Information About *Dow Corning*® Brand Thermally Conductive Materials

Thermally Conductive Materials

Long-term, reliable protection of sensitive circuits and components is important in many of today's delicate and demanding electronic applications. With the increase in processing power and the trend toward smaller, more compact electronic modules, the need for thermal management is growing. Dow Corning's family of thermally conductive materials provides excellent thermal management options. Thermally conductive silicones function as heat transfer media, durable dielectric insulation, barriers against environmental contaminants and as stress-relieving shock and vibration absorbers over a wide temperature and humidity range.

In addition to sustaining their physical and electrical properties over a broad range of operating conditions, silicones are resistant to ozone and ultraviolet degradation and have good chemical stability. Dow Corning's line of thermal management materials includes adhesives, encapsulants, compounds and gels.

Good heat transfer is dependent on a good interface between the heat producing device and the heat transfer media. Silicones have a low surface tension that enables them to wet most surfaces, which can lower the thermal contact resistance between the substrate and the material.

Thermally Conductive Adhesives

Type
Noncorrosive, one-part, moisture-cure RTV and one- or two-part heat-cure silicone elastomers

Physical Form
Nonflowing and flowable options; cure to flexible elastomers

Special Properties
Room-temperature or fast thermal cure; variety of thermal conductivities; resist humidity and other harsh environments; good dielectric properties; self-priming adhesion; low stress

Potential Uses
Heat sink or base plate attach; potting power supplies

Thermally Conductive Encapsulants

Type
Two-part silicone elastomers

Physical Form
Flowable liquid; cures to flexible elastomer

Special Properties
Constant cure rate, regardless of sectional thickness or degree of confinement; no post-cure required

Potential Uses
Potting of high-voltage transformers and sensors; assembly of substrates to heat sinks; gap fill material between heat sources and heat sinks

Thermally Conductive Compounds

Type
Non-curing; thermally conductive silicone pastes

Special Properties
High thermal conductivity; low bleed; high-temperature stability

Potential Uses
Gap fill materials between heat sources and heat sinks

Thermally Conductive Gels

Type
Two-part heat-cure gels

Physical Form
1:1 mix ratio; low viscosity

Special Properties
Heat accelerable; wide operating temperatures; cure to low-modulus materials

Potential Uses
Gap fill material; potting of electronic modules; base materials for thermally conductive gel sheet

Materials for Pad Manufacturing

Type
Two-part heat-cure materials

Special Properties
Soft, good thermal conductivity, low viscosity

Potential Uses
Base material for thermally conductive pads

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PRODUCT INFORMATION – THERMALLY CONDUCTIVE ADHESIVES

Dow Corning® Brand Product	Description	Features
Thermally Conductive Adhesives		
SE4420 Thermally Conductive Adhesive	One-part moisture cure	Flowable with moderate thermal conductivity; fast tack-free
SE4422 Thermally Conductive Adhesive	One-part moisture cure	High viscosity with moderate thermal conductivity; UL 94 V-1 rating; fast tack-free
SE4486 CV Thermally Conductive Adhesive	Flowable; one-part moisture cure	Flowable with good thermal conductivity and controlled volatility (D4-D10 < 0.002); fast tack-free
SE9184 CV Thermally Conductive Adhesive	One-part; non-flow; moisture cure	Moderate thermal conductivity; UL 94 V-0 rating; controlled volatility (D4-D10 0.003); fast tack-free
SE4400 Thermally Conductive Adhesive	Two-part; semi-flowable	Long pot life; rapid heat cure; self-priming
SE4402 CV Thermally Conductive Adhesive	One-part; gray; heat cure	Moderate thermal conductivity; controlled volatility
SE4450 Thermally Conductive Adhesive	One-part; gray; heat cure	High thermal conductivity
1-4173 Thermally Conductive Adhesive	One-part; low flow; gray	Rapid heat cure; high thermal conductivity
1-4174 Thermally Conductive Adhesive	One-part; low flow; gray	Rapid heat cure; high thermal conductivity; contains 7-mil (178-micron) glass beads for bond line control
Q1-9226 Thermally Conductive Adhesive	Two-part; semi-flowable	Long pot life; rapid heat cure; self-priming
3-1818 Thermally Conductive Adhesive	One-part; gray	Rapid heat cure and primerless adhesion to common substrates used in the electronics industry; contains 7-mil (178 micron) glass beads for bond line control
Q3-3600 Thermally Conductive Encapsulant	Two-part; gray; 1:1	Rapid heat cure; long pot life; excellent flow; self-priming; UL 94 V-1 rating
3-6605 Thermally Conductive Elastomer	Two-part; gray; 1:1; medium viscosity; heat cure	Good flowability
3-6751 Thermally Conductive Adhesive	Two-part; gray	Low modulus; low viscosity; heat curable; UL94 V-0 rating
3-6752 Thermally Conductive Adhesive	One-part; gray	Rapid heat cure and primerless adhesion to common substrates used in the electronics industry
3-6753 Thermally Conductive Adhesive	Two-part; gray; heat cure	Low modulus; low viscosity; contains 7-mil (178 micron) glass beads for bond line control

Dow Corning® Brand Product	Potential Uses	Application Methods
Thermally Conductive Adhesives		
SE4420 Thermally Conductive Adhesive	Adhesive for power supply components, ink jet printer heads; bonding ICs with heat sinks	Automated or manual dispensing
SE4422 Thermally Conductive Adhesive	Adhesive for power supply components, ink jet printer heads; bonding ICs with heat sinks; sealing gas hot water heater burners	Automated or manual dispensing
SE4486 CV Thermally Conductive Adhesive	Adhesive for power supply components, ink jet printer heads; bonding ICs with heat sinks	Automated or manual dispensing
SE9184 CV Thermally Conductive Adhesive	Bonding integrated circuit substrates; adhering lids and housings; heat sink attach	Automated or manual dispensing
SE4400 Thermally Conductive Adhesive	Bonding hybrids or microprocessors to heat sinks	Automated or manual dispensing
SE4402 CV Thermally Conductive Adhesive	Adhesive for power supply components, ink jet printer heads; bonding ICs with heat sinks	Automated or manual dispensing
SE4450 Thermally Conductive Adhesive	Adhesive for power supply components, ink jet printer heads; bonding ICs with heat sinks	Automated or manual dispensing
1-4173 Thermally Conductive Adhesive	Bonding integrated circuit substrates; adhering lids and housings; base plate attach; heat sink attach	Automated or manual dispensing
1-4174 Thermally Conductive Adhesive	Bonding integrated circuit substrates; adhering lids and housings; base plate attach; heat sink attach	Automated or manual dispensing
Q1-9226 Thermally Conductive Adhesive	Bonding hybrids or microprocessors to heat sinks	Automated or manual dispensing
3-1818 Thermally Conductive Adhesive	Bonding heat sinks to electronics devices; bonding printed circuit boards to substrates	Manual or automated dispensing
Q3-3600 Thermally Conductive Adhesive	Potting of high voltage transformers and sensors; assembly of hybrid substrates to heat sinks	Automated or manual dispensing
3-6605 Thermally Conductive Adhesive	Bonding integrated circuit substrates; adhering lids and housings; base plate attach; heat sink attach	Automated, two-part airless mix equipment; manual mixing and de-airing
3-6751 Thermally Conductive Adhesive	Bonding heat sinks to electronics devices; bonding printed circuit boards to substrates	Manual or automated meter-mix and dispensing
3-6752 Thermally Conductive Adhesive	Bonding hybrid circuit substrates, power semiconductor components and devices to heat sinks as well as for use in other bonding applications where flexibility and thermal conductivity are needed	Manual or automated dispensing
3-6753 Thermally Conductive Adhesive	Bonding heat sinks to electronic devices; bonding printed circuit boards to substrates	Manual or automated meter-mix and dispensing

PRODUCT INFORMATION – THERMALLY CONDUCTIVE MATERIALS

Dow Corning® Brand Product	Description	Features
Thermally Conductive Encapsulants		
SE4410 Thermally Conductive Encapsulant	Two-part; low viscosity	Heat cure; moderate thermal conductivity; UL 94 V-0 rating
SE4447 CV Thermally Conductive Encapsulant	Two-part; gray	Excellent thermal conductivity; low volatility; excellent high temperature stability and low temperature resistance
SE4448 CV Thermally Conductive Encapsulant	Two-part, thermally conductive elastomer	Excellent thermal conductivity; low volatility (D4-D10 0.03% wt); heat cure; high viscosity
Q3-3600 Thermally Conductive Encapsulant	Two-part; gray	Rapid heat cure; long pot life; excellent flow; self-priming; UL 94 V-1 rating
3-6651 Thermally Conductive Encapsulant	Two-part; gray	Low modulus; low viscoisty; good thermal conducitivity; UL 94 V-0 rating
3-6652 Thermally Conductive Encapsulant	Two-part; gray	Low modulus; thixotropic; good thermal conductivity
3-6655 Thermally Conductive Encapsulant	Two-part; gray	Low viscosity; soft; excellent thermal conductivity; UL 94 V-0
Thermally Conductive Compounds		
SC102 Thermally Conductive Compound	Non-curing, thermally conductive silicone paste	Moderate thermal conductivity; low bleed; stable at high temperatures
340 Heat Sink Compound	Non-curing, thermally conductive silicone paste	Low bleed; stable at high temperatures
SE4490CV Thermally Conductive Compound	Non-curing, thermally conductive silicone paste	High thermal conductivity; low bleed; stable at high temperatures; low volatility; low thermal-cycle-induced pump-out
TC-5021 Thermally Conductive Compound	Non-curing, thermally conductive silicone paste	Low thermal resistance; high thermal conductivity
TC-5022 Thermally Conductive Compound	Non-curing, thermally conductive silicone paste	Low thermal resistance; high thermal conductivity
Thermally Conductive Gels		
SE4440-LP Thermally Conductive Gel	Two-part; thermally conductive gel	Heat cure; low viscosity
SE4445CV Thermally Conductive Gel	Two-part; thermally conductive gel	Heat cure; moderate viscosity; UL 94 V-0 rating; controlled volatility (D4-D10 0.09)
SE4446CV Thermally Conductive Gel	Two-part; thermally conductive gel	Heat cure; moderate viscosity; controlled volatility (D4-D10 0.04)
Thermally Conductive Materials for Pad Manufacturing		
SE4430	Two-part; thermally conductive elastomer	Soft; good thermal conducitvity; low viscosity

Dow Corning® Brand Product	Potential Uses	Application Methods
Thermally Conductive Encapsulants		
SE4410 Thermally Conductive Encapsulant	Adhesive for power supply components, ink jet printer heads; bonding ICs with heat sinks	Automated or manual dispensing
SE4447 CV Thermally Conductive Encapsulant	Cured-in-place gap filling between heat-generating electronic components and the case or heat sink	Automated meter-mix
SE4448 CV Thermally Conductive Encapsulant	Excellent cured-in-place gap filling between heat-generating electronic components and the case or heat sink	Automated meter-mix
Q3-3600 Thermally Conductive Encapsulant	Potting of high voltage transformers and sensors; assembly of hybrid substrates to heat sinks	Automated or manual dispensing
3-6651 Thermally Conductive Encapsulant	Potting or encapsulating power supplies, power convertors and similar electronic applications where heat dissipation is critical	Manual or automated meter-mix
3-6652 Thermally Conductive Encapsulant	Gap filler where a soft, thermally conductive material is required; thixotropic property allows the user to dispense onto specific components without flow onto other components	Manual or automated meter-mix
3-6655 Thermally Conductive Encapsulant	Potting or encapsulating power supplies, power convertors and similar electronic applications where heat dissipation is critical	Manual or automated meter-mix
Thermally Conductive Compounds		
SC102 Thermally Conductive Compound	Gap fill material between electronic heat sources and heat sinks	Automated or manual dispensing
340 Heat Sink Compound	Thermal coupling of electrical/electronic devices to heat sinks	Automated or manual dispensing
SE4490CV Thermally Conductive Compound	Gap fill material between electronic heat sources and heat sinks	Automated or manual dispensing
TC-5021 Thermally Conductive Compound	Thermal interface for CPUs, etc.	Screen print, stencil print or dispense
TC-5022 Thermally Conductive Compound	Thermal interface for CPUs, etc.	Screen print, stencil print or dispense
Thermally Conductive Gels		
SE4440-LP Thermally Conductive Gel	Gap fill or potting material between electronic heat sources and heat sinks	Automated or manual dispensing
SE4445CV Thermally Conductive Gel	Gap fill or potting material between electronic heat sources and heat sinks	Automated or manual dispensing
SE4446CV Thermally Conductive Gel	Gap fill or potting material between electronic heat sources and heat sinks	Automated or manual dispensing
Thermally Conductive Materials for Pad Manufacturing		
SE4430	Base material for thermally conductive pads	Manual or automated meter-mix

TYPICAL PROPERTIES – THERMALLY CONDUCTIVE ADHESIVES

Specification Writers: Please contact your local Dow Corning sales office or your Global Dow Corning Connection before writing specifications on these products.

Dow Corning® Brand Product	Product Form	Color	Viscosity/Flowability, centipoise or mPa*s	Durometer (Shore scale)	Specific Gravity	Working Time[1] at RT	Cure Time at RT, hr	Heat Cure Time[2], minutes			Unprimed Adhesion, Lap Shear		
								at 100°C (212°F)	at 125°C (257°F)	at 150°C (302°F)	psi	N/cm²	kgf/cm²
Thermally Conductive Adhesives													
SE4420 Thermally Conductive Adhesive	One-Part	White	108,000	74 A	2.26	<10 min	200[3]	NA	NA	NA	500	345	35
SE4422 Thermally Conductive Adhesive	One-Part	Gray	200,000	69 A	2.17	<10 min	144[3]	NA	NA	NA	230	160	16
SE4486 CV Thermally Conductive Adhesive	One-Part	White	19,000	78 A	2.59	<4 min	120[3]	NA	NA	NA	200	140	14
SE9184 CV Thermally Conductive Adhesive	One-Part	White	Nonflow	72 A	2.22	NA	48[3]	NA	NA	NA	300	205	21
SE4400 Thermally Conductive Adhesive	Two-Part	Gray	76,000	78 A	2.15	17 hr	–	–	–	30	439	303	30.9
SE4402 CV Thermally Conductive Adhesive	One-Part	Gray	34,000	74 A	2.16	NA	–	–	–	30	485	335	34
SE4450 Thermally Conductive Adhesive	One-Part	Gray	61,000	95 A	2.74	NA	–	–	–	30	530	365	37
1-4173 Thermally Conductive Adhesive	One-Part	Gray	58,000	92 A	2.7	NA	–	90	30	20	640	440	45
1-4174 Thermally Conductive Adhesive	One-Part	Gray	58,000	92 A	2.71	NA	–	90	30	20	590	405	41
Q1-9226 Thermally Conductive Adhesive	Two-Part	Gray	50,000	66 A	2.13	16 hr	–	60	–	30	–	–	–
3-1818 Thermally Conductive Adhesive	One-Part	Gray	68,700	88 A	2.6	NA	–	60	45	10	510	352	35.9
Q3-3600 Thermally Conductive Encapsulant	Two-Part	Gray	4,700	87 A	2.13	24 hr	–	60	–	30	–	–	–
3-6605 Thermally Conductive Elastomer	Two-Part	Gray	47,000	78 A	2.14	>24 hr	–	90	45	<15	350	241	24.6
3-6751 Thermally Conductive Adhesive	Two-Part	Gray	10,000	67 A	2.3	2 hr	NA[4]	50	40	10	555	383	39.0
3-6752 Thermally Conductive Adhesive	One-Part	Gray	81,000	87 A	2.6	NA	NA	40	10	3	540	372	37.9
3-6753 Thermally Conductive Adhesive	Two-Part	Gray	11,000	72 A	2.3	2 hr	NA[4]	50	40	10	540	372	37.9

[1] Time to double initial mixed viscosity.

[2] Time to 90 percent of final hardness and adhesion or 90 percent of curve height for elastic modulus; additional time may be required for the part to warm to near oven temperature.

[3] Cure time for 3 mm thickness at 20°C (68°F) and 55 percent relative humidity.

[4] Material will cure after 24+ hours at room temperature, but requires heat cure for chemical bonding adhesion.

Dow Corning® Brand Product	Thermal Conductivity at 25°C (77°F), Watt/meter-K	Tensile Strength			Elongation,%	Compression Modulus at 10%, psi	Linear CTE, micron/mC	Dielectric Strength		Dielectric Constant at 100 Hz	Dielectric Constant at 100 kHz	Dielectric Constant at 1 MHz	Dissipation Factor at 100 Hz	Dissipation Factor at 100 kHz	Dissipation Factor at 1 MHz	Volume Resistivity, ohm-cm	Shelf Life from Date of Manufacture, months
		psi	MPa	kgf/cm²				volts/mil	kV/mm								
Thermally Conductive Adhesives																	
SE4420 Thermally Conductive Adhesive	0.9	725	5	50.9	90	–	162	370	14.6	3.96	3.87	4.8	0.00525	0.00153	0.002	1.00E+15	12
SE4422 Thermally Conductive Adhesive	0.9	754	5.2	53	120	–	203	365	14.3	4.44	4.38	4.9	0.00498	0.00498	0.006	5.00E+15	9
SE4486 CV Thermally Conductive Adhesive	1.53	551	3.8	38.7	50	–	124	329	13	4.16	4.12	4.8	0.00807	0.00325	0.003	2.00E+14	12
SE9184 CV Thermally Conductive Adhesive	0.84	421	2.9	29.6	70	–	–	508	20	–	–	3.9	–	–	0.002	1.00E+15	7
SE4400 Thermally Conductive Adhesive	0.92	841	5.8	59.1	90	–	–	635	25	–	–	4.2	–	–	0.002	1.00E+15	7
SE4402 CV Thermally Conductive Adhesive	0.92	885	6.1	62.2	120	–	–	660	26	–	–	4.8	–	–	0.002	3.00E+15	6 @ 10°C
SE4450 Thermally Conductive Adhesive	1.97	1,044	7.2	73.4	40	–	–	610	24	–	–	4.7	–	–	0.002	2.00E+15	6
1-4173 Thermally Conductive Adhesive	1.9	900	6.2	63.3	20	–	126	425	16.7	4.98	4.86	–	0.008	<0.003	–	2.20E+14	6 @ 5°C
1-4174 Thermally Conductive Adhesive	1.9	900	6.2	63.3	22	–	–	425	16.7	–	4.63	–	–	0.0021	–	1.90E+14	6 @ 5°C
Q1-9226 Thermally Conductive Adhesive	0.74	508	3.5	35.7	110	–	–	635	25	–	4.5	–	–	0.0013	–	1.90E+14	12
3-1818 Thermally Conductive Adhesive	1.8	625	4.3	43.9	20	–	137	395	15.6	5.6	5.5	–	0.0059	<0.0002	–	6.85E+13	6
Q3-3600 Thermally Conductive Encapsulant	0.77	957	6.6	67.3	55	–	–	660	26	–	–	–	–	–	–	1.00E+13	12
3-6605 Thermally Conductive Elastomer	0.85	850	5.9	59.8	90	–	225	455	17.9	4.51	4.5	–	0.0058	<0.001	–	1.00E+14	12
3-6751 Thermally Conductive Adhesive	1.1	400	2.76	28.1	35	125	179	454	17.9	4.7	4.7	–	0.0045	0.00013	–	7.20E+13	12
3-6752 Thermally Conductive Adhesive	1.8	545	3.76	38.3	15	–	138	400	15.7	5.6	5.5	–	0.007	<0.0001	–	7.10E+13	6
3-6753 Thermally Conductive Adhesive	1.4	400	2.76	28.1	35	125	179	454	17.9	4.7	4.7	–	0.0045	0.00013	–	7.2E+13	12

TYPICAL PROPERTIES – THERMALLY CONDUCTIVE MATERIALS

Specification Writers: Please contact your local Dow Corning sales office or your Global Dow Corning Connection before writing specifications on these products.

Dow Corning® Brand Product	Product Form	Color	Viscosity/Flowability, centipoise or mPa*s	Durometer (Shore scale)	Penetration (1/10 of mm)	Specific Gravity	Working Time[1] at RT	Cure Time at RT, hr	Heat Cure Time[2], minutes			Unprimed Adhesion, Lap Shear			Thermal Conductivity at 25°C (77°F), Watt/meter-K
									at 100°C (212°F)	at 125°C (257°F)	at 150°C (302°F)	psi	N/cm²	kgf/cm²	
Thermally Conductive Encapsulants															
SE4410 Thermally Conductive Encapsulant	Two-Part	Gray	3,500	87 A	NA	2.14	24 hr	–	–	–	30	370	255	26	0.92
SE4447 CV Thermally Conductive Encapsulant	Two-Part	Gray	140,000	86 OO	39	3.01	–	4	5.5	4.9	3.7	NA	NA	NA	2.5
SE4448 CV Thermally Conductive Encapsulant	Two-Part	Gray	102,000	59 OO	36	2.86	3.5 hr	5	–	30 min @ 120°C	–	NA	NA	NA	2.2
Q3-3600 Thermally Conductive Encapsulant	Two-Part	Gray	4,700	87 A	NA	2.13	24 hr	–	60	–	30	NA	NA	NA	0.77
3-6651 Thermally Conductive Encapsulant	Two-Part	Gray	32,000	53 OO	NA	2.4	20 min	5	3.3	2.1	1.6	NA	NA	NA	1.1
3-6652 Thermally Conductive Encapsulant	Two-Part	Gray	34,000	71 OO	NA	2.7	>6 hr	7	5.0	3.1	2.4	NA	NA	NA	1.9
3-6655 Thermally Conductive Encapsulant	Two-Part	Gray	33,000	71 OO	NA	2.7	1 hr	17	7.7	6.0	3.6	NA	NA	NA	1.8
Thermally Conductive Compounds															
SC102 Thermally Conductive Compound	One-Part	White	Nonflowing	NA	NA	2.37	NA	NA	NA	NA	NA	NA	NA	NA	0.8
340 Heat Sink Compound	One-Part	White	Nonflowing	NA	NA	2.1	NA	NA	NA	NA	NA	NA	NA	NA	0.59
SE4490CV Thermally Conductive Compound	One-Part	White	500,000	NA	NA	2.62	NA	NA	NA	NA	NA	NA	NA	NA	1.7
TC-5021 Thermally Conductive Compound	One-Part	Gray	102,000	NA	NA	3.5	NA	NA	NA	NA	NA	NA	NA	NA	3.3
TC-5022 Thermally Conductive Compound	One-Part	Gray	91,000[3]	NA	NA	3.23	NA	NA	NA	NA	NA	NA	NA	NA	4.0
Thermally Conductive Gels															
SE4440-LP Thermally Conductive Gel	Two-Part	Gray	3,600	NA	58	2.01	24 hr	–	–	30 min @ 120°C	–	NA	NA	NA	0.83
SE4445CV Thermally Conductive Gel	Two-Part	Gray	14,000	NA	57	2.36	5 hr	–	–	45	–	NA	NA	NA	1.26
SE4446CV Thermally Conductive Gel	Two-Part	Gray	22,000	NA	55	2.14	4 hr	–	–	30 min @ 120°C	–	NA	NA	NA	1.26
Thermally Conductive Materials for Pad Manufacturing															
SE4430	Two-Part	Gray	5,600	70 OO	35	2.2	4 hr	7	3.5	2.5	1.9	NA	NA	NA	0.95

[1] Time to double initial mixed viscosity.

[2] Time to 90 percent of final hardness and adhesion or 90 percent of curve height for elastic modulus; additional time may be required for the part to warm to near oven temperature.

[3] Measurement after dilution with 1 wt % *Dow Corning*® OS-30 Fluid.

Dow Corning® Brand Product	Tensile Strength			Elongation, %	Compression Modulus at 10%, psi	Linear CTE, micron/mC	Dielectric Strength		Dielectric Constant at 100 Hz	Dielectric Constant at 100 kHz	Dielectric Constant at 1 MHz	Dissipation Factor at 100 Hz	Dissipation Factor at 100 kHz	Dissipation Factor at 1 MHz	Volume Resistivity, ohm-cm	Shelf Life from Date of Manufacture, months
	psi	MPa	kgf/cm²				volts/mil	kV/mm								
Thermally Conductive Encapsulants																
SE4410 Thermally Conductive Encapsulant	972	6.7	68.3	60	–	–	660	26	–	–	4.4	–	–	0.002	1.00E+15	12
SE4447 CV Thermally Conductive Encapsulant	20	0.14	1.4	20	7	72	270	10.6	6.6	6.5	–	0.002	<0.0001	–	8.2E+14	6
SE4448 CV Thermally Conductive Encapsulant	–	–	–	–	–	–	279	11	–	–	5.9	–	–	0.0006	2.0E+15	6
Q3-3600 Thermally Conductive Encapsulant	957	6.6	67.3	55	–	–	660	26	–	–	–	–	–	–	1.00E+13	12
3-6651 Thermally Conductive Encapsulant	85	0.59	6	180	3	180	335	13.2	4.1	4.1	–	0.003	<0.0001	–	8.80E+14	12
3-6652 Thermally Conductive Encapsulant	45	0.31	3.2	70	10	137	405	15.9	5.7	5.7	–	0.001	<0.0003	–	2.30E+13	12
3-6655 Thermally Conductive Encapsulant	45	0.31	3.2	90	6.5	145	345	13.6	5.2	5.2	–	0.001	<0.0001	–	1.10E+15	12
Thermally Conductive Compounds																
SC102 Thermally Conductive Compound	NA	NA	NA	NA	–	–	210	21.7	–	–	4.4	–	–	0.02	5.00E+15	24
340 Heat Sink Compound	NA	NA	NA	NA	–	–	210	8.3	5	5	–	0.001	0.02	–	2.00E+15	60
SE4490CV Thermally Conductive Compound	NA	NA	NA	NA	–	–	100	35	–	–	–	–	–	–	2.00E+14	11
TC-5021 Thermally Conductive Compound	NA	NA	NA	NA	–	–	128	5	–	–	–	–	–	–	3.7E+11	24
TC-5022 Thermally Conductive Compound	NA	NA	NA	NA	–	–	115	4.5	–	18 @ 1 kHz	–	0.128 @ 1 kHz	–	–	5.5E+10	24
Thermally Conductive Gels																
SE4440-LP Thermally Conductive Gel	NA	NA	NA	NA	–	–	330	13	–	–	4.0	–	–	0.001	1.00E+15	12
SE4445CV Thermally Conductive Gel	NA	NA	NA	NA	–	–	127	5	–	–	6.2	–	–	0.009	7.00E+15	6
SE4446CV Thermally Conductive Gel	NA	NA	NA	NA	–	–	150	6	–	–	6.0	–	–	0.01	3.00E+16	6
Thermally Conductive Materials for Pad Manufacturing																
SE4430	60	0.4	4.2	400	–	174	455	17.9	4.6	4.6	–	0.002	0.00015	–	1.90E+14	8

THERMALLY CONDUCTIVE ADHESIVES

Dow Corning offers a variety of noncorrosive, thermally conductive silicone adhesives that are ideally suited for use in bonding hybrid circuit substrates, power semiconductor components and devices to heat sinks as well as for use in other bonding applications where flexibility and thermal conductivity are major concerns. The flowable versions are also ideal for use as thermally conductive potting materials for transformers, power supplies, coils and other electronic devices that require improved thermal dissipation.

The thermally conductive adhesives cure either with moisture or heat to produce durable, relatively low-stress elastomers. The one-part RTV-cure materials have a noncorrosive by-product and are available in a variety of viscosities. RTV-cure thermally conductive adhesives with controlled volatility and UL listings are available.

The heat-cure, thermally conductive adhesives produce no by-products in the cure process, allowing their use in deep section and complete confinement. These adhesives will develop good, primerless adhesion to a variety of common substrates including metals, ceramics, epoxy laminate boards, reactive materials and filled plastics. Controlled volatility adhesives and UL-rated adhesives are available.

THERMALLY CONDUCTIVE ENCAPSULANTS

Dow Corning thermally conductive silicone encapsulants are supplied as two-part liquid component kits. When the liquid components are thoroughly mixed, the mixture cures to a flexible elastomer, suitable for the protection of electrical/electronic applications where heat dissipation is critical. These elastomers cure without exotherm at a constant rate regardless of sectional thickness or degree of confinement. *Dow Corning* thermally conductive elastomers require no post-cure and can be placed in service immediately at operating temperatures of -45 to 200°C (-49 to 392°F) following the completion of the cure schedule.

THERMALLY CONDUCTIVE COMPOUNDS

Dow Corning thermally conductive compounds are grease-like silicone materials, heavily filled with heat-conductive metal oxides. This combination promotes high thermal conductivity, low bleed and high-temperature stability. The compounds resist changes in consistency at temperatures up to 177°C (350°F), maintaining a positive heat sink seal to improve heat transfer from the electrical/electronic device to the heat sink or chassis, thereby increasing the overall efficiency of the device. Refer to Table I for specific test results.

THERMALLY CONDUCTIVE GELS

Dow Corning silicone gels are soft and cure to form a cushioning, low-modulus, resilient, gelled material. Cured gels retain much of the stress relief capability while developing the dimensional stability of an elastomer.

Dow Corning offers a line of thermally conductive gels that couple the stress-relieving capability of a silicone gel with the ability to dissipate heat from devices. These thermally conductive gels can be used as potting materials for transformers, power supplies, coils, relays and other electronic devices that require a low-modulus material for thermal dissipation. They can also be used as ingredients in formulations for thermally conductive gel sheets.

These silicone gels cure without exotherm at a constant rate regardless of sectional thickness or degree of confinement. Dow Corning features thermally conductive gels that have controlled volatility, including one UL 94 V-0 approved product.

Specific versions of thermally conductive gels contain glass beads designed to guarantee a minimum bond line, ensuring a reliable electrical insulation. Those materials find their use as liquid gap fillers and can favorably replace thermal pads.

Table I. Thermally Conductive Compound Properties

Dow Corning Product	Test	Test Method	Result
SC102 Thermally Conductive Compound	Oil Separation	JIS K 2220	0.02%
	Consistency	JIS K2220 10/mm	308
	Volatile Content	24 hr/120°C	0.40%
340 Heat Sink Compound	Bleed after 24 hr/200°C	Fed Std 791 Method 321.2	0.05%
	Consistency	ASTM D 217	300
	Evaporation after 24 hr/200°C	Fed Std 791 Method 321.2	0.50%
SE4490CV Thermally Conductive Compound	Oil Separation	JIS K 2220	0.00%
	Consistency	JIS K2220 10/mm	250
	Volatile Content	24 hr/120°C	0.40%
TC-5021 Thermally Conductive Compound	Volatile Content	24 hr/150°C	<1%
	Bleed	24 hr/150°C	0.15%
TC-5022 Thermally Conductive Compound	Volatile Content	24 hr/150°C	<0.05%
	Thermal Resistance	0.02-mm Bond Line, 40 psi	0.06°C·cm^2/W

THERMALLY CONDUCTIVE MATERIALS FOR PAD MANUFACTURING

Dow Corning thermally conductive materials for pad manufacturing are soft, two-part, thermally conductive elastomers. These low-viscosity materials feature good thermal conductivity, making them suitable as base material for thermally conductive pads.

FAST FORMULATION

In addition to existing products, Dow Corning provides a ***Fast Formulation*** service in which minor product modifications to color, rheology, hardness, cure rate, etc., can be quickly formulated to meet your *exact* needs. Contact Dow Corning or vist the Electronics Services section of the Dow Corning Electronics Solutions website (www.dowcorning.com/electronics) to learn more about this capability.

Using *Dow Corning* Thermally Conductive Materials

PREPARING SURFACES

All surfaces should be thoroughly cleaned and/or degreased with solvents such as *Dow Corning*® brand OS Fluids, naphtha, mineral spirits, or methyl ethyl ketone (MEK). Light surface abrasion is recommended whenever possible, because it promotes good cleaning and increases the surface area for bonding. A final surface wipe with acetone or IPA is also useful to remove residues that may be left behind by other cleaning methods. On some surfaces, different cleaning techniques will give better results than others. Users should determine the best techniques for their applications.

SUBSTRATE TESTING FOR CURE AND ADHESION COMPATIBILITY

Due to the wide variety of substrate types and differences in substrate surface conditions, general statements on adhesion and bond strength are impossible. To ensure maximum bond strength for elastomers and adhesives on a particular substrate, 100 percent cohesive failure of the adhesive in a lap shear or similar adhesive strength is needed. This ensures compatibility of the adhesive with the substrate being considered. Also, this test can be used to determine minimum cure time or to detect the presence of surface contaminants such as mold release agents, oils, greases and oxide films.

MIXING AND DE-AIRING (TWO-PART MATERIALS ONLY)

Upon standing, some filler may settle to the bottom of the liquid after several weeks. To ensure a uniform product mix, the material in each container should be thoroughly mixed prior to use.

Two-part materials should be mixed in the proper ratio either by weight or volume. The presence of light-colored streaks or marbling indicates inadequate mixing.

Automated airless dispense equipment can be used to reduce or avoid the need to de-air. If de-airing is required to reduce voids in the cured elastomer, consider a vacuum de-air schedule of >28 inches Hg (or a residual pressure of 10-20 mm of Hg) for 10 minutes or until bubbling subsides.

POT LIFE/WORKING TIME (TWO-PART MATERIALS ONLY)

Cure reaction begins with the mixing process. Initially, cure is evidenced by a gradual increase in viscosity, followed by gelation and conversion to its final state. Pot life is defined as the time required for viscosity to double after Parts A and B (base and curing agent) are mixed. Please refer to individual data for each material.

CURE CONDITIONS

The one-part moisture-cure adhesives are generally cured at room temperature and in a range of 20 to 80 percent relative humidity. Greater than 90 percent of their full physical properties should be attained within 24 to 72 hours depending on the product chosen. These materials are not typically used for highly confined or deep section cures. Materials will generally cure about 0.25 inch (6.35 mm) per 7 days.

Addition-cure adhesives should be cured at 100ºC (212ºF) or above. The cure rate is rapidly accelerated with heat (see heat-cure times in Typical Properties table). Thin sections of less than 2 mils may be cured in 15 minutes at 150ºC (302ºF). For thicker sections, a pre-cure at 70ºC (158ºF) may be necessary to reduce voids in the elastomer. Length of pre-cure will depend on section thickness and confinement of adhesive. It is recommended that 30 minutes at 70ºC (158ºF) be used as a starting point for determining necessary pre-cure time. Addition-curing materials contain all the ingredients needed for cure with no by-products from the cure mechanism. Deep-section or confined cures are possible. Cure progresses evenly throughout the material. These adhesives generally have long working times.

REPAIRING

In the manufacture of electrical/electronic devices it is often desirable to salvage or reclaim damaged or defective units. With most non-silicone rigid potting/encapsulating materials, removal or entry is difficult or impossible without causing excessive damage to internal circuitry. Silicones from Dow Corning can be selectively removed with relative ease, any repairs or changes accomplished, and the repaired area repotted in place with additional product.

To remove silicones, simply cut with a sharp blade or knife and tear and remove unwanted material from the area to be repaired. Sections of the adhered material are best removed from substrates and circuitry by mechanical action such as scraping or rubbing and can be assisted by applying *Dow Corning* OS Fluids.

PRIMER SELECTION GUIDE

Specification Writers: Please contact your local Dow Corning sales office or your Global Dow Corning Connection before writing specifications on these products.

Dow Corning® brand Primer or Adhesion Promoter	Flash Point, °C (°F)	Volatile Organic Content (VOC)[4], grams/liter	Special Properties	For Use On	For Use With
P5200 Clear[1]	31 (87)	77/522		Most metals, glass, ceramics and some plastics	Pigmented two-part addition cure
1200 Clear	13 (55)	723			
1200 Red	13 (55)	723	Colored for easier identification		
P5200 Red[2]	31 (87)	77/521			
1204	8 (46)	753		Most metals, glass and ceramics	All one-part alcohol cure
P5204[3]	14 (57)	205/591			
1205	13 (55)	862	Film-forming	Most plastics	All
3-6060	15 (59)	784	Improves inhibition resistance	Most plastics and metals	All two-part addition cure
92-023	-13 (9)	681		Most metals, glass and ceramics	
Sylgard® Prime Coat	-13 (9)	688			

[1]P5200 Clear is a low-VOC alternative to 1200 Clear.
[2]P5200 Red is a low-VOC alternative to 1200 Red.
[3]P5204 is a low-VOC alternative to 1204.
[4]The lower VOC value is for states and air quality management districts that have recognized volatile methylsiloxanes as VOC exempt.

A gel can simply be poured into the cleaned repaired area and cured. When repairing an area using an encapsulant, roughen the exposed surfaces of the cured encapsulant with an abrasive paper and rinse with a suitable solvent. This will enhance adhesion and permit the repaired material to become an integral matrix with the existing encapsulant. Silicone prime coats are not recommended for adhering products to themselves.

ADHESION

Dow Corning silicone adhesives are specially formulated to provide unprimed adhesion to many reactive metals, ceramics and glass, as well as to selected laminates, resins and plastics. However, good adhesion cannot be expected on non-reactive metal substrates or non-reactive plastic surfaces such as *Teflon*®, polyethylene or polypropylene. Special surface treatments such as chemical etching or plasma treatment can sometimes provide a reactive surface and promote adhesion to these types of substrates.

Dow Corning® brand primers can be used to increase the chemical activity on difficult substrates. For best results, the primer should be applied in a very thin, uniform coating and then wiped off after application. After application, primers should be thoroughly air dried prior to application of the silicone elastomer. Additional instructions for primer usage can be found in the Dow Corning literature, "*Dow Corning*® brand Primers, Prime Coats and Adhesion Promoters" (Form 10-909) and in the information sheets specific to the individual primers. Alternatively, use a low-viscosity primerless adhesive to pot your components.

Poor adhesion can be experienced on plastic or rubber substrates that are highly plasticized, since the mobile plasticizers act as release agents. Small-scale laboratory evaluation of all substrates is recommended before production trials are made.

In general, increasing the cure temperature and/or cure time will improve the ultimate adhesion.

COMPATIBILITY

Certain materials, chemicals, curing agents and plasticizers can inhibit the cure of addition-cure materials. Most notable of these include:

- Organotin and other organometallic compounds
- Silicone rubber containing organotin catalyst
- Sulfur, polysulfones or other sulfur-containing materials
- Amines, urethanes or amine-containing materials
- Unsaturated hydrocarbon plasticizers
- Some solder flux residues

If a substrate or material is questionable with respect to potentially causing inhibition of cure, it is recommended that a small-scale compatibility test be run to ascertain suitability in a given application. The presence of liquid or uncured product at the interface between the questionable substrate and the cured gel indicates incompatibility and inhibition of cure.

SOLVENT EXPOSURE
Although highly filled silicones such as those discussed in this data sheet are generally more resistant to solvent or fuel exposure, standard silicones are intended only to survive splash or intermittent exposures. Testing should be done to confirm performance of the adhesives in the application and under the specified environmental conditions.

OPERATING TEMPERATURE RANGES
For most uses, silicone elastomers and adhesives should be operational over a temperature range of -45 to 200ºC (-49 to 392ºF) for long periods of time. Silicone gels should be operational over a temperature range of -45 to 150ºC (-49 to 302ºF). However, at both the low and high temperature ends of the spectrum, behavior of the materials and performance in particular applications can become more complex and require additional considerations.

For low-temperature performance, thermal cycling to conditions such as -55ºC (-67ºF) may be possible for most products, but performance should be verified for your parts or assemblies. Factors that may influence performance are configuration and stress sensitivity of components, cooling rates and hold times, and prior temperature history.

At the high-temperature end, the durability of the cured silicones is time and temperature dependent. As expected, the higher the temperature, the shorter the time the material will remain useable.

STORAGE AND SHELF LIFE
Shelf life is indicated by the "Use By" date found on the product label.

For best results, Dow Corning thermally conductive materials should be stored at or below the maximum specified storage temperature. Special precautions must be taken to prevent moisture from contacting these materials. Containers should be kept tightly closed and head or air space minimized. Partially filled containers should be purged with dry air or other gases, such as nitrogen.

Any special storage and handling instructions will be printed on the product containers.

LIMITATIONS
These products are neither tested nor represented as suitable for medical or pharmaceutical uses.

SAFE HANDLING INFORMATION
PRODUCT SAFETY INFORMATION REQUIRED FOR SAFE USE IS NOT INCLUDED IN THIS DOCUMENT. BEFORE HANDLING, READ PRODUCT AND MATERIAL SAFETY DATA SHEETS AND CONTAINER LABELS FOR SAFE USE, PHYSICAL AND HEALTH HAZARD INFORMATION. THE MATERIAL SAFETY DATA SHEET IS AVAILABLE ON THE DOW CORNING WEBSITE AT WWW.DOWCORNING.COM, OR FROM YOUR DOW CORNING REPRESENTATIVE, OR DISTRIBUTOR, OR BY CALLING YOUR GLOBAL DOW CORNING CONNECTION.

HEALTH AND ENVIRONMENTAL INFORMATION
To support customers in their product safety needs, Dow Corning has an extensive Product Stewardship organization and a team of Product Safety and Regulatory Compliance (PS&RC) specialists available in each area.

For further information, please see our website, www.dowcorning.com, or consult your local Dow Corning representative.

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The information contained herein is offered in good faith and is believed to be accurate. However, because conditions and methods of use of our products are beyond our control, this information should not be used in substitution for customer's tests to ensure that Dow Corning's products are safe, effective, and fully satisfactory for the intended end use. Suggestions of use shall not be taken as inducements to infringe any patent.

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Your exclusive remedy for breach of such warranty is limited to refund of purchase price or replacement of any product shown to be other than as warranted.

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