PCB AND SYSTEMS ASSEMBLY

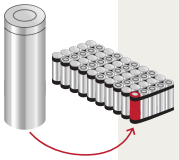
Imagine designs for the future–today

E-mobility materials selection guide

DOW®

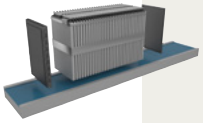
Designing *the future*

xEV Battery module designs



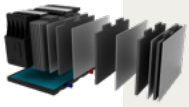
Cylindrical cells

These are the most common cell type in the battery industry. Used in specific electric vehicle applications, silicone materials supporting the use of more efficient, automated assembly processes deliver consistent performance.



Prismatic cells

As an increasingly popular alternative to cylindrical cells, their energy density offers performance improvements – while their shape simplifies the task of connecting cells together into battery packs. Due to higher energy density, sufficient thermal management is critical to manage the performance of these cell types.



Pouch cells

Comprised of thinly separated pouches, these cells require additional processing steps for assembly, due to their lack of rigidity. In return, they are able to deliver high specific energy, and application-specific customization. Selecting the right adhesives, encapsulants, and thermal management solutions for these varied battery forms is a critical process.

The market for plug-in hybrid and battery-powered electric vehicles (xEV) is on track to grow exponentially in the coming years, fueled by tumbling lithium-ion battery prices, favorable government policies, and aggressive plans from automakers to ramp up production. But realizing that potential will depend on a number of factors, including the industry's ability to meet consumer expectations for reliability, performance, and value.

This will challenge battery makers to design for the large-volume production of lithium battery packs that are smaller, lighter, and less expensive. These higher-energy-density packs will be capable of delivering more power, longer, through better thermal control.

Manufacturers and designers of other xEV components – including battery management systems, power control units, DC/DC converters, and electric motors – face many of the same thermal management, assembly, and protection challenges. We engineer new, innovative materials to help you create new, energy-efficient products. Let's find solutions. With excitement. With focus. With ingenuity. Together.

Silicone advantages

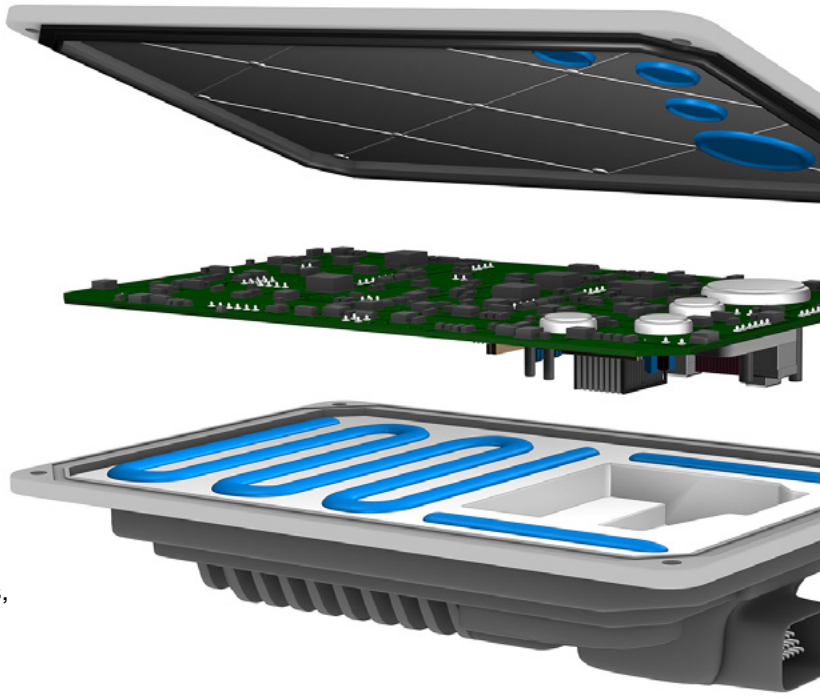
The silicone properties enabling Dow materials to excel in a wide range of PCB system assembly and automotive applications could prove invaluable in addressing challenges associated with designing, and producing large volumes of lithium battery systems, and other components, for the electric vehicles of tomorrow. Some of silicone's inherent properties addressing these challenges are:

- Very low thermal resistance
- Flow, wetting, adhesion, and cure properties that can help speed and simplify processing
- Excellent thermal stability – wide operating temperature range
- Reliable performance under harsh conditions – resistance to thermal shock, oxidation, moisture, and chemicals
- Excellent electrical insulation (dielectric strength)
- Excellent stress relief
- Silicone foams enable light weighting

Materials innovation for thermal management

Thermally-conductive silicone materials from Dow have properties that can help you reduce operating temperatures, and extend the life and performance of batteries and other electric vehicle PCB system components.

- **Thermal gap fillers** are soft, compressible, two-part silicone, high thermal-conductivity materials specifically formulated to process easily, and to effectively dissipate heat from critical automotive parts, such as battery packs or module assemblies, and other high-heat applications.
- **Thermally-conductive silicone adhesives** used for coupling the battery pack to the cooling plate
- **Non-curing, thermally-conductive silicone compounds**, with a possible applied temperature range of -40°C to 150°C, for conducting heat in ADAS modules.
- **Thermally-conductive silicone gels and encapsulants** are flowable materials that facilitate high-volume processes in automated production, and can be used as an alternative to pre-cured pads, to provide lightweight thermal coupling between cells and modules.



Proven solutions

Silicone adhesives, conformal coatings and encapsulants, foams, and thermal management solutions have already demonstrated decades of proven performance under the harshest automotive conditions. They are resistant to shock, oxidation and moisture, and maintain their mechanical and chemical properties across operating temperatures from -40°C to 200°C.

- **Thermal management materials –** From engineered elastomers designed for heat-resistant sealing and gasketing, to silicone gels and encapsulants for potting PCB circuitry in the battery pack's power management system – thermal management materials from Dow are consistently reliable.
- **Adhesives –** Used in a variety of applications, including staking large capacitors for vibration control, extra support for large components on circuit boards, electromagnetic shielding, and housing sealing, DOWSIL™ self-priming adhesives form long-lasting bonds, without the need for mechanical fastening and clamping. In addition, many are re-workable to allow for easier module repair. They are typically solventless solutions that minimize the need for special storage, handling, or ventilation.
- **Foams –** Our silicone foams are designed for efficiency in processing. The two-part, RTV foams are dispensed directly on the part surface. Foams can be a lightweight alternative to traditional encapsulant and sealant options.
- **Conformal coatings –** Silicone conformal coatings offer an extraordinarily broad range of durometers, as well as extremely low modulus options. That means they deliver better stress relief on delicate board components during thermal cycling. DOWSIL™ conformal coatings come in a range of viscosities to help you meet all of your processing and application demands.

DOWSIL™

silicones by DOW

Innovative technologies

Meeting the needs for performance, design flexibility, and cost control

DOWSIL™ EA-4700 CV Adhesive

Designed for automotive applications where fast curing to achieve adhesive and sealing performance is critical, including electronic control units, sensor modules, and battery pack applications where lid seal, base plate attaching, gasketing or connector sealing is required.

DOWSIL™ TC-4535 CV Thermally Conductive Gap Filler

Designed to dissipate the heat from PCB module assemblies mounted on printed circuit board to heat sink, this gap filler provides a reliable cooling solution for engine or transmission control units, on board chargers, or in battery packs or modules.

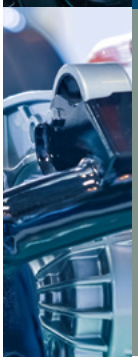
SILASTIC™ 3-8186 Thixotropic Foam

Designed to form dispensed-in-place compression gaskets in applications that require low sealing force. Uses include sealing automotive components and lighting.

Improved thermal conductivity, easier processing, and long-term performance stability

The versatile properties of silicones enable highly tunable performance attributes that are driving new innovations for streamlining assembly, and enhancing the performance of advanced automotive batteries. Besides designing new materials to meet specific performance and processing requirements, Dow offers many proven, innovative, and emerging silicone technologies for xEV applications.

Contents



Section	Application	Material set
EV Battery	**EV Battery pack**	
	Thermal management	Thermally-conductive adhesives, thermal materials
	Assembly	Adhesives, EMI shielding, silicone foams
	Protection	Adhesive, silicone foams, gels
	Battery management system (BMS)	
	PCB protection	Conformal coatings, gels
Powertrain	**Inverter/Converter**	
	Thermal management	Thermally-conductive adhesives, compounds, and gap fillers
	Assembly	Adhesives, EMI shielding, silicone foam gasket, cure-in-place gaskets
	PCB protection	Conformal coatings
	Electric motor	
	Control unit thermal management	Thermally-conductive adhesives, thermally-conductive encapsulant
	Protection	Conformal coatings, thermally-conductive encapsulants
	On-board charger	
	Thermal management	Thermally-conductive encapsulants and gap fillers
	Assembly	Adhesives, EMI shielding
	Protection	Conformal coatings, gels
Thermal system	**PTC heater**	
	Thermal management and assembly	Thermally-conductive adhesives
	Electric compressor	
	Protection	Conformal coatings
	Sheath heater	
	Protection	Encapsulants

EV Battery

EV Battery pack

Thermal management

	Product	1- or 2-part	Color	Thermal conductivity (W/m.K)	Cure type	Cure (time/temp.)
Thermally-conductive adhesives	DOWSIL™ 1-4173 Thermally Conductive Adhesive	1-part	Gray	1.8	Heat	1.5 hr @ 100°C 30 min @ 125°C 20 min @ 150°C
	DOWSIL™ SE 4485 Thermally Conductive Adhesive	1-part	White	2.8	Moisture	–
Encapsulants	SYLGARD™ 170 Silicone Elastomer	2-part (1:1)	Dark gray to black	0.48	Room temperature or heat accelerated	1 day @ 25°C 25 min @ 70°C 10 min @ 100°C
	SYLGARD™ 170 Fast Cure Silicone Elastomer	2-part (1:1)	Black	0.4	Room temperature or heat accelerated	10 min @ 25°C
Thermally-conductive gap fillers	DOWSIL™ TC-4515 Thermal Gap Filler	2-part (1:1)	Part A: White Part B: Blue	1.8	Room temperature or heat accelerated	2.5 hrs @ 25°C 30 min @ 80°C
	DOWSIL™ TC-4535 CV Thermally Conductive Gap Filler	2-part (1:1)	Part A: White Part B: Blue	3.4	Room temperature or heat accelerated	2 hrs @ 25°C

Assembly

	Product	1- or 2-part	Color	Cure type	Cure (time/temp.)	Viscosity (cP)
Adhesives	DOWSIL™ SE 9168 RTV Adhesive	1-part	Gray	Room temperature	Tack free: 6.5 min @ 25°C	–
	DOWSIL™ EA-4700 CV Adhesive	2-part (1:1)	Part A: White Part B: Black	Fast, room temperature or heat accelerated	2 hrs @ 25°C	Part A: 24,000 Part B: 18,000 Mixed: 27,000
EMI shielding	DOWSIL™ EC-6601 Electrically Conductive Adhesive	1-part	Tan	Room temperature with mild heat acceleration	Skin over: 30 min	Initial extrusion rate @ g/min: 2.20
Silicone foam	DOWSIL™ 3-3186 Thixotropic Foam	2-part (1:1)	Part A: Black Part B: Off white	Heat	10 min @ 75°C	Part A: 135,000 Part B: 125,000

CV=Controlled volatility
JIS=Japanese Industrial Standard

	Viscosity (cP)	Specific gravity (cured)	Lap shear (MPa)	Durometer	Notes
	61,000	2.7	4.5, 650 psi (Al)	92 Shore A	UL 94 V-0
	–	2.9	1.2, 168 psi (Glass to glass)	90 Shore A (JIS)	
	Part A: 3,160 Part B: 1,110 Mixed: 2,135	Parts A/B: 1.37 Uncured	–	47 Shore A	UL 94 V-0
	Part A: 3,436 Part B: 1,287 Mixed: 2,361	Parts A/B: 1.38 Uncured	–	45 Shore A	UL 94 V-0
	Part A: 215,000 Part B: 230,000 Mixed: 240,000	2.7 Uncured	NA	50 Shore 00	UL 94 V-0 CTI ≥ 600 certifications
	Part A: 200,000 Part B: 230,000 Mixed: 205,000	3.1 (density)	NA	52 Shore 00 18 JIS Type E	UL 94 V pending

	Specific gravity (cured)	Lap shear (MPa)	Durometer	Tensile strength (MPa)	Elongation (%)	Notes
	1.32	1.9, 275 psi (Glass)	44 Shore A (JIS)	3.69	363	
	1.16 (density)	1.2 @ 2 hrs 2.2 @ 8 hrs 3.1 @ 24 hrs 3.9 @ 3 days (Al) 1.8 @ 2 hrs 2.0 @ 8 hrs 2.1 @ 24 hrs 2.7 @ 3 days (PBT)	19 Shore A (JIS)	3.7	630	
	3.37	1.30 (Al)	80 Shore A	1.51	194	Volume resistivity: 2.7E -3 ohm *cm Shielding effectiveness: 86 dB
	0.225 (density)	NA	–	Die A, 0.18	140	Compression deflection ILD @ 23°C 25%: 0.032 MPa, 4.7 psi 50%: 0.085 MPa, 12.4 psi 75%: 0.33 MPa, 48.6 psi Compression set 72 hrs @ 23°C 50% deflection: 3%

EV Battery pack (continued)

Protection

	Product	1- or 2-part	Color	Thermal conductivity (W/m.K)	Cure type	Cure (time/temp.)
Adhesive	DOWSIL™ 7091 Adhesive Sealant	1-part	Black, white, gray	–	Room temperature	3-7 days @ 25°C
Silicone foam	DOWSIL™ 3-6548 Silicone RTV Foam	2-part (1:1)	Black	NA	Room temperature	Rate varies with dispensed thickness
Gels	SYLGARD™ 567 Primerless Silicone Encapsulant	2-part (1:1)	Black	0.29	Room temperature or heat accelerated	3 hrs @ 70°C 2 hrs @ 100°C
	SYLGARD™ 527 Silicone Dielectric Gel	2-part (1:1)	Clear or red	0.19	Room temperature or heat accelerated	3.5 hrs @ 100°C 75 min @ 125°C 35 min @ 150°C

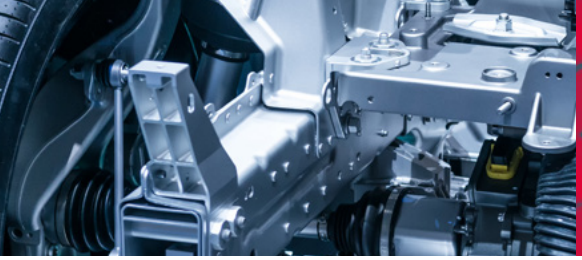
Battery management system (BMS)

PCB protection

	Product	1- or 2-part	Color	Viscosity (cP)	Cure type	Cure (time/temp.)
Conformal coatings	DOWSIL™ 1-2577 Low VOC Conformal Coating	1-part	Transparent	1,050	Room temperature or mild heat acceleration	6 min @ 25°C 1.5 min @ 60°C (15% RH)
	DOWSIL™ 3-1953 Conformal Coating	1 -part	Translucent	350	Room temperature	8 min @ 25°C 0.5 min @ 60°C (15% RH)
	DOWSIL™ CC-3122 Conformal Coating	1-part	Translucent	80	Room temperature or heat accelerated	Skin over: 6 min @ 25°C (50% RH)
Gels	DOWSIL™ EG-4200 Dielectric Tough Gel	2-part (1:1)	Blue	Parts A/B: 400	Fast, room temperature	–
	DOWSIL™ EG-4230 Gel	2-part (1:1)	Black	Part A: 350 Part B: 310 Mixed: 480	Fast, room temperature	Gel time: 13 min @ 25°C

	Viscosity (cP)	Specific gravity (cured)	Durometer	Tensile strength (MPa)	Elongation (%)	Notes
	Non-flowing	1.4	30 Shore A	2.5	680	UL 94 V-1
	Part A: 40,000 - 60,000 Part B: 50,000 - 75,000	0.22 - 0.32 (density)	–	0.28, 33 psi	NA	Compression deflection: @ 20%: 5.2 psi, 35,900 N/m^2 @ 40%: 10.1 psi, 69,600 N/m^2 @ 60%: 21.2 psi, 146,000 N/m^2
	Part A: 2,060 Part B: 570	1.24 Uncured	40 Shore A	NA	NA	UL 94 V-0, MIL-PRF-2358 6F (Grade B2) Type 1, Class IV QPL
	Part A: 470 Part B: 454 Mixed: 465	0.95 Uncured	NA	NA	NA	UL 94 HB

	Nonvolatile content (%)	Specific gravity (cured)	Durometer	Notes
	Forced draft volatility: 33.6	1.12	85 Shore A 25 Shore D	UL 94 V-0; UL 94 5VA; UL 746E; MIL-I-46058C Amend 7; IPC-CC-830B
	99.4	0.98	34 Shore A	UL 94 V-0; UL 746E; MIL-I-46058C Amend 7; IPC-CC-830B
	–	1.03	75 Shore A	
	–	0.97 Uncured	61 Shore 00	UV indicator for inspection; UL 94 V-1 @ 10.9 mm
	–	0.97 Uncured	33 Shore 00	UL 94 HB



Powertrain

Inverter/Converter

Thermal management

	Product	1- or 2-Part	Color	Thermal conductivity (W/m.K)	Thermal resistance (°C/W)	Cure type
Thermally-conductive adhesives	DOWSIL™ Q1-9226 Thermally Conductive Adhesive	2-part (1:1)	Gray	0.8	NA	Heat
	DOWSIL™ 1-4174 Thermally Conductive Adhesive	1-part	Gray	1.78	NA	Heat
	DOWSIL™ TC-2030 Adhesive	2-part (1:1)	Gray	2.7	NA	Heat
	DOWSIL™ TC-2035 Adhesive	2-part (1:1)	Part A: White Part B: Reddish brown	3.3	NA	Heat
Thermally-conductive compounds	DOWSIL™ TC-5026 Thermally Conductive Compound	1-part	Gray	2.9	0.03 @ 40 psi	Non-curing
	DOWSIL™ TC-5625C Thermally Conductive Compound	1-part	Greenish yellow	2.7	0.09 @ 40 psi	Non-curing
	DOWSIL™ SC 4471 CV Thermally Conductive Compound	1-part	White	2.0	–	Non-curing
Thermally-conductive gap fillers	DOWSIL™ TC-4515 Thermal Gap Filler	2-part (1:1)	Part A: White Part B: Blue	1.8	NA	Room temperature or heat accelerated
	DOWSIL™ TC-4525 Thermally Conductive Gap Filler	2-part (1:1)	Part A: White Part B: Blue	2.6	0.42 @ 85 µm 0.73 @ 45 µm 1.23 @ 309 µm	Room temperature or heat accelerated
	DOWSIL™ TC-4535 CV Thermally Conductive Gap Filler	2-part (1:1)	Part A: White Part B: Blue	3.4	NA	Room temperature or heat accelerated

CV=Controlled volatility
JIS=Japanese Industrial Standard

	Cure (time/temp.)	Viscosity (cP)	Specific gravity (cured)	Lap shear	Durometer	CTE (ppm/K)	Notes
	100°C or above	Part A: 48,000 Part B: 43,000 Mixed: 59,001	2.14	375 psi, 2.6 MPa (Al)	67 Shore A	–	
	1.5 hrs @ 100°C 30 min @ 125°C 20 min @ 150°C	62,300	2.71 Uncured	646 psi, 4.5 MPa (Al)	92 Shore A	–	UL 94 V-0
	1 hr @ 130°C	Part A: 250,000 Part B: 200,000 Mixed: 220,000	2.9 (density)	435 psi, 3 MPa (Al)	92 Shore A	–	
	30 min @ 125°C 10 min @ 150°C	Part A: 130,000 Part B: 118,000 Mixed: 125,000	3.0 (density)	381 psi, 2.63 MPa (Al) 416 psi, 287 MPa (Cu)	95 Shore A (JIS Type A) 45 Shore D	–	UL 94 V-0
	Non-curing	100,000	3.5 Uncured	–	–	–	
	Non-curing	77,000	4.2 Uncured	–	–	–	
	Non-curing	116,000	2.76	–	–	–	
	2.5 hrs @ 25°C 30 min @ 80°C	Part A: 215,000 Part B: 230,000 Mixed: 240,000	2.7 Uncured	NA	50 Shore 00	160: -50°C to 150°C	UL 94 V-0
	2 hrs @ 25°C 20 min @ 50°C 10 min @ 80°C	Part A: 207,000 Part B: 193,000 Mixed: 217,000	2.9	NA	55 Shore 00	95: -50°C to 80°C 123: -50°C to 150°C	UL 94 V-0
	2 hrs @ 25°C	Part A: 200,000 Part B: 230,000 Mixed: 205,000	3.1 (density)	NA	52 Shore 00 18 JIS Type E	–	UL 94 Pending

Inverter/Converter (continued)

Assembly

	Product	1- or 2-Part	Color	Cure type	Cure (time/temp.)	Viscosity (cP)
Adhesives	DOWSIL™ EA-6060 Adhesive	2-part (1:1)	Part A: Black Part B: White	Heat accelerated	30 min @ 80°C 15 min @ 90°C 10 min @ 100°C	Part A: 190,000 Part B: 90,000 Mixed: 115,000
	DOWSIL™ 3-6265 Thixotropic Adhesive	1-part	Black	Heat	1 hr @ 125°C 30 min @ 150°C	Low shear: 1,020,000 High shear: 235,000
	DOWSIL™ EA-4700 CV Adhesive	2-part (1:1)	Part A: White Part B: Black	Fast, room temperature or heat accelerated	2 hrs @ 25°C	Part A: 24,000 Part B: 18,000 Mixed: 27,000
EMI shielding	DOWSIL™ EC-6601 Electrically Conductive Adhesive	1-part	Tan	Room temperature with mild heat acceleration	Skin over: 30 min	Initial extrusion rate @ g/min: 2.20
Silicone foam gasket	DOWSIL™ 3-8209 Silicone Foam	2-part (1:1)	Part A: Dark gray Part B: Colorless	Room temperature	Tack-free: 10 min max @ 25°C	Part A: 11,000 - 17,000 Part B: 12,000 - 17,000

	Product	1- or 2-Part	Color	Cure type	Cure (time/temp.)	Specific gravity
Cure-in-place gaskets (CIPG)	SILASTIC™ RBL-9694-20P Liquid Silicone Rubber	2-part (1:1)	Part A: Black Part B: White	Addition	2 min, 45 sec @ 115°C	1.17
	SILASTIC™ RBL-9694-30P Liquid Silicone Rubber	2-part (1:1)	Part A: Black Part B: White	Addition	46 sec @ 115°C	1.20
	SILASTIC™ RBL-9694-45M Liquid Silicone Rubber	2-part (1:1)	Part A: Black Part B: White	Addition	34 sec @ 115°C	1.20

CV=Controlled volatility
JIS=Japanese Industrial Standard
* 3.2 mm nozzle @ 0.63 MPa
** 90 psi, 1/8-inch orifice

PCB Protection

	Product	1- or 2-Part	Color	Cure type	Cure (time/temp.)
Conformal coatings	DOWSIL™ 3-1953 Conformal Coating	1-part	Translucent	Fast, RTV, with mild heat acceleration possible	Tack-free: 8 min @ 25°C 0.5 min @ 60°C (15% RH)
	DOWSIL™ 3-1965 Conformal Coating	1-part	Translucent	RTV, with mild heat acceleration possible	Tack-free: 6 min @ 25°C
	DOWSIL™ 1-2577 Low VOC Conformal Coating	1-part	Transparent	RTV, with mild heat acceleration possible	Tack-free: 6 min @ 25°C 1.5 min @ 60°C (15% RH)

	Specific gravity (cured)	Lap shear (MPa)	Durometer	Tensile strength (MPa)	Elongation (%)	CTE (ppm/°C)	Notes
	1.25	2.8 (AlSi10Mg) 2.3 (AlMg1)	42 Shore A	3.1	290	214	UV indicator for inspection
	1.34	611 psi (Al)	60 Shore A	4.8	165	275	UV indicator for inspection
	1.16 (density)	2 hrs @ 25°C: 1.2 5 min @ 80°C: 1.3 (Al) 2 hrs @ 25°C: 1.8 5 min @ 80°C: 1.5 (PBT)	19 Shore A (JIS)	3.7	630	–	
	3.37	1.30 (Al)	80 Shore A	1.51	194	–	Volume resistivity: 2.7E -3 ohm *cm Shielding effectiveness: dB
	A/B: 1.07/1.01	NA	45 Shore 00	–	–	–	Compression set @ 50%, 22 hr @ 70°C: -Non-post cured: 32% -Post-cured 1 hr @ 100°C: 4% -Stress-strain characteristics in compression: 74 KPa

	Lap shear adhesion (MPa)	Durometer	Extrusion rate (g/min)	Tensile strength (MPa)	Elongation (%)	Modulus 100% (MPa)	Tear strength (Kn/m)	Compression set - 22 hrs @ 25%
	1.3: 10 min @ 150°C (Vinyl ester)	21 Shore A	Part A: 119* Part B: 282	Die C: 5.9	925	0.39	Die B: 13	@ 132°C: 36%
	1.0: 10 min @ 150°C (Al)	32 Shore A	Part A: 75* Part B: 178	Die C: 7.2	820	0.8	Die B: 14	@ 177°C: 31%
	1.64: 10 min @ 150°C (Al) 1.35: 10 min @ 150°C (PA66 GF30)	45 Shore A	Part A: 77** Part B: 98	Die C: 7.25	600	1.45	Die B: 45	@ 177°C: 29%

	Viscosity (cP)	Specific gravity (cured)	Durometer	Nonvolatile content (%)	Notes
	350	0.98	34 Shore A	99.4	UV indicator for inspection; Non solvent based; UL 94 V-0; MIL I-46058C Amend 7; IPC-CC-830B
	115	0.99	33 Shore A	–	UV indicator for inspection; UL 94 V-0; UL 746E; MIL I-46058C Amend 7; IPC-CC-830 with Amendment 1
	1,050	1.12	85 Shore A 25 Shore D	Forced draft volatility: 33.6	UV indicator for inspection; UL 94 V-0; UL 94 5VA; UL 746E; MIL I-46058C Amend 7; IPC-CC-830B

Electric motor

Control unit thermal management

	Product	1- or 2-Part	Color	Thermal conductivity (W/m.K)	Cure type
Thermally-conductive adhesives	DOWSIL™ Q1-9226 Thermally Conductive Adhesive	2-part (1:1)	Gray	0.8	Heat
	DOWSIL™ 1-4174 Thermally Conductive Adhesive	1-part	Gray	1.78	Room temperature or heat accelerated
	DOWSIL™ TC-2030 Adhesive	2-part (1:1)	Gray	2.7	Heat
	DOWSIL™ TC-2035 Adhesive	2-part (1:1)	Part A: White Part B: Reddish brown	3.3	Room temperature or heat accelerated
Thermally-conductive encapsulant	DOWSIL™ TC-6020 Thermally Conductive Encapsulant*	2-part (1:1)	Gray	2.7	Room temperature or heat accelerated

JIS=Japanese Industrial Standard
*Pending availability in some geographies

Protection

	Product	1- or 2 Part	Color	Thermal conductivity (W/m.K)	Cure type
Conformal coatings	DOWSIL™ 3-1953 Conformal Coating	1-part	Translucent	NA	Room temperature
	DOWSIL™ 3-1965 Conformal Coating	1-part	Translucent	NA	Room temperature or heat accelerated
Thermally-conductive encapsulants	DOWSIL™ TC-4605 HLV Thermally Conductive Encapsulant	2-part (1:1)	Gray	1.0	Heat
	DOWSIL™ SE 4445 CV Encapsulant	2-part (1:1)	Gray	1.34	Heat

CV=Controlled volatility

	Cure (time/temp.)	Viscosity (cP)	Specific gravity (cured)	Lap shear	Durometer	Notes
	100°C or above	Part A: 48,000 Part B: 43,000 Mixed: 59,001	2.14	375 psi, 2.6 MPa (Al)	67 Shore A	
	1.5 hr @ 100°C 30 min @ 125°C 20 min @ 150°C	62,300	2.71 Uncured	646 psi, 4.5 MPa (Al)	92 Shore A	UL 94 V-0
	1 hr @ 130°C	Part A: 250,000 Part B: 200,000 Mixed: 220,000	2.90 (density)	435 psi, 3 MPa (Al)	92 Shore A	
	30 min @ 125°C 10 min @ 150°C	Part A: 130,000 Part B: 118,000 Mixed: 125,000	3.0 (density)	381 psi, 2.63 MPa (Al) 416 psi, 2.87 MPa (Cu)	95 Shore A (JIS Type A) 45 Shore D	UL 94 V-0
	23 min @ 60°C, T90% 13 min @ 80°C, T90% 5 min @ 100°C, T90%	Part A: 10,800 Part B: 9,960 Mixed: 10,640	2.926	40.5 psi (Al)	63 Shore A	UL 94 V-0

	Cure (time/temp.)	Viscosity (cP)	Specific gravity (cured)	Durometer	Nonvolatile content (%)	Notes
	Tack-free: 8 min @ 25°C 0.5 min @ 60°C (15% RH)	350	0.98	34 Shore A	99.4	UL 94 V-0; UL 746E; MIL I-46058C Amend 7; IPC-CC-830B
	Tack-free: 6 min @ 25°C	115	0.99	33 Shore A	–	UL 94 V-0; MIL I-46058C Amend 7; IPC-CC-830 with Amendment 1
	1 hr @ 120°C	Part A: 1,600 Part B: 1,400 Mixed: 1,900	1.67	60 Shore A	–	UL 94 V-0 @ 1.5 mm
	45 min @ 125°C	Mixed: 15,025	2.36 (density)	–	–	UL 94 V-0

On-board charger

Thermal management

	Product	1- or 2 Part	Color	Thermal conductivity (W/m.K)	Cure type
Thermally-conductive encapsulants	DOWSIL™ TC-4605 HLV Thermally Conductive Encapsulant	2-part (1:1)	Gray	1.0	Heat
	DOWSIL™ TC-6020 Thermally Conductive Encapsulant	2-part (1:1)	Gray	2.7	Room temperature or heat accelerated
Thermally-conductive gap fillers	DOWSIL™ TC-4515 Thermal Gap Filler	2-part (1:1)	Part A: White Part B: Blue	1.8	Room temperature or heat accelerated
	DOWSIL™ TC-4525 Thermally Conductive Gap Filler	2-part (1:1)	Part A: White Part B: Blue	2.6	Room temperature or heat accelerated
	DOWSIL™ TC-4535 CV Thermally Conductive Gap Filler	2-part (1:1)	Part A: White Part B: Blue	3.5	Room temperature or heat accelerated

CV=Controlled volatility
JIS=Japanese Industrial Standard

Assembly

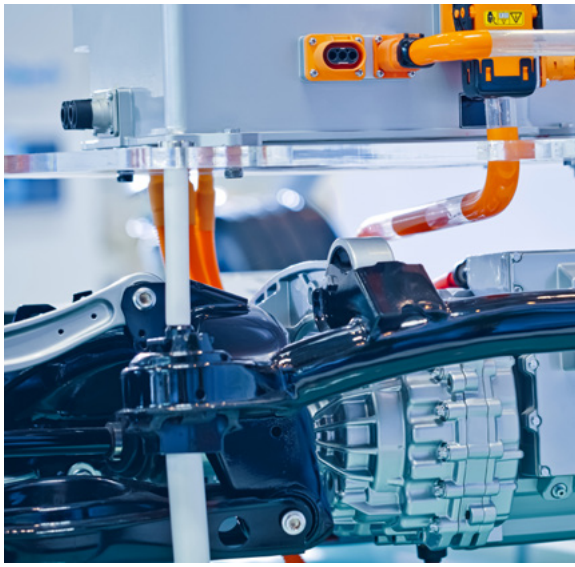
	Product	1- or 2 Part	Color	Thermal conductivity (W/m.K)	Cure type	Cure (time/temp.)
Adhesives	DOWSIL™ EA-9189 H RTV Adhesive	1-part	White	0.88	Room temperature	Tack-free 2 min @ 25°C
	DOWSIL™ 3-6265 HP Adhesive	1-part	Black	–	Heat	4 hrs @ 100°C 50 min @ 120°C 25 min @ 125°C 10 min @ 150°C
EMI shielding	DOWSIL™ EC-6601 Electrically Conductive Adhesive	1-part	Tan	Room temperature with mild heat acceleration	Skin over: 30 min	Initial extrusion rate @ g/min: 2.20

Protection

	Product	1- or 2 Part	Color	Cure type	Cure (time/temp.)
Conformal coatings	DOWSIL™ 3-1953 Conformal Coating	1-part	Translucent	Fast, RTV with mild heat acceleration possible	Tack-free: 8 min @ 25°C 0.5 min @ 60°C (15% RH)
	DOWSIL™ 3-1965 Conformal Coating	1-part	Translucent	RTV with mild heat acceleration possible	Tack-free: 6 min @ 25°C
Gels	DOWSIL™ 3-4150 Dielectric Gel*	2-part (1:1)	Parts are blue and yellow, transparent green when mixed	Fast, room temperature	1.5 hrs @ 25°C
	SYLGARD™ 527 Silicone Dielectric Gel	2-part (1:1)	Clear or red	Room temperature or heat accelerated	3.5 hrs @ 100°C 1.25 hrs @ 125°C 35 min @ 150°C

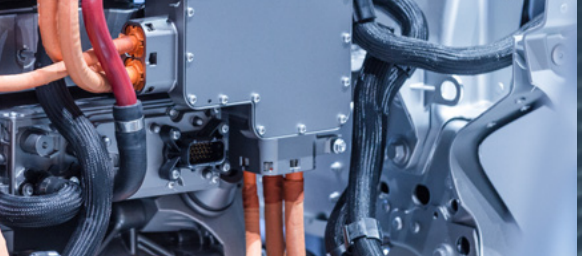
* Available outside China

	Cure (time/temp.)	Viscosity (cP)	Durometer	Notes
	1 hr @ 120°C	Part A: 1,600 Part B: 1,400 Mixed: 1,900	60 Shore A	UL 94 V-0 @ 1.5 mm
	23 min @ 60°C, T90% 13 min @ 80°C, T90% 5 min @ 100°C, T90%	Part A: 10,800 Part B: 9,960 Mixed: 10,640	63 Shore A	UL 94 V-0
	2.5 hrs @ 25°C 30 min @ 80°C	Part A: 215,000 Part B: 230,000 Mixed: 240,000	50 Shore 00	UL 94 V-0
	2 hrs @ 25°C 20 min @ 50°C 10 min @ 80°C	Part A: 207,000 Part B: 193,000 Mixed: 217,000	55 Shore 00	UL 94 V-0
	2 hrs @ 25°C 30 min @ 80°C	Part A: 200,000 Part B: 230,000 Mixed: 205,000	52 Shore 00 18 JIS Type E	UL 94 Pending



	Specific gravity (cured)	Lap shear	Durometer	Tensile strength (MPa)	Elongation (%)	Notes
	1.78	327 psi, 2.2 MPa (Al) 343 psi, 2.3 MPa (Cu) 187 psi, 1.2 MPa (PC) 349 psi, 2.4 MPa (FR4)	80 Shore A	3.9	32	UL 94 V-0
	1.33	825 psi, 5.7 MPa (Al)	68 Shore A	5.8	275	
	3.37	1.30 (Al)	80 Shore A	1.51	194	Volume resistivity: 2.7E -3 ohm *cm Shielding effectiveness: 86 dB

	Viscosity (cP)	Specific gravity (cured)	Durometer	Nonvolatile content (%)	Notes
	350	0.98	34 Shore A	99.4	UL 94 V-0; MIL I-46058C Amend 7; IPC-CC-830B; UL 746E
	115	0.99	33 Shore A	–	UL 94 V-0; MIL I-46058C Amend 7; IPC-CC-830 with Amendment 1
	Part A: 475 Part B: 450 Mixed: 475	0.97	Gel hardness: 115 grams	–	
	Part A: 470 Part B: 454 Mixed: 465	0.95 Uncured	Gel hardness: 113 grams	–	UL 94 HB



Thermal system

PTC Heater

Thermal management and assembly

	Product	1- or 2 Part	Color	Thermal conductivity (W/m.K)	Cure type	Cure (time/temp.)
Thermally-conductive adhesives	DOWSIL™ Q1-9226 Thermally Conductive Adhesive	2-part (1:1)	Gray	0.8	Heat	100°C or above
	DOWSIL™ TC-2035 Adhesive	2-part (1:1)	Part A: White Part B: Reddish brown	3.3	Heat	30 min @ 125°C 10 min @ 150°C
	DOWSIL™ TC-2022 Thermally Conductive Adhesive	1-part	Gray	1.7	Heat	15 min @ 100°C
	DOWSIL™ 1-4173 Thermally Conductive Adhesive	1-part	Gray	1.8	Heat	1.5 hrs @ 100°C 30 min @ 125°C 20 min @ 150°C

JIS=Japanese Industrial Standard

Electric compressor

Protection

	Product	1- or 2 Part	Color	Cure type	Cure (time/temp.)
Conformal coatings	DOWSIL™ 3-1953 Conformal Coating	1-part	Translucent	Room temperature or heat accelerated	Tack free: 8 min @ 25°C 0.5 min @ 60°C (15% RH)
	DOWSIL™ 3-1965 Conformal Coating	1-part	Translucent	Room temperature or heat accelerated	Tack free: 6 min @ 25°C
	DOWSIL™ 1-2577 Low VOC Conformal Coating	1-part	Translucent	Room temperature or heat accelerated	Tack free: 6 min @ 25°C 1.5 min @ 60°C (15% RH)

Sheath heater

Protection

	Product	1- or 2 Part	Color	Thermal conductivity (W/m.K)	Cure (type)
Encapsulants	SYLGARD™ 170 Silicone Elastomer	2-part (1:1)	Dark gray to black	0.48	Room temperature or heat accelerated
	SYLGARD™ 170 Fast Cure Silicone Elastomer	2-part (1:1)	Black	0.4	Room temperature or heat accelerated

	Viscosity (cP)	Specific gravity (cured)	Lap shear (MPa)	Durometer	Notes
	Part A: 48,000 Part B: 43,000 Mixed: 59,000	2.14	2.6, 375 psi (Al)	67 Shore A	
	Part A: 130,000 Part B: 118,000 Mixed: 125,000	3.01 (density)	2.63, 381 psi (Al) 2.87, 416 psi (Cu)	95 Shore A (JIS Type A) 45 Shore D	UL 94 V-0
	190,000	2.7	4.1, 600 psi (Al)	90 Shore A	
	61,000	2.7	4.5, 650 psi (Al)	92 Shore A	UL 94 V-0

	Viscosity (cP)	Specific gravity (cured)	Durometer	Nonvolatile Content (%)	Notes
	350	0.98	34 Shore A	99.4	UV indicator for inspection; UL 94 V-0; MIL-1-46058C Amend 7; IPC-CC-830B;UL 746E
	115	0.99	33 Shore A	–	UV indicator for inspection; UL 84 V-0; MIL-1-46058C Amend 7; IPC-CC-830 with Amendment 1
	1,050	1.12	85 Shore A 25 Shore D	Forced draft volatility: 33.6	UV indicator for inspection; UL 746E; UL 94 V-0; UL 94 5VA; MIL-1-46058C Amend 7; IPC-CC-830B

	Cure (time/temp.)	Viscosity (cP)	Specific gravity (uncured)	Durometer	Notes
	1 day @ 25°C 25 min @ 70°C 10 min @ 100°C	Part A: 3,160 Part B: 1,110 Mixed: 2,135	Parts A/B: 1.37	47 Shore A	UL 94 V-0
	10 min @ 25°C	Part A: 3,436 Part B: 1,287 Mixed: 2,361	Parts A/B: 1.38	45 Shore A	UL 94 V-0

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