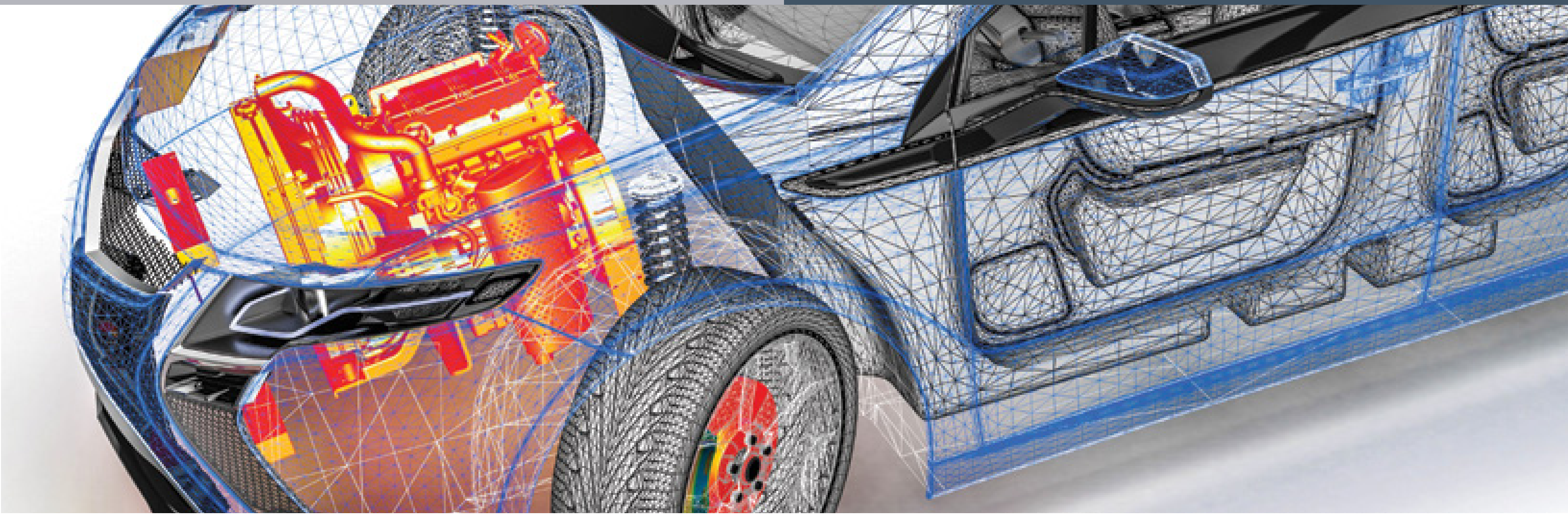
ELECTRONICS AND ADVANCED ASSEMBLY SOLUTIONS

Imagine: Enhanced performance and reliability of your electronics design

Thermally conductive materials selection guide

Why choose Dow Performance Silicones?

Dow Performance Silicones has been a global leader in silicone-based technology for more than 70 years. Headquartered in Michigan, USA, we maintain manufacturing sites, sales and customer service offices, and research and development labs in every major geographic market worldwide to ensure you receive fast, reliable support for your processing and application development needs.



Unique product technology

To describe Dow Performance Silicones is to describe the history and evolution of silicone technology, which generated a legacy of innovative and reliable products under the *Dow Corning*® label for more than seven decades. Today that legacy continues under the DOWSIL™ brand name, which encompasses more than 7,000 proven silicone products and services. Few companies offer an encapsulant portfolio with comparable breadth and proven performance, and none match our history in silicone technology.

Extensive know-how

Dow Performance Silicones multiplies the value of its products with deep in-house expertise and an extended network of industry resources.

Collaborative culture

Dow Performance Silicones works closely with you to help reduce time and cost at every stage of your new-product development.

Stability

For more than seven decades, Dow Performance Silicones has been a global leader who invests in manufacturing and quality to help fuel customer innovation through a consistent supply of proven silicone products.

DOWSIL™ silicones by DOW

Why heat is the enemy of devices

The reasons may vary from application to application. Yet, improved thermal management is increasingly critical to maintaining the long-term performance and reliability of PCB system assemblies in virtually every industry.

Transportation: From rail to road, vehicles are increasingly reliant on PCB system assemblies for everything from optimized fuel consumption and safety to propulsion and braking. As this trend accelerates, it will drive demand for higher performance and more cost-effective thermal management solutions.

Heat management: The trend toward smaller devices with more densely packed PCB system components is converging with expanded use of flip chip and stacked die architectures. As a result, new thermal management solutions are needed to effectively dissipate heat and deliver greater device reliability.

Solid-state lighting: Unlike conventional light sources, the ability to manage the temperature of an LED module has a direct impact on the reliability, output quality, lifetime and system cost of the device. Moreover, thermal management is becoming an increasingly important performance metric for the entire LED value chain, as solid-state lighting competes with conventional illumination for high-intensity and high-temperature applications.

Power devices: Power supplies and controls for industry, computer servers, and solar and wind energy are all managing higher electrical loads and, with them, increasing temperatures. The trend is creating a need for improved thermal management to dissipate heat in these devices, as this translates into improved performance, reliability and lifetime. Improved thermal management also offers needed design flexibility.

Consumer devices and telecommunications: Form factor optimization is one of the challenges facing this industry. Thin is in for consumer devices, requiring compact, multifunctional thermal management solutions.

Why silicone thermal solutions from Dow?

The inherent versatility of silicone chemistry can help expand your design freedom, increase your processing options, and enhance the performance and reliability of your device. As a class of materials, silicones generally offer demonstrable benefits over organic-based urethane and epoxy solutions, including:

- Superior stability and reliability across temperatures from -45°C to 200°C
- More physically robust under mechanical stress caused by thermal cycling or mismatched coefficient of thermal expansion
- Higher elongation and compression for extraordinary protection against shock and vibration
- Greater hydrostability and stronger resistance to chemicals
- None of the toxicity issues of organics, helping to reduce or eliminate special handling precautions
- Simpler processing without the need for oven-drying or concerns about exotherms
- Stable pot life and ease of reworkability

Dow builds on silicone's inherent potential by combining it with industry-leading materials knowledge, application expertise, customer collaboration and a global footprint. The value we add is further evident in the unmatched breadth of our industry-leading product portfolio, which encompasses a broad selection of thermally conductive adhesives, compounds, encapsulants and dispensable pads – all available in a wide range of delivery formats, viscosities, cure chemistries, and thermal and mechanical profiles.

There likely is a specific category or grade that delivers the optimal processing and performance advantages for your device design, and we've designed this guide to help you quickly narrow your search for a thermal management solution that meets your design goals for heat dissipation, processability and low cost of ownership.

Next-generation thermal management materials ... today!

Dow listens closely to its customers and continuously innovates across product technologies to deliver next-generation thermal solutions when you need them – today.

Available in a broad range of viscosities and cure chemistries, our thermally conductive materials come in various delivery formats.

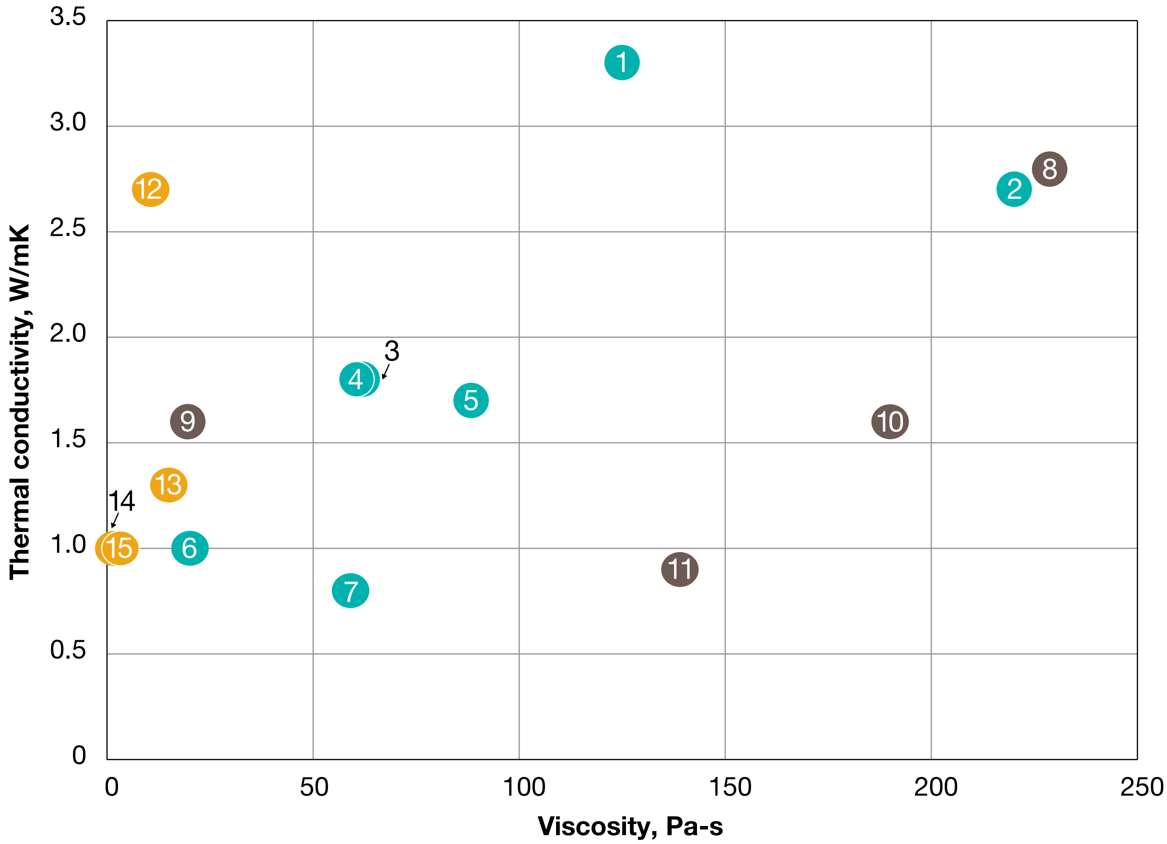
Thermally Conductive Adhesives

Thermally Conductive Encapsulants and Gels

Thermally Conductive Compounds

Thermally Conductive Gap Fillers

Thermal conductivity vs. viscosity

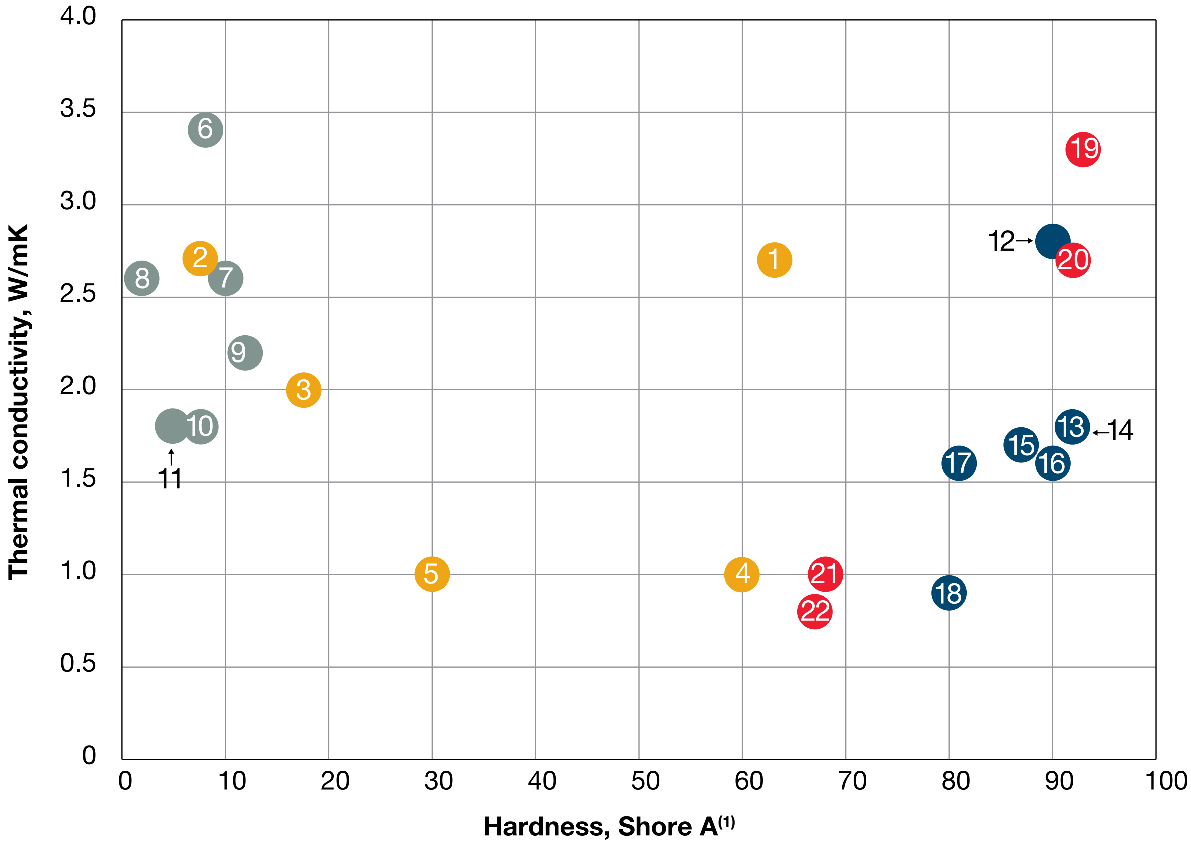


1 DOWSIL™ TC-2035 Thermally Conductive Adhesive
2 DOWSIL™ TC-2030 Thermally Conductive Adhesive
3 DOWSIL™ 1-4174 Thermally Conductive Adhesive
4 DOWSIL™ 1-4173 Thermally Conductive Adhesive
5 DOWSIL™ 3-6752 Thermally Conductive Adhesive
6 DOWSIL™ 3-6751 Thermally Conductive Adhesive
7 DOWSIL™ Q1-9226 Thermally Conductive Adhesive
8 DOWSIL™ SE 4485 Thermally Conductive Adhesive
9 DOWSIL™ SE 4486 Thermally Conductive Adhesive
10 DOWSIL™ TC-2022 Thermally Conductive Adhesive
11 DOWSIL™ EA-9189 H RTV Adhesive
12 DOWSIL™ TC-6020 Thermally Conductive Encapsulant
13 DOWSIL™ SE4445 CV Thermally Conductive Gel
14 DOWSIL™ TC-4605 HLV Thermally Conductive Encapsulant
15 DOWSIL™ TC-6011 Thermally Conductive Encapsulant

Legend:

- Encapsulants and gels
- Room temperature cure adhesives
- Heat cure adhesives

Thermal conductivity vs. hardness



1. DOWSIL™ TC-6020 Thermally Conductive Encapsulant
2. DOWSIL™ TC-4025 Dispensable Thermal Pad
3. DOWSIL™ TC-3015 Reworkable Thermal Gel
4. DOWSIL™ TC-4605 HLV Thermally Conductive Encapsulant
5. DOWSIL™ TC-6011 Thermally Conductive Encapsulant
6. DOWSIL™ TC-4535 CV Thermally Conductive Gap Filler
7. DOWSIL™ TC-4525 Thermally Conductive Gap Filler
8. DOWSIL™ TC-4525 CV Thermally Conductive Gap Filler
9. DOWSIL™ SE 4448 CV
10. DOWSIL™ TC-4515 Thermally Conductive Gap Filler
11. DOWSIL™ TC-4515 CV Thermally Conductive Gap Filler
12. DOWSIL™ SE 4485 Thermally Conductive Adhesive
13. DOWSIL™ 1-4173 Thermally Conductive Adhesive
14. DOWSIL™ 1-4174 Thermally Conductive Adhesive
15. DOWSIL™ 3-6752 Thermally Conductive Adhesive
16. DOWSIL™ TC-2022 Thermally Conductive Adhesive
17. DOWSIL™ SE 4486 Thermally Conductive Adhesive
18. DOWSIL™ EA-9189 H RTV Adhesive
19. DOWSIL™ TC-2035 Thermally Conductive Adhesive
20. DOWSIL™ TC-2030 Thermally Conductive Adhesive
21. DOWSIL™ 3-6751 Thermally Conductive Adhesive
22. DOWSIL™ Q1-9226 Thermally Conductive Adhesive

Legend:

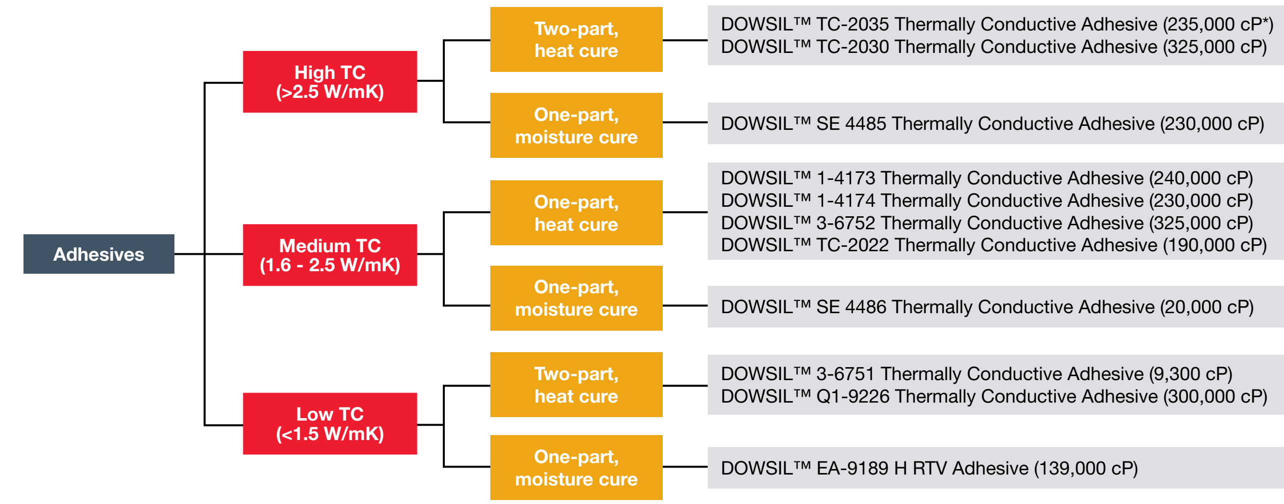
- Encapsulants
- Gap fillers
- One-part adhesives
- Two-part adhesives

(1) Some hardness data estimated from Shore OO data.

Choose your thermally conductive adhesive

DOWSIL™ thermally conductive silicone adhesives are suitable for bonding and sealing hybrid circuit substrates; semiconductor components; heat spreaders; and other applications that demand broad design, flexible processing options and excellent thermal management.

The high-performance materials in our portfolio encompass moisture-cure grades for simple, room-temperature processing as well as heat-cure solutions for speeding productivity and time to market. Options range from low-viscosity liquids that fill oddly shaped gaps and ensure large contact areas for maximal heat transfer to nonslump formulations to hold vertical position prior to cure completion.



*Viscosity is low shear

Thermally conductive adhesives

Decreasing thermal conductivity

		Key features/advantages																								
	Cure type (chemistry)	Unique features	Room temperature cure	Heat cure	Short tack-free time	Controlled volatility	UL 94 V-0	Low viscosity	Flowable	Thixotropic	High tensile strength	180 µm glass beads	High performance stability through operating life	Appearance	Thermal conductivity, W/mK	Viscosity, Pa-s: @ 10 s⁻¹[3] @ 20 rpm, RVF 7[4]	Tack-free time @ 25°C/55% RH, min	Cure conditions	Density @ 25°C, g/cm³	Durometer: Shore A[10] JIS Type A[11]	Linear coefficient of thermal expansion, ppm/°C	Tensile strength, MPa	Elongation at break, %	Lap shear adhesion, MPa (substrate)	Dielectric strength, kV/mm	Shelf life
														CTM 0176/ ASTM E284	CTM 1163[1] CTM 1388[2]	CTM 1094[3] CTM 0050/ ASTM D1084[4]	CTM 0095/ ASTM D2377	CTM 0663[5] CTM 0099/ASTM D2240[6] CTM 0243/ASTM D816[7]	CTM 0022/ ASTM D792[8] CTM 0097/ ASTM D1475[9]	CTM 0099/ ASTM D2240	CTM 0585/ ASTM E831	CTM 0137/ ASTM D412	CTM 0137/ ASTM D412	CTM 0243/ ASTM D816	CTM 0114/ ASTM D149	
One-part adhesives																										
DOWSIL™ SE 4485 Thermally Conductive Adhesive	Alkoxy moisture		✓			✓	✓		Semi					White	2.8[1]	230.0[4]	3	5 hr/0.6 mm @ 25°C/50% RH 72 hr/2 mm @ 25°C/50% RH[5]	2.9[8]	90[11]	80	3.4	25	2.3 (Al) 1.2 (GL)	19	9 months @ 25°C
DOWSIL™ 1-4173 Thermally Conductive Adhesive	Addition by hydrosilylation			✓			✓			✓	✓			Gray	1.8[1]	61.3[4]	NA	90 min @ 100°C 30 min @ 125°C 20 min @ 150°C[6]	2.7[9]	92[10]	125	6.2	22	4.5 (Al)	18	6 months @ 5°C cold storage
DOWSIL™ 1-4174 Thermally Conductive Adhesive	Addition by hydrosilylation			✓			✓			✓	✓	✓		Gray	1.8[1]	62.3[4]	NA	90 min @ 100°C 30 min @ 125°C 20 min @ 150°C[6]	2.7[9]	92[10]	125	5.2	NA	4.4 (Al)	16	6 months @ 5°C cold storage
DOWSIL™ 3-6752 Thermally Conductive Adhesive	Addition by hydrosilylation			✓			✓							Gray	1.7[1]	88.3[4]	NA	40 min @ 100°C 10 min @ 125°C 3 min @ 150°C[6]	2.6[9]	87[10]	138	3.8	15	3.6 (Al)	16	6 months @ 25°C
DOWSIL™ SE 4486 Thermally Conductive Adhesive	Alkoxy moisture		✓			✓		✓	✓					White	1.6[1]	19.6[3]	4	72 hr/3 mm @ 25°C/55% RH[5]	2.6[8]	81[10]	140	3.9	43	0.7 (Al) 1.6 (GL)	20	12 months @ 25°C
DOWSIL™ TC-2022 Thermally Conductive Adhesive	Thermal radical cure	Fast cure at moderate temperature										✓		Gray	1.6[1]	190[4]	NA	15 min @ 100°C[7]	2.7[8]	90[10]	125	4.7	100	4.1 (Al)	16	12 months @ - 5°C cold storage
DOWSIL™ EA-9189 H RTV Adhesive	Alkoxy moisture		✓		✓	✓	✓							White	0.9[2]	139[3]	2	72 hr/3 mm @ 20°C/55% RH[5]	1.7[8]	80[10]	189	3.9	31	2.2 (Al) 2.3 (Cu) 2.4 (FR4)	28	9 months @ 25°C
Two-part 1:1 mix ratio adhesives																										
DOWSIL™ TC-2035 Thermally Conductive Adhesive	Addition by hydrosilylation	Low bond line thickness of 80 µm; optimized wetting on typical electronics substrates		✓			✓						✓	Part A: White Part B: Pink Mixed: Pink	3.3[1]	Part A: 130[3] Part B: 118[3] Mixed: 125[3]	NA	30 min @ 125°C 10 min @ 150°C[7]	3.0[8]	93[10]	92	3.6	43	2.7 (Al)	21	6 months @ 25°C
DOWSIL™ TC-2030 Thermally Conductive Adhesive	Addition by hydrosilylation	Bond line thickness above 130 µm		✓									✓	Part A: White Part B: Gray Mixed: Gray	2.7[1]	Part A: 250[3] Part B: 200[3] Mixed: 220[3]	NA	60 min @ 130°C[7]	2.9[8]	92[10]	60	4.7	50	3.3 (Al)	21	12 months @ 25°C
DOWSIL™ 3-6751 Thermally Conductive Adhesive	Addition by hydrosilylation	Low viscosity; low elastomeric modulus		✓			✓							Part A: White Part B: Gray Mixed: Gray	1.0[1]	Mixed: 20.2[4]	NA	60 min @ 100°C 45 min @ 125°C 10 min @ 150°C[7]	2.3[9]	68[10]	180	2.8	36	3.5 (Al)	18	12 months @ 25°C
DOWSIL™ Q1-9226 Thermally Conductive Adhesive	Addition by hydrosilylation	Moderate flow; long pot life; good resilience due to high elongation; low elastomeric modulus		✓										Part A: White Part B: Gray Mixed: Gray	0.8[1]	Part A: 48[4] Part B: 43[4] Mixed: 59[4]	NA	60 min @ 100°C 45 min @ 125°C 10 min @ 150°C[7]	2.1[9]	67[10]	168	4.1	124	2.6 (Al)	25	12 months @ 25°C

Decreasing thermal conductivity

NA – test data not available.

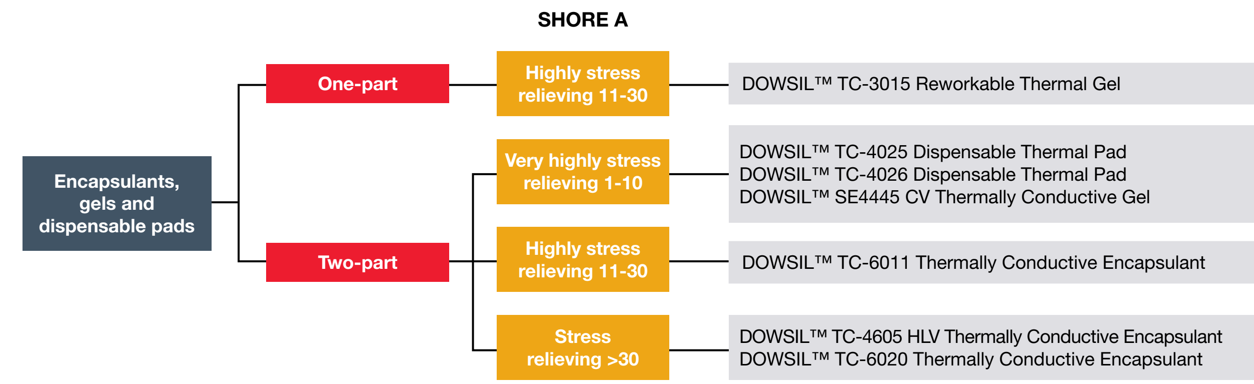
Specification writers: These values are not intended for use in preparing specifications. Please contact your local Dow representative or sales office before writing specifications on these products.

Choose your thermally conductive encapsulant, gel or dispensable thermal pad

Dow's selection of DOWSIL™ and SYLGARD™ thermally conductive silicone elastomers and gels presents flexible options for protecting sensitive components from harsh environmental conditions as well as from heat. Offering low viscosity before cure, these products process easily and fully embed tall components, delicate wires and solder joints to enhance thermal management – even for the most complex structures. Additionally, DOWSIL™ thermal pads enable you to quickly and precisely print a thermally conductive silicone compound in controllable thicknesses on complex substrates.

The silicone products in this versatile portfolio include:

- **Encapsulants**, which come in a variety of viscosities and cure chemistries and cure into rubbery elastomers that provide reliable protection from harsh environmental conditions
- **Gels** that offer remarkably low modulus to protect the most sensitive and delicate components against mechanical stress and the effects of thermal cycling
- **Dispensable thermal pads** that offer a versatile, cost-effective alternative to prefabricated thermal pads



Thermally conductive encapsulants, gels and dispensable thermal pads

Decreasing thermal conductivity ↓

	Mix ratio	Cure type (chemistry)	Key features/advantages: Unique properties	Develops adhesion	Room temperature cure	Heat cure	UL 94 V-0	Controlled volatility	Reworkable, printable	Excellent dielectric properties	Appearance	Thermal conductivity, W/mK	Viscosity, Pa-s: @ 20 rpm, RFV 7[3] @ 20 rpm, RFV 3[4] @ 100 rpm, RVF 3[5] @ 3 rpm, LVT 3[6] @ 10s-1[7]	Cure conditions	Density @ 25°C, g/cm³	Durometer: Shore A[15] Shore OO[16] Penetration 10⁻¹ mm[17]	Tensile strength, MPa	Elongation, %	Lap shear adhesion, MPa (substrate)	Dielectric strength, kV/mm	Volume resistivity, Ω•cm	Shelf life
											CTM 0176/ ASTM E284	CTM 1163/ JIS R 2618-1992[1] CTM 1388/ ASTM D5334[2]	CTM 0050/ ASTM D1084[4, 5] CTM 1094/ ASTM D4440[7]	CTM 1098 (T90)/ ASTM D4440[8] CTM 0155/ JIS K 2207[9] CTM 0099/ ASTM D2240[10] CTM 0243/ ASTM D816[11]	CTM 0022/ ASTM D792[12] CTM 0097/ ASTM D1475[13] CTM 0768/ ASTM D4052[14]	CTM 0099/ ASTM D2240[15, 16] CTM 0155/ JIS K 2207/ ASTM D217[17]	CTM 0137/ ASTM D412	CTM 0137/ ASTM D412	CTM 0243/ ASTM D816	CTM 0114/ ASTM D149	CTM 0249/ ASTM D257	
DOWSIL™ TC-6020 Thermally Conductive Encapsulant	Two-part 1:1	Addition by hydrosilylation	High thermal conductivity with good flowability		✓		✓			✓	Part A: White Part B: Gray Mixed: Gray	2.7[2]	Part A: 10.8[4] Part B: 10.0[4] Mixed: 10.6[4]	23 min @ 60°C[8] 13 min @ 80°C[8] 5 min @ 100°C[8] 30 min @ 80°C[10]	2.9[12]	63 Shore A[15]	1.0	21	0.3 (Al)	24	8.22E+15	9 months @ 25°C
DOWSIL™ TC-4025 Dispensable Thermal Pad	Two-part 1:1	Addition by hydrosilylation	DOWSIL™ TC-4026 Dispensable Thermal Pad provides 180 µm glass bead		✓		✓		✓		Part A: White Part B: Blue Mixed: Blue	2.7[1]	Part A: 73[7] Part B: 74[7] Mixed: 70[7]	24 hr @ 25°C[10] 30 min @ 100°C[10]	2.8[12]	50 Shore OO[16]	0.2	209	NA	18	3.90E+12	6 months @ 25°C
DOWSIL™ TC-3015 Reworkable Thermal Gel	One-part	Addition by hydrosilylation				✓	✓	✓	✓		Pink	2.0[2]	220[7]	7 hr @ 60°C[10] 30 min @ 100°C[10]	2.8[12]	66 Shore OO[16]	0.3	485	NA	15	5.90E+14	6 months @ -25°C cold storage
DOWSIL™ SE4445 CV Thermally Conductive Gel	Two-part 1:1	Addition by hydrosilylation				✓		✓			Part A: White Part B: Black Mixed: Gray	1.3[1]	Mixed: 15.0[3]	30 min @ 120°C[9]	2.4[14] 2.4[12]	51 P[17]	0.1	350	NA	6	3.00E+15	6 months @ 25°C
DOWSIL™ TC-4605 HLV Thermally Conductive Encapsulant	Two-part 1:1	Addition by hydrosilylation	Low viscosity	✓		✓	✓			✓	Part A: White Part B: Gray Mixed: Gray	1.0[1]	Part A: 1.6[5] Part B: 1.4[5] Mixed: 1.9[5]	60 min @ 120°C[11]	1.7[13]	60 Shore A[15]	2.6	95	1.5 (Al)	24	1.08E+15	6 months @ 25°C
DOWSIL™ TC-6011 Thermally Conductive Encapsulant	Two-part 1:1	Addition by hydrosilylation		✓		✓	✓			✓	Part A: White Part B: Gray Mixed: Gray	1.0[1]	Part A: 3.2[5] Part B: 2.4[5] Mixed: 3.0[5]	60 min @ 120°C[11]	1.6[13]	30 Shore A[15]	0.8	100	0.8 (Al)	21	5.3E+14	9 months @ 25°C

NA – test data not available.
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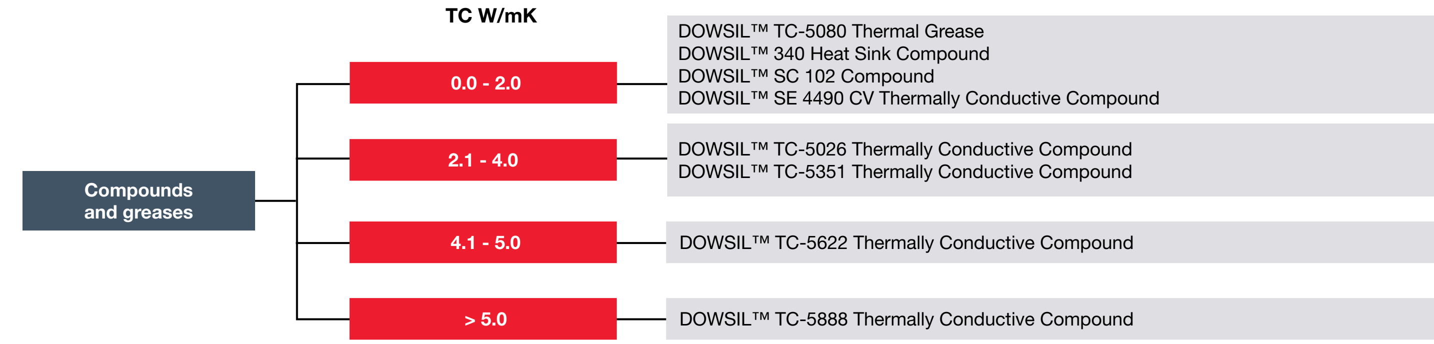
Choose your thermally conductive compound

DOWSIL™ thermally conductive silicone compounds deliver high bulk conductivity and low thermal resistance to efficiently draw heat away from sensitive PCB components and dissipate it into the ambient environment. Applied via screen or print processes or by standard dispensing equipment, our thermal compounds flow easily to fully cover and fill surface irregularities for maximum coverage. Select grades from this family of products offer thermal conductivity as high as 4.3 W/mK.



Thermally conductive compounds

Decreasing thermal conductivity ↓

	Key features/advantages																		
	Unique features	Thixotropic	Thin bond line	UL 94 V-0	Flowable	Nonflowable	Controlled volatility	Appearance	Thermal conductivity, W/mK	Viscosity, Pa.s: @ 10 s^{-1}[3] @ dilatant strain, 10 rad/s[4] @ 1 rpm CPE 52[5] @ 10 rpm BS #7[6]	Density @ 25°C, g/cm³	Volatile content: ppm, D4-D10[9] %, 24 hr @ 150°C[10] %, 24 hr @ 120°C[11] %, 48 hr @ 125°C[12] %, 24 hr @ 105°C[13]	Thermal resistance @ 2.75 kPa/40 psi, °C*cm²/W	Minimum BLT @ 2.75 kPa/40 psi, µm	Dielectric strength, kV/mm	Volume resistivity, Ω•cm	Dielectric constant @ frequency	Dissipation factor @ frequency	Shelf life
								CTM 0176/ ASTM E284	CTM 1163/ JIS R 2618-1992[1] CTM 1388/ ASTM D5334[2]	CTM 1094/ ASTM D4440[3] CTM 1098/ ASTM D4065[4] CTM 50/ ASTM D4287[5, 6]	CTM 540/ ASTM D70[7] CTM 0097/ ASTM D1475[8]	CTM 839[9] CTM 0033[10, 11]	ASTM D5470		CTM 0114/ ASTM D149[14] CTM 1035[15]	CTM 249/ ASTM D257	CTM 0112/ ASTM D150[16] CTM 1139/ ASTM D150[17]	CTM 0112/ ASTM D150[18] CTM 1139/ ASTM D150[19]	
DOWSIL™ TC-5888 Thermally Conductive Compound	Excellent resistance to pump-out in high-stress MCP architecture; low volatiles content	✓						Gray	5.2[2]	100[4]	2.6[7]	0.02%[12]	0.05	20	NA	NA	NA	NA	12 months @ 25°C
DOWSIL™ TC-5622 Thermally Conductive Compound			✓	✓				Gray	4.3[2]	95[5]	2.53[7]	0.08%[10]	0.06	20	NA	NA	NA	NA	24 months @ 25°C
DOWSIL™ TC-5021 Thermally Conductive Compound					✓			Gray	3.3[1]	83[5]	3.47[7]	<1%[10]	0.2	NA	5.0[14]	3.70E+11	8.1 @ 1 MHz[16]	6E-02 @ 1 kHz[18]	24 months @ 25°C
DOWSIL™ TC-5351 Thermally Conductive Compound	Vertical holding capability	✓		✓			✓	Gray	3.3[1]	300[6]	3.12[7]	<400[9]	0.24	50	6.2[15]	3.10E+13	NA	NA	12 months @ 25°C
DOWSIL™ SC 4476 CV Thermally Conductive Compound							✓	Gray	3.1[1]	310[6]	3.04[7]	60[9]	NA	NA	25	1.50E+14	5.4[16]	1E-01 @ 50 Hz[18]	12 months @ 25°C
DOWSIL™ TC-5026 Thermally Conductive Compound			✓		✓			Gray	2.9[2]	102[5]	3.53[7]	0.05%[10]	0.032	7	8.9[14]	5.90E+11	7.4 @ 1 kHz[16]	3E-04 @ 1 kHz[18]	24 months @ 25°C
DOWSIL™ TC-5121 Thermally Conductive Compound			✓		✓			Gray	2.5[2]	86[5]	4.18[7]	0.07%[10]	0.096	20	1.89[14]	1.2 E+12	19.3 @ 1 kHz[17]	7E-02 @ 1 kHz[19]	24 months @ 25°C
DOWSIL™ SC 4471 CV					✓		✓	White	2.0[1]	116[6]	2.76[7]	0.11%[13]	NA	NA	NA	2.0 E+15	NA	NA	12 months @ 25°C
DOWSIL™ SE 4490 CV Thermally Conductive Compound						✓	✓	White	1.9[1]	520[6]	2.63[7]	253[9] 0.4%[11]	0.77	210	NA	2.0 E+14	4.8 @ 50 Hz[16]	1E-03 @ 50 Hz[18]	11 months @ 25°C
DOWSIL™ TC-5080 Thermal Grease	Stable high-temperature performance					✓		White	1.0[2]	836[6]	2.1[8]	0.14%[10]	0.325	20	8.7[14]	2.89E+15	NA	NA	12 months @ 25°C
DOWSIL™ SC 102 Compound						✓		White	0.8[1]	290[3]	2.45[7]	0.4%[11]	0.62	50	2.1[14]	2.0 E+16	4.0 @ 50 Hz[16]	2E-02 @ 50 Hz[18]	24 months @ 25°C

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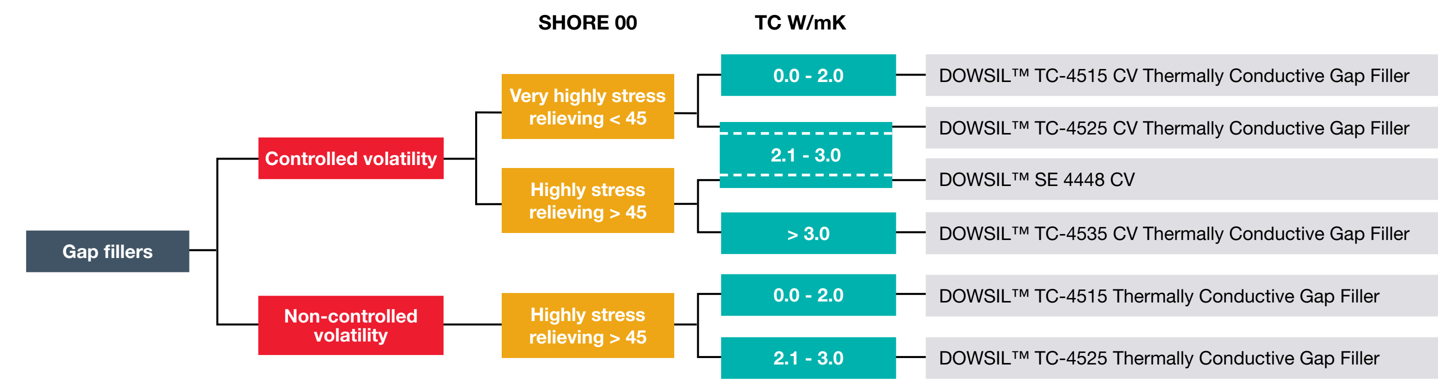
Choose your thermally conductive gap filler

DOWSIL™ thermally conductive silicone gap fillers are soft, compressible solutions specifically formulated to process easily from the original packaging with minimal to no additional process preparation. They avoid slumping on vertical surfaces during assembly and maintain their vertical stability after cure, even after long use. These highly advanced silicone formulations dissipate heat away from sensitive PCB components by efficiently conducting it to a heat sink. Able to withstand peak exposure at 200°C, these materials perform reliably at operating temperatures up to 150°C. Our gap fillers also offer effective vibration-damping.



Thermally conductive gap fillers

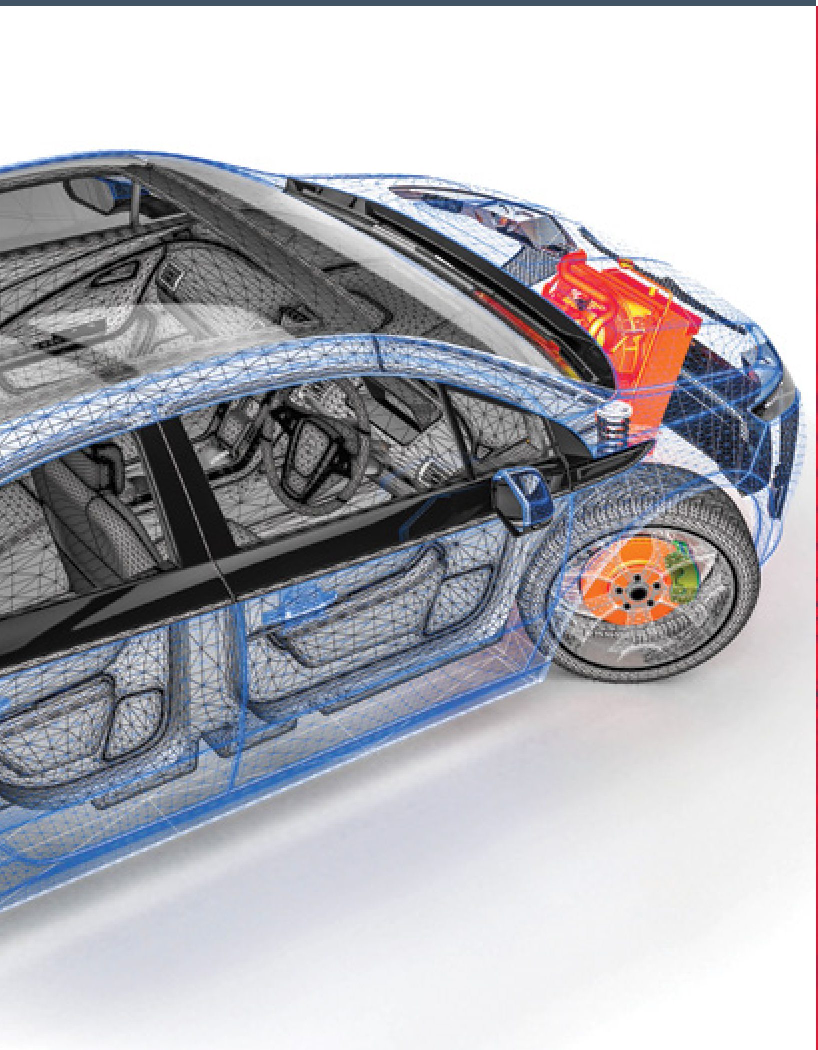
Decreasing thermal conductivity ↓

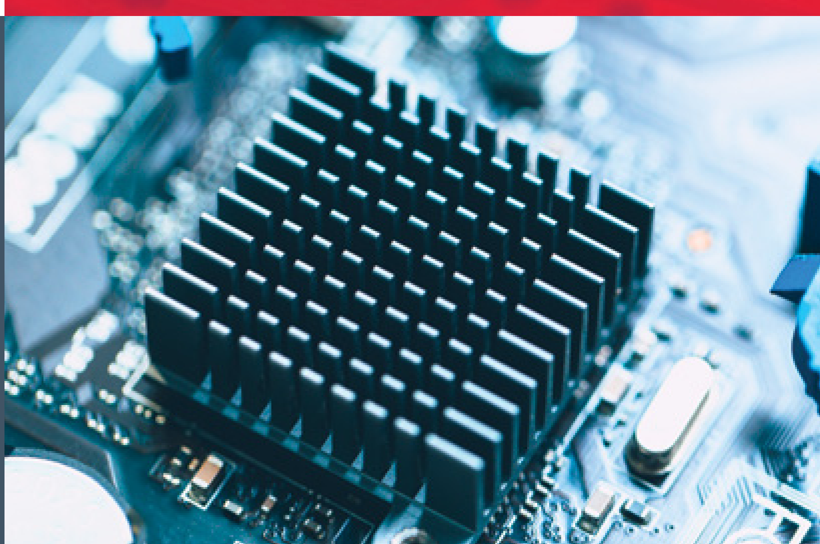
			Key features/advantages																			
	Cure type (chemistry)	Mix ratio	Room temperature cure	Glass bead option	Nonslump/nonflowable	Vertical holding capability	UL 94 V-0	Controlled volatility D4-D10	Long-term performance stability	Appearance	Thermal conductivity, W/mK	Viscosity, Pa s: @ $10\ s^{-1}$[3] @ 10rpm KK #6[4]	Thixotropic index (mixed)	Room temperature cure time	Heat cure time	Density @ 25°C, g/cm^3	Durometer, Shore OO	Low-molecular-weight siloxane content (D4-D10), ppm	Dielectric strength, kV/mm	Volume resistivity, Ω•cm	Dielectric constant @ 1 MHz	Shelf life
										CTM 0176/ ASTM E284	CTM 1163/ JIS R 2618-1992[1] CTM 1388/ ASTM D5334[2]	CTM 1094/ ASTM D4440[3] CTM 0050/ ASTM D1084[4]	CTM 1094/ ASTM D4440[5]	CTM 0099/ ASTM D2240[6] CTM 1098 / ASTM D4440[7]	CTM 0099/ ASTM D2240[8] CTM 1098 / ASTM D4440[9]	CTM 540/ ASTM D70[10] CTM 0097/ ASTM D1475[11] CTM 0022/ ASTM D792[12]	CTM 0099/ ASTM D2240	CTM 0839B	CTM 0114/ ASTM D149[13] JIS2 K 6249[14]	CTM 0249/ ASTM D257[15] JIS2 K 6249[16]	CTM 0112/ ASTM D150[17] JIS2 K 6249[18] CTM 1139/ ASTM D150[19]	
DOWSIL™ TC-4535 CV Thermally Conductive Gap Filler	Addition by hydrosilylation	Two-part 1:1	✓		✓	✓	Pending	✓	✓	Part A: White Part B: Blue Mixed: Blue	3.4[1]	Part A: 200[3] Part B: 230[3] Mixed: 205[3]	3.6[5]	120 min @ 25°C	10 min @ 80°C[9]	3.1[12]	52	8	22[14]	3.00 E+13[16]	6.5 E-3[18]	6 months @ 25°C (target 12 months)
DOWSIL™ TC-4525 Thermally Conductive Gap Filler	Addition by hydrosilylation	Two-part 1:1	✓	✓	✓	✓	✓		✓	Part A: White Part B: Blue Mixed: Blue	2.6[1]	Part A: 207[3] Part B: 193[3] Mixed: 217[3]	4.3[5]	120 min @ 25°C[7]	10 min @ 80°C[9]	2.9[12]	55	NA	18[13]	2.40E+14[16]	6.6[18]	12 months @ 25°C
DOWSIL™ TC-4525 CV Thermally Conductive Gap Filler	Addition by hydrosilylation	Two-part 1:1	✓		✓	✓	✓	✓	✓	Part A: White Part B: Blue Mixed: Blue	2.6[1]	Part A: 223[3] Part B: 216[3] Mixed: 217[3]	4.0[5]	120 min @ 25°C[7]	10 min @ 80°C[9]	2.9[12]	40	15	23[14]	2.60 E+14[16]	6.2[18]	12 months @ 25°C
DOWSIL™ SE 4448 CV	Addition by hydrosilylation	Two-part 1:1	✓	✓	✓			✓	✓	Part A: White Part B: Gray Mixed: Gray	2.2[1]	Part A: 52.8[4] Part B: 50.3[4] Mixed: 51.5[4]	Not measured	300 min @ 25°C[6]	30 min @ 120°C[8]	2.9[11]	59	300	11[14]	2.00 E+15[15]	5.9[19]	12 months @ 25°C
DOWSIL™ TC-4515 Thermally Conductive Gap Filler	Addition by hydrosilylation	Two-part 1:1	✓	✓	✓	✓	✓		✓	Part A: White Part B: Blue Mixed: Blue	>1.8[2]	Part A: 215[3] Part B: 227[3] Mixed: 240[3]	5.0[5]	150 min @ 25°C[6]	30 min @ 80°C[8]	2.7[10]	50	NA	16[13]	8.13 E+14[15]	4.27 @ 1 KHz[17]	9 months @ 25°C (target 12 months)
DOWSIL™ TC-4515 CV Thermally Conductive Gap Filler	Addition by hydrosilylation	Two-part 1:1	✓		✓	✓	Pending	✓	✓	Part A: White Part B: Blue Mixed: Blue	>1.8[1]	Part A: 155[3] Part B: 153[3] Mixed: 151[3]	5.6[5]	120 min @ 25°C[7]	10 min @ 80°C[9]	2.8[12]	44	8	19[14]	1.00 E+12[16]	5.4[18]	12 months @ 25°C

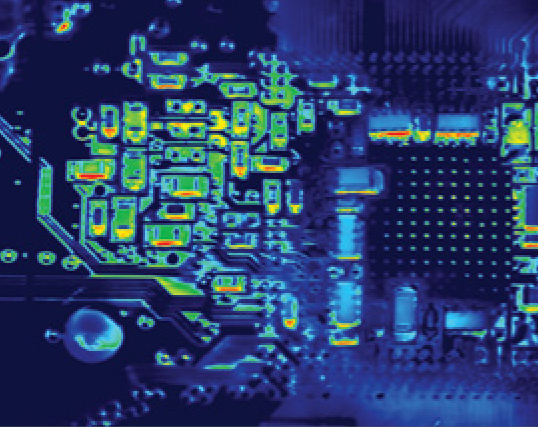
NA – test data not available.
Specification writers: These values are not intended for use in preparing specifications. Please contact your local Dow representative or sales office before writing specifications on these products.

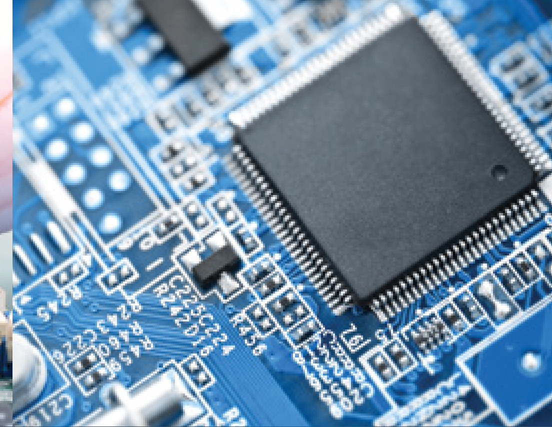
Corporate Test Methods and equivalents

Corporate Test Method (CTM)	CTM description	Reference/ equivalent standard method
CTM 0022	Specific gravity – wet/dry or Jolly balance technique: A solid sample is weighed in air and in water.	ASTM D792
CTM 0050	Viscosity by rotational viscometer such as a Brookfield Synchro-Lectric viscometer or a Wells-Brookfield cone/ plate viscometer. Since materials measured are non-Newtonian, no correlation should be expected between results obtained using different spindles (cones) or speeds.	ASTM D1084 (spindle) ASTM D4287 (cone/plate)
CTM 0095	The skin-over time, a measure of cure rate, is defined as the time in minutes required for a curing material to form a nontacky surface film. This method uses polyethylene film contact to determine the nontacky characteristic.	ASTM D2377
CTM 0097	Specific gravity of liquid or semiliquid materials by weighing the amount of material contained in a calibrated weighing cup. Specific gravity is the ratio of the mass of a given volume of material at a given temperature to the mass of an equal volume of water at a reference temperature.	ASTM D1475
CTM 0099	Durometer – a measure of hardness on the Shore A or OO scale.	ASTM D2240
CTM 0112 (CTM 1139)	Dielectric constant and dissipation factor for solid insulating materials at frequencies to 107 hertz by the air gap method. The dielectric constant and dissipation factor of solid materials at specified frequencies to 107 hertz are determined by the direct measurement of voltage and phase across a capacitor made from the material in an appropriate test fixture. The measurement is made using a digital impedance analyzer.	ASTM D150 ASTM D618
CTM 0114	Dielectric strength and dielectric breakdown voltage – solid and semisolid insulating materials in transformer oil.	ASTM D149
CTM 0137	Determination of tensile strength, elongation, set and modulus of elastomeric materials. Samples are pulled at a constant rate to the point of rupture and the appropriate values calculated.	ASTM D412 JIS K 6301
CTM 0155	Penetration – gel-like materials with modified penetrometer. This method is used to determine the firmness of soft gels. A lightweight blunt-head shaft is used. The results are not correlated with either quarter- or full-scale penetration results. The results are reported in tenths of a millimeter.	JIS K 2207 ASTM D217
CTM 0176	Appearance – visual examination covering a wide variety of physical characteristics. The characteristics of importance are specified. Any unusual appearance is noted. Material uniformity is the major factor.	ASTM E284
CTM 0243	Adhesion – lap shear.	ASTM D816
CTM 0249	Volume resistivity, surface resistivity and insulation resistance of solid insulating materials are measured using a commercial ohmmeter equipped with circular electrodes as described in ASTM D257.	ASTM D257
CTM 540	Specific gravity by water displacement. It is the ratio of the material mass to an equal volume of water at 25 ±0.2°C.	ASTM D70
CTM 0585	Linear thermal coefficient of expansion by TMA is determined over a specified temperature range between -100 to 500°C by positioning a dilatometer probe upon the solid.	ASTM E831
CTM 0663	Cure in depth determined by measuring how far below the surface a curing material has hardened in a specified time.	
CTM 0768	Density by measuring the period of vibration for a hollow oscillator when filled with different fluids at a constant temperature. The period is measured for fluids with known density at the operating temperature. Air and water are most commonly used as reference fluids.	ASTM D4052
CTM 839	Gas-liquid chromatographic method used for separation, detection and quantitation of specified components where the flame ionization detector provides the most suitable means of detection, and where it is either not desirable or not possible to determine all the components present. The quantitative measurement is based on rationing the adjusted peak area of the specified component to the adjusted peak area of the added internal standard. The results are reported as weight percent.	
(CTM 1094) CTM 1098	Rheological properties of viscoelastic materials are characterized using a dynamic mechanical spectrometer. Several modes of operation may be selected. Typically, an oscillating strain is imposed on the sample and the resulting stress measured over the sweep range. Values for the energy stored (elastic or storage modulus, G') and the energy lost (viscous or loss modulus, G") are obtained. Values for torque, complex viscosity, tangent delta and other attributes are measured or computed from G' and G" results.	ASTM D4440 ASTM D4065
CTM 1139 (CTM 112)	The dielectric constant using air as the comparative dielectric. The dielectric constant and dissipation factor of solid materials at specified frequencies to 107 hertz are determined by the direct measurement of voltage and phase across a capacitor made from the material in an appropriate test fixture. The measurement is made using a digital impedance analyzer.	ASTM D150 ASTM D618
CTM 1163	Thermal conductivity of any solid form in 60 seconds. Measure the amount of heat transferred through the material from a heated wire to a thermocouple.	JIS R 2618-1992
CTM 1388	Thermal conductivity of solids and viscous liquids using the ThermTest-TT-TK04 instrument. The equipment uses the transient line source (needle probe method) with an accuracy of ±2% and a measuring range of 0.1-10.0 W/mK.	ASTM D5334









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