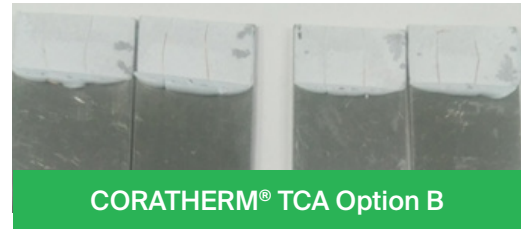
- High throughput, low defect application, lower abrasion, favorable applied cost
- Between cells, cell and module, cell and cooling plate, module and cooling plate

Trusted global supplier to OEMs & Tiers

CORATHERM® Thermal Conductive Adhesive

Excellent Adhesive Performance

	CORATHERM® TCA Option A	CORATHERM® TCA Option B
Shore A	65	70
Tensile strength (MPa)	≥ 8.0	≥ 8.0
Elongated (%)	≥ 30	≥ 40
Lap shear strength (MPa)	≥ 10	≥ 8.0
T-block strength (MPa)	≥ 10	≥ 8.0



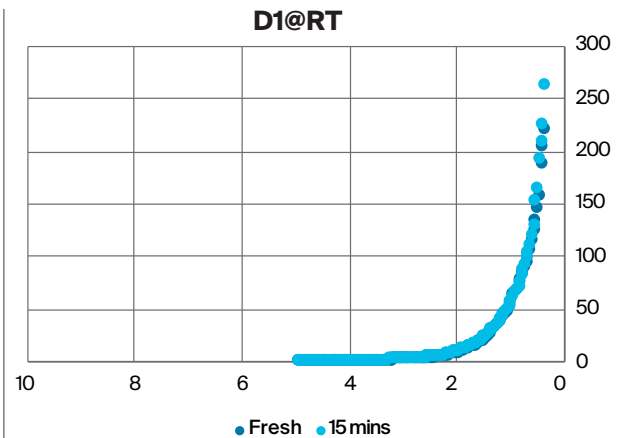
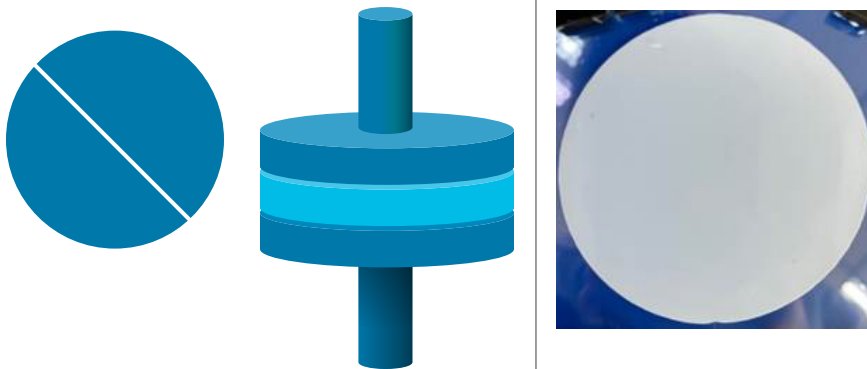
Test Method:

1. Lap shear strength: Al3003, 25mm x 12.5mm x 0.2 mm, speed 30 mm/min
2. T-block strength: Al 6063, 25 mm x 25 mm x 0.2 mm, speed 20 mm/min

CORATHERM® Thermal Conductive Adhesive

Excellent Compressibility Performance

D50mm



Comments

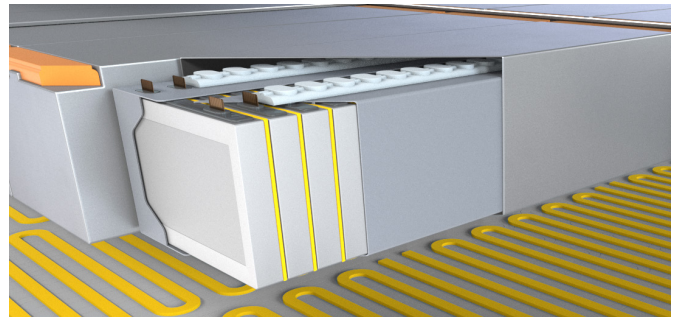
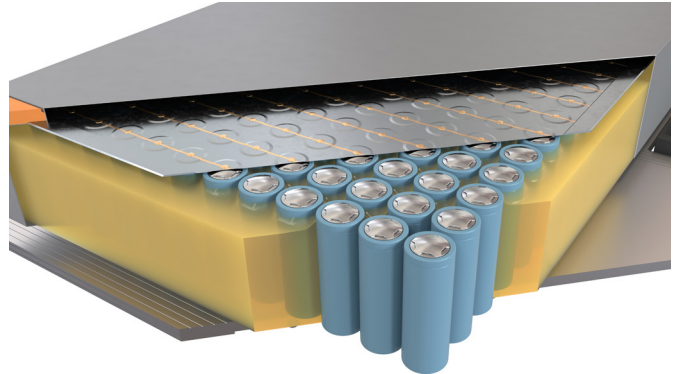
- D1@RT: Before test, the adhesive have been storage in plastic cartridge for one day
- Speed:60mm/mins

Compression Force at 0.5mm Fresh mixed at 25°C	78-85N
Compression Force at 0.5mm 15mins later at 25°C	83-97N

CORATHERM® Resilient Insulation Foam and Pads

Standard Attributes

- Foam-in-place or preformed pads and parts
- High resilience, rebound after compression
- Thermal insulation
- Flame resistance
- Silicone-free
- Low-density
- Ambient cure
- Adjustable electrical insulation properties (dielectric isolation)



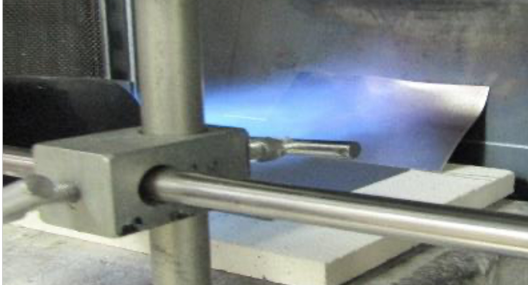
CORATHERM® Resilient Insulation Foam Parameters

Resilient Insulation Foam	
Color	White
Density (pcf)	12-25
Flammability (UL 94 V)	V-0
Compression set (%) ASTM D 3574-95 (70°C)	4-12
Thermal conductivity (W/m. K) ASTM D7984	0.03-0.05



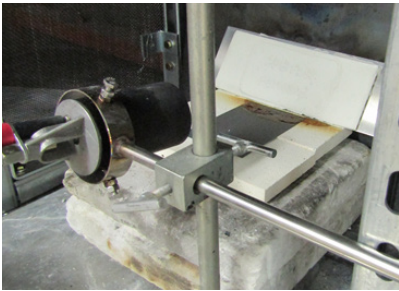
CORATHERM® Resilient Insulation Compressible Pad

Torch Test - aluminum panel without protection



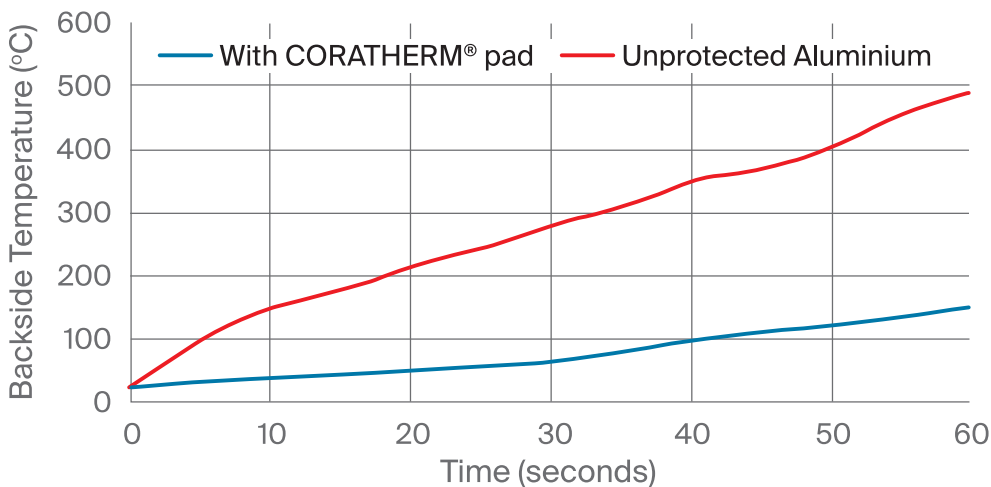
Substrate deformed < 60s

Torch Test - aluminum panel coated with PPG CORATHERM® Resilient Insulation Compressible Pad



Preliminary backside temperature comparison with PPG CORATHERM® Resilient Insulation Compressible Pad

Test Backside Temperature vs Time: 1-minute ~1200°C propane torch test



- 1-minute side by side comparison with torch test
- The final temperature on the backside: 470°C (Al panel) VS 150°C (Al panel with compressible pad)
- The compressible pad provides protection to Al panel

Visit ppgautocoatings.com and ppg.com for more information or email PPGMobility@ppg.com

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