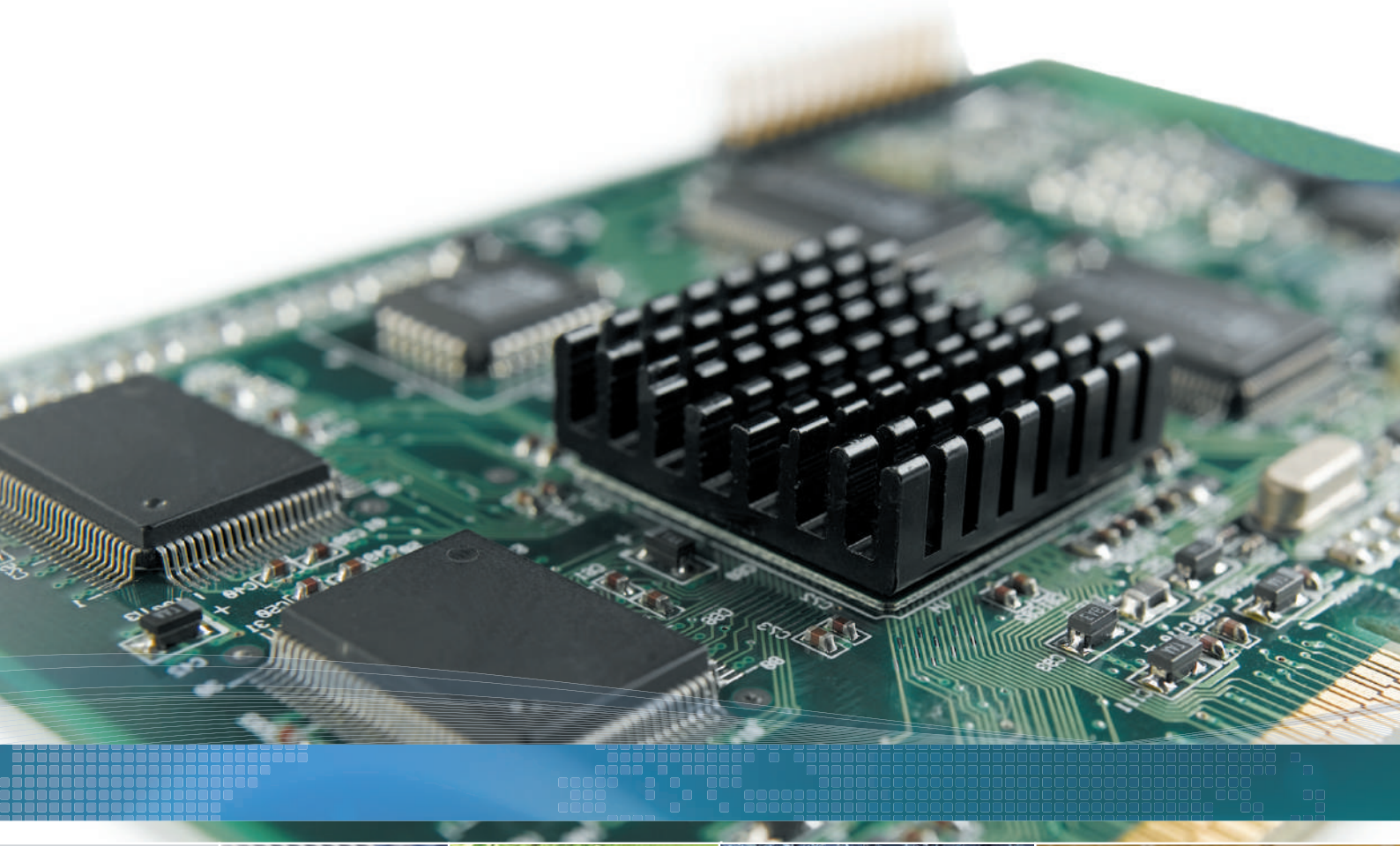
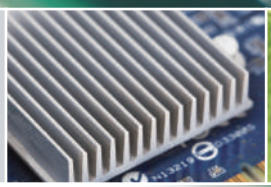
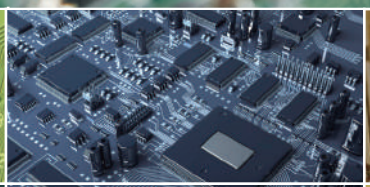
MOMENTIVE™

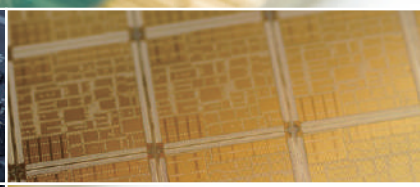
Thermal Management Silicones for Electronics













Thermal Management Solutions from Momentive Performance Materials

Long-term, reliable protection of sensitive electronic components is essential to many electronic applications today. Increasingly small systems and rising circuit densities have resulted in hotter operating temperatures, and driven demand for high-performance solutions for heat dissipation.

Designers confronting these challenges will find a range of solutions from Momentive Performance Materials, Silicones. Our SilCool* family of adhesives and compounds deliver the high-thermal conductivity, thin bond lines, and low thermal resistance required for high-performance components. For applications requiring moderate level thermal management, Momentive offers a selection of standard-grade silicone adhesives, encapsulants, and potting materials.

Thermally Conductive Silicone Grease Compounds

Momentive's thermally conductive SilCool grease compounds offer excellent thermal conductivity, as well as excellent stability, penetration, temperature resistance, and low bleed. These properties enable SilCool grease compounds to draw heat away from devices, contributing to improved reliability and operational efficiency of electronic components.

The combination of processing performance and thermal conductivity that these grease compounds offer makes them good candidates for thermal interface applications in a wide range of high-performance devices and packages. (p. 3~4)

Thermally Conductive Silicone Adhesives

Momentive Performance Materials developed its family of SilCool thermally conductive adhesives to help deliver thin bond lines, which contribute to low thermal resistance while providing excellent adhesion and reliability. This series of heat-cured adhesives excel in thermal interface applications that demand good structural adhesion. Examples include spreaders and heat generators, and thermal interfaces to heat sinks in TIM2 applications. (p. 5~6)

Additional thermal adhesives from Momentive offer the process convenience of 1-Part condensation cure with moderate heat dissipation. Target applications include board assemblies and sealants in power modules and sensors. (p. 7)

Thermal Gap Filler Liquid Dispensed Pad

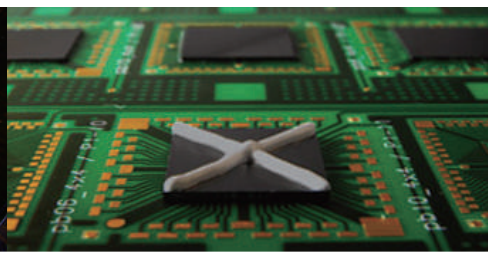
Momentive's thermally conductive Gap Fillers are non-slumping, dispensable materials that can be applied to gaps to create a heat path. These non-adhesive curing type TIMs form a soft, stress-absorbing thermal interface. In additon to filling gaps in electronic components, they can be applied to flat or high-profile 3-dimentional surfaces as a cure-in-place thermal pad or as a pump-out resistant alternative to greases.(p. 8)

Encapsulants & Potting Compounds

Momentive Performance Materials offers a variety of heat or room temperature cure, thermally conductive encapsulants that help remove heat from critical components. This selection of grades cures to form a soft rubber, gel matetrial, and consists of low-viscosity grades for potting applications, as well as grades with moderate viscosities that provide the necessary dispense stability for bead formulation. This category of thermal products also includes grades that can be considered for use as gap fillers or as liquid-dispensed alternatives to thermal pads. (p. 9)





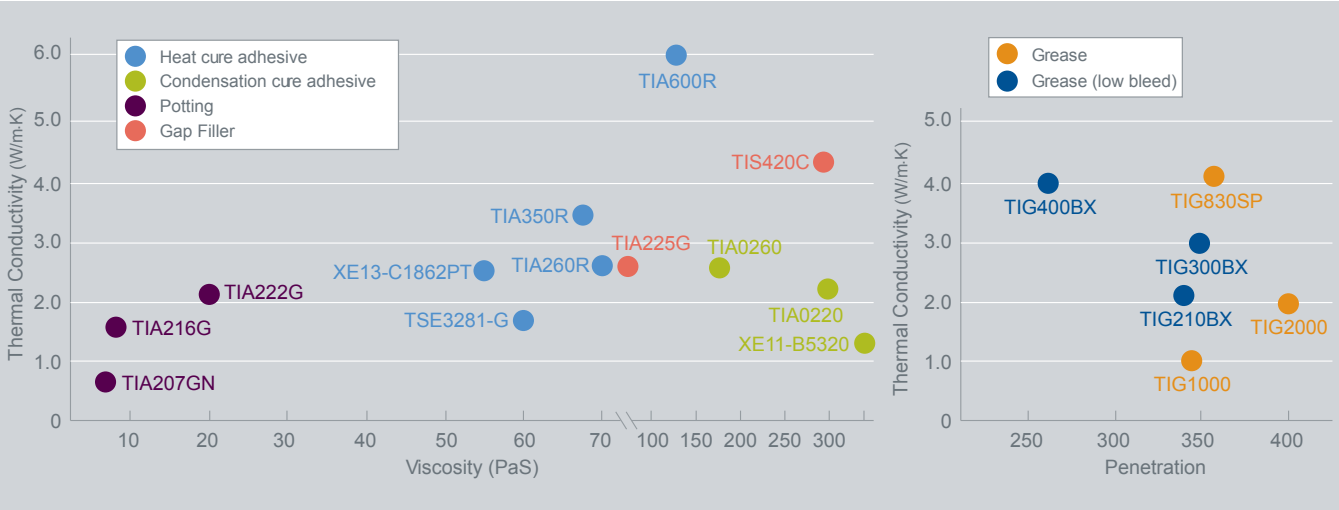


Product Selector Guide

The task of component design challenges materials suppliers to address an array of thermal management applications that impose a variety of performance and process profiles. Momentive brings to this challenge a broad and versatile range of thermally conductive materials. Whether an application requires superior performance in thermal interfaces, general heat dissipation in assemblies, thermal performance in board-level assembly, or potting and encapsulation, we offer a solution to help match the application's parameters.

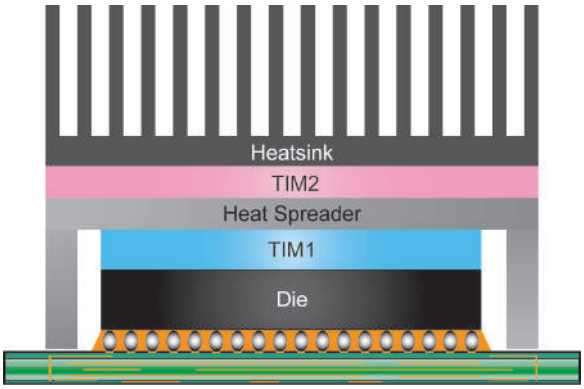
Application	Performance Characteristics		Solutions	
Thermal Interface in high-performance devices and semiconductor packages as TIM1 interfaces or TIM2 thermal paths to heat sinks.	• High thermal conductivity • Wide operating temperatures • Repairability	• Low thermal resistance • Minimal ionic impurities • Thin bond lines	TIG830SP TIG400BX TIG300BX TIG210BX	4.1 W/m·K 4.0 W/m·K 3.0 W/m·K 2.1 W/m·K
	• High thermal conductivity • Structural adhesion • Minimal ionic impurities	• Low thermal resistance • Thin bond lines • Wide operating temperatures	TIA600R TIA350R TIA260R XE13-C1862PT	6.0 W/m·K 3.5 W/m·K 2.5 W/m·K 2.5 W/m·K
Thermal management for optical pick-ups, automotive control units and power supplies	• High thermal conductivity • Structural adhesion	• Low thermal resistance • Room temperature cure	TIA0260 TIA0220	2.6 W/m·K 2.2 W/m·K
	• High thermal conductivity • Non-adhesive, repairable	• Low thermal resistance • Room temperature cure	TIS420C TIA225GF	4.2 W/m·K 2.5 W/m·K
Thermal interface with heat dissipation devices in control units, medium-performance chipsets, etc.	• Moderate thermal conductivity	• Wide operating temperatures	TIG1000 TIG2000	1.0 W/m·K 2.0 W/m·K
	• Moderate thermal conductivity • Structural adhesion	• Low thermal resistance	TSE3281-G	1.7 W/m·K
Board level & power supply component assembly.	• Moderate thermal conductivity • Structural adhesion	• Low thermal resistance • Room temperature cure	TIA0260 TIA0220 XE11-B5320	2.6 W/m·K 2.2 W/m·K 1.3 W/m·K
Rubber and Gel potting / encapsulation in power modules, converters, IGBT units.	• Good thermal conductivity • Low ~ moderate viscosities	• Handling & cure benefits • Stress relief	TIA222G TIA216G TIA208R	2.2 W/m·K 1.6 W/m·K 0.7 W/m·K

Thermally Conductive Silicone Portfolio Map



SilCool* Silicone Grease Compounds

Momentive's family of SilCool series silicone grease compounds feature outstanding thermal conductive and dielectric properties, excellent workability, virtually no oil separation, and minimal weight loss at elevated temperatures. These high-performance grease products were formulated to help address heat management challenges resulting from higher frequencies, higer power, and miniaturization in the development of electric and electronic devices.



Key Features

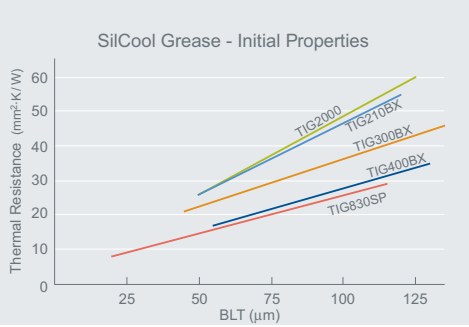
- Highly workable – excels in automated dispensing, screen printing, and stamping applications
- High thermal conductivity
- Wide operating temperature range
- Low oil separation and minimal weight loss at elevated temperatures
- Minimal ionic impurities & excellent dielectric properties

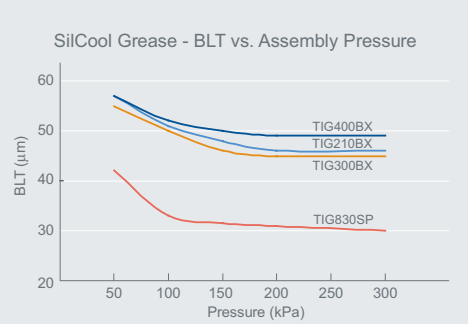
Product Details

Properties		TIG830SP	TIG400BX	TIG300BX	TIG210BX	TIG2000	TIG1500	TIG1000
Features		High thermal conductivity, low thermal resistance	High thermal conductivity, low oil bleed, temperature resistance	High thermal conductivity, low oil bleed, temperature resistance	Low oil bleed, temperature resistance	Grease with good thermal conductivity	Temperature resistant grease	General purpose thermal grease
Property / Color		Gray Paste	Gray Paste	Gray Paste	Gray Paste	Pale Blue Paste	White Paste	White Paste
Thermal Conductivity[1]	W/m·K	4.1	4.0	3.0	2.1	2.0	1.5	1.0
Thermal Resistance[2] (BLT)	mm^2·K/W	8 (20μm)	17 (55μm)	20 (45μm)	26 (50μm)	26 (50μm)	35 (55μm)	33 (50μm)
Specific Gravity (23°C)		2.88	3.18	3.00	2.90	2.80	2.7	2.50
Penetration[3] (23°C)		360	260	350	345	400	300	340
Viscosity (23°C)	Pa.s	300	350	250	250	150	100	-
Bleed[3] (150°C/24h)	wt%	0.0*	0.0*	0.0*	0.0*	0.1	-	0.1
Evaporation (150°C/24h)	wt%	0.3	0.3	0.1	0.1	0.1	-	0.1
Volume Resistivity[4]	MΩ·m	$1x10^3$	$3x10^3$	$5x10^3$	$1x10^6$	$1x10^6$	$2x10^5$	$3x10^6$
Dielectric Strength	kV/0.25mm	4.5	5.0	5.0	3.0	5.0	3.0	-
Volatile Siloxane (D_4-D_{10})	ppm	<100	<100	<100	<100	<100	<100	<100
Ionic Content[5] (Na^+/K^+/Cl^-)	ppm	0.5, 0.0, 0.1	0.05, 0.03, 0.3	1.0, 0.3, 0.3	2.0, 0.0, 0.0	-	-	-

[1]Hot wire method, [2]Laser flash analysis on Si-Si sandwiched material, [3]JIS K 2220, [4]MIL-S-8660B, [5]Ion chromotography analysis on water extracts,
*Measurement limit Typical property data values should not be used as specifications

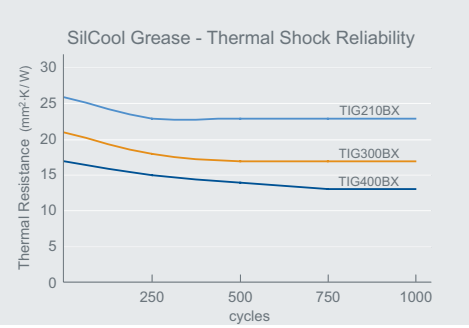
Thermal Resistance is proportional to the thickness of the material through which the heat must travel. The ability to control and reduce thickness (BLT) of the thermal interface is a key factor in the component assembly process. Increases in assembly pressures are known to contribute to reductions in BLT, and subsequently, reduced thermal resistance.



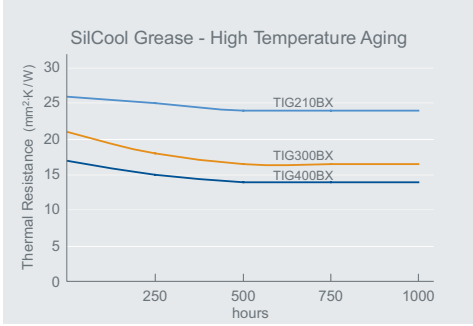


Test Conditions: Sandwich 0.02ml of material between10mm×10mm silicon dies, and apply desired pressure for 1 minute. Measure BLT.

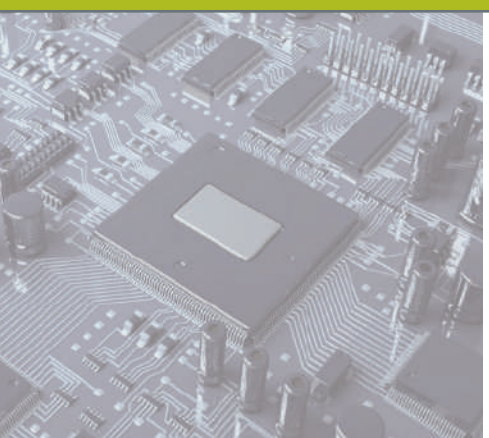




Test Conditions: Sandwich material between10mm×10mm silicon dies, and apply 300kPa pressure. Thermal cycle (-55°C~125°C, dwell time 30 minutes at each extreme). Measure thermal resistance using laser flash method.

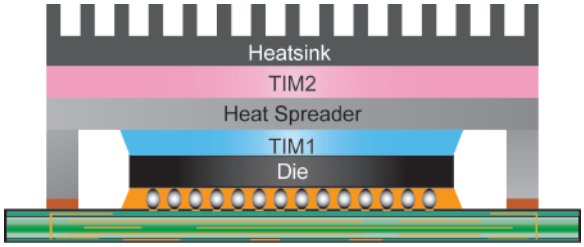


Test Conditions: Sandwich material between10mm×10mm silicon dies, and apply 300kPa pressure. Expose to 150°C tempertures up to 1000 hours. Measure thermal resistance using laser flash method.



SilCool* Silicone Adhesive - Addition Cure

The SilCool series silicone adhesives from Momentive Performance Materials offer 1-Part, heat curable materials that bond well to a wide variety of substrates without the need for primers. They help deliver outstanding thermal conductivity, low thermal resistance, excellent dielectric properties, and low stress. SilCool adhesives are excellent candidates for addressing the heat management challenges arising from the higher frequencies, power, and miniaturization in today's electronic devices. Designed to efficiently conduct heat, these materials are valuable additions to semiconductor packages that incorporate heat-generating chips, heat spreaders, and heat sinks (TIM1 & TIM2).



Key Features

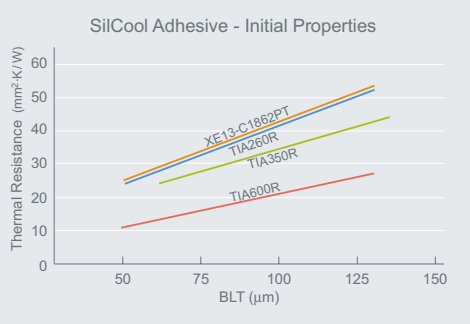
- Highly workable – excels in automated dispensing, screen printing, and stamping applications
- Fast cure & good adhesion
- High thermal conductivity
- Low thermal resistance
- Wide operating temperature range
- Compatible with high-temperature lead-free processing
- Minimal ionic impurities & excellent dielectric properties

Product Details

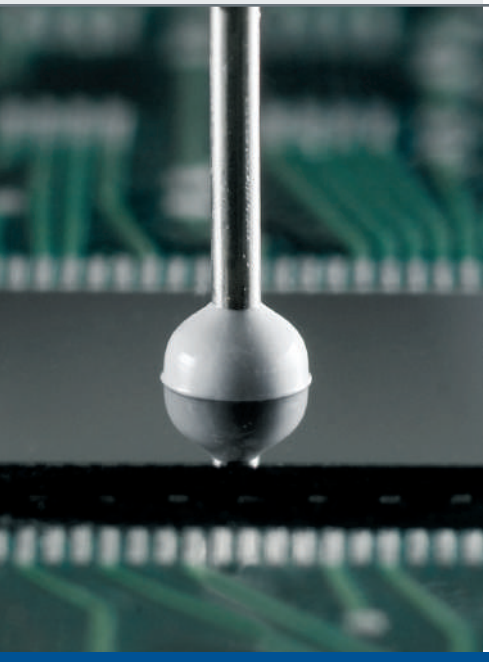
Properties		TIA600R	TIA350R	TIA260R	XE13-C1862PT	TSE3281-G
Features		High thermal conductivity, strong adhesion	High thermal conductivity, low temperature fast cure	Good thermal conductivity, low temperature fast cure	Good thermal conductivity, high elongation	-
Type		1 Part	1 Part	1 Part	1 Part	1 Part
Property (uncured)		Flowable	Flowable	Flowable	Flowable	Flowable
Color		Gray	Gray	Gray	Gray	Gray
Viscosity (23°C)	Pa.s	130	67	70	55	60
Cure Condition	°C/h	150 / 1	120 / 0.5	120 / 0.5	150 / 1	150 / 1
Thermal Conductivity[1]	W/m·K	6.0	3.5	2.5	2.5	1.7
Thermal Resistance[2] (BLT)	mm^2·K/W	11 (50µm)	24 (60µm)	25 (50µm)	25 (50µm)	35 (50µm)
Specific Gravity (23°C)		3.44	3.1	2.89	2.87	2.70
Hardness (Type A)		95	77	55	65	84
Tensile Strength	MPa	7.0	1.6	1.1	1.5	4.5
Elongation	%	10	20	40	80	50
Adhesion (Al lap shear)	MPa	5.4 (Ni/Ni)	1.0	0.8	1.0	2.5
CTE	ppm/K	90	115	130	130	140
Glass Transition Temp.	°C	-120	-120	-120	-120	-120
Volume Resistivity	MΩ·m	$4.8x10^6$	$4.8x10^6$	$4.8x10^6$	$4.8x10^6$	$4.8x10^6$
Dielectric Strength	kV/mm	20	20	20	20	15
Volatile Siloxane (D_4-D_{10})	ppm	<100	<150	<200	<200	-
Ionic Content[3] ($Na^+/K^+/Cl^-$)	ppm	each <5	each <5	each <5	each <5	each <10
Moisture Absorption	wt%	<0.6	<0.6	<0.6	<0.6	<0.6

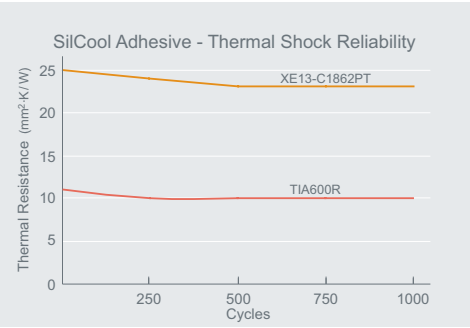
[1]Hot wire method, [2]Laser flash analysis on Si-Si sandwiched material, [3]Ion chromotography analysis on water extracts
*[4]Impressed voltage: 100V Typical property data values should not be used as specifications

Thermal Resistance is proportional to the thickness of the material through which the heat must travel. Increases in pressure during the component assembly process are known to contribute to reductions in thickness of the thermal interface (BLT), and subsequently, reduced thermal resistance.

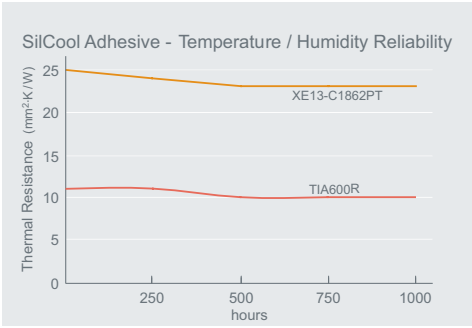


Test Conditions: Sandwich material between10mm×10mm silicon dies, and cure for 1 hour at 150°C. Measure thermal resistance using laser flash method.





Test Conditions: Sandwich material between10mm×10mm silicon dies, assemble at 500kPa and cure at 150°C for 1 hour. Thermal cycle (-55°C~150°C, dwell time 30 minutes at each extreme). Measure thermal resistance using laser flash method.



Test Conditions: Sandwich material between10mm×10mm silicon dies, assemble at 500kPa and cure at 150°C for 1 hour. High temperature / humidity test (85°C, 85%RH, 250, 500, 750, 1000 hours). Measure thermal resistance using laser flash method.



Silicone Adhesive - Condensation Cure

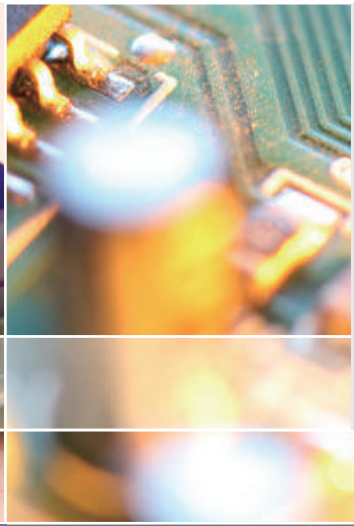
Momentive Performance Materials offers a range of condensation cure adhesives & sealants that deliver thermal conductive performance. These materials cure to form an elastic rubber when exposed to atmospheric moisture at room temperatures, eliminating the need for heat ovens. The result is a unique combination of process efficiency and excellent thermal conductivity. Our condensation-cure adhesives and sealants are commonly applied in board assembly and sensor applications that require moderate thermal management performance and ease of use.

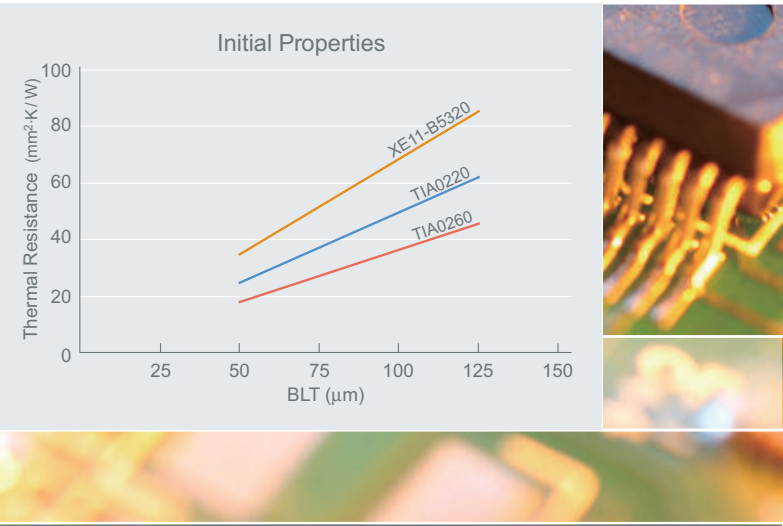
Product Details

Properties		TIA0260	TIA0220	XE11-B5320
Features		High thermal conductivity, strong adhesion	High thermal conductivity, strong adhesion	Fast tack free time, UL certified
Type		1 Part	1 Part	1 Part
Property (uncured)		Semi-Flowable	Semi-Flowable	Non-Flowable
Color		Light Gray	Gray	White
Viscosity (23°C)	Pa.s	150	300	-
Tack Free Time	min	10	10	5
Thermal Conductivity[1]	W/m·K	2.6	2.2	1.3
Thermal Resistance[2] (BLT)	mm^2·K/W	18 (50µm)	25 (50µm)	35 (50µm)
Specific Gravity (23°C)		3.01	2.87	2.59
Hardness (Type A)		90	88	80
Tensile Strength	MPa	4.8	5.2	3.6
Elongation	%	20	40	40
Adhesive Strength	MPa	3.0	4.2	1.3
CTE	ppm/K	100	110	120
Volume Resistivity	MΩ·m	$7.0x10^6$	$1.0x10^7$	$2.0x10^7$
Dielectric Strength	kV/mm	20	20	17
Volatile Siloxane (D_4-D_{10})	ppm	10	20	100
Flame Retardancy		UL94 V-0	-	UL94 HB

[1]Hot wire method, [2]Laser flash analysis on Si-Si sandwiched material
Typical property data values should not be used as specifications







Thermal Gap Filler / Liquid Dispensed Pad

Momentive's thermally conductive Gap Fillers are non-slumping, dispensable materials that can be applied to gaps to create a heat path. These non-adhesive curing type TIMs form a soft, stress-absorbing thermal interface. In additon to filling gaps in electronic components, they can be applied to flat or high-profile 3-dimentional surfaces as a cure-in-place thermal pad or as a pump-out resistant alternative to greases.

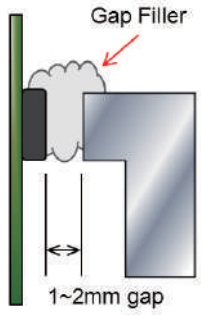
Key Features

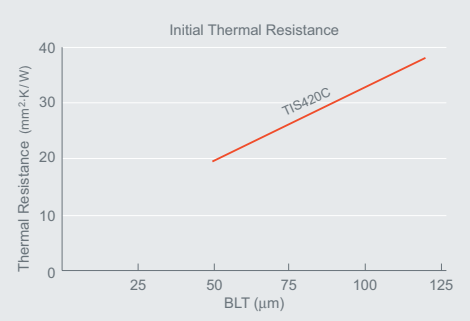
- Good thermal conductivity
- Fast, low temperature cure
- Helps provide stress relief during thermal cycling
- Conforms to complex, 3-dimensional designs
- Non-adhesive, repairable

Product Details

Properties		TIS420C	TIA225GF	TIA241GF
Type		1 Part Condensation Cure	2 Part Heat Cure	2 Part Heat Cure
Mixing Ratio ((A):(B) by weight)		-	100:100	100:100
Property (uncured)		Non-Flowable	Non-Flowable	Non-Flowable
Color		Gray	Gray	Blue
Viscosity (23°C)	Pa.s	300	90	130
Workable Life (23°C)	h	-	4	3
Tack Free Time	min	30	-	-
Cure Condition (heat)	°C/h	-	70 / 0.5	70 / 0.5
Cure Condition (room temp)	h	-	24	24
Specific Gravity (23°C)		3.2	2.9	3.14
Thermal Conductivity[1]	W/m·K	4.2	2.5	4.1
Thermal Resistance[2] (BLT)	mm^2·K/W	20 (50µm)	35 (50µm)	30 (80µm)
Volume Resistivity	MΩ·m	$3.0x10^3$	$6.0x10^6$	$1.0x10^4$
Volatile Siloxane (D_4-D_{10})	ppm	100	200	150
Flame Retardancy		-	UL94 V-0	-

[1]Hot wire method, [2]Laser flash analysis on Si-Si sandwiched material
Typical property data values should not be used as specifications





Thermally Conductive Encapsulants & Potting Compounds

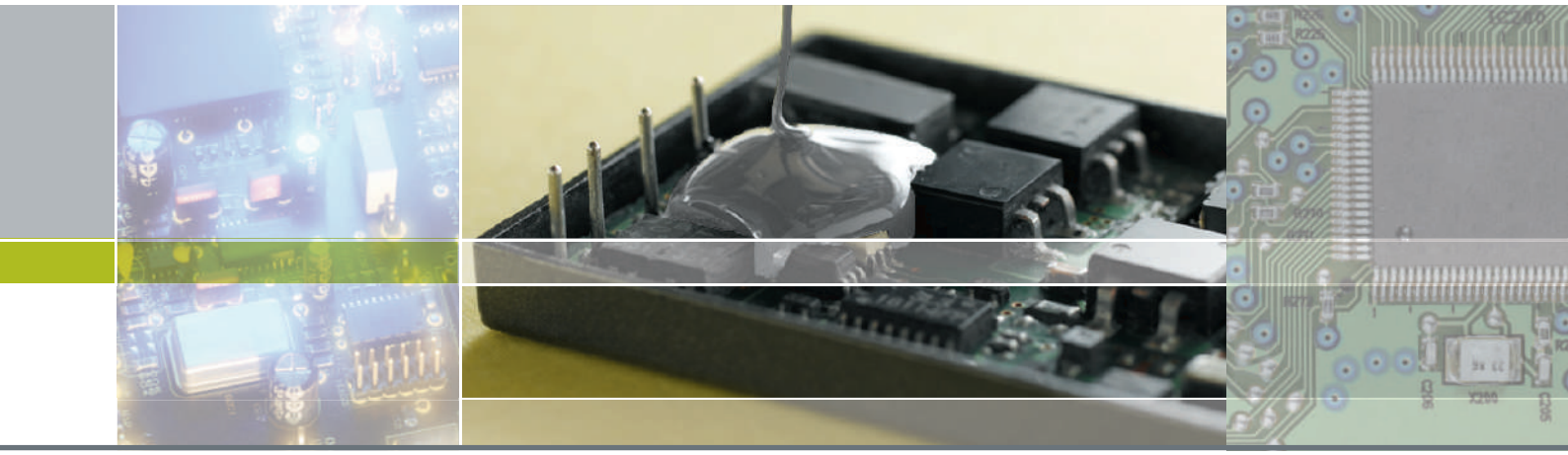
Momentive Performance Materials' silicone encapsulants deliver thermal conductive performance, contributing to the long-term reliability of heat-generating electronic components. These thermal products cure to a soft rubber, gel material, and include low viscosity grades that can be used for potting applications, and higher viscosity grades that exhibit dispensing stability needed for bead formulation. Some products are also candidates as gap fillers or liquid-dispensed alternatives to thermal pads.

Product Details

Properties		TIA222G	TIA216G	TIA208R
Features		High thermal conductivity, tacky adhesion, fast heat & R/T cure	Low viscosity, tacky adhesion, fast heat & R/T cure	Low viscosity, primerless adhesion, fast heat & R/T cure
Type		2 Part	2 Part	2 Part
Property (uncured)		Flowable	Flowable	Flowable
Color		Gray	Gray	Black
Mixing Ratio ((A):(B) by weight)		100:100	100:100	100:100
Workable Life (23°C)	h	4	0.5	1.5
Viscosity (23°C)	Pa.s	20	8	4.5
Cure Condition (heat)	°C/h	70 / 0.5	70 / 0.5	70 / 0.5
Cure Condition (room temp)	h	24	6	24
Thermal Conductivity[1]	W/m·K	2.2	1.6	0.7
Specific Gravity (23°C)		2.81	2.69	1.6
Hardness (Type E)		45	45	40 (type A)
Adhesion Strength (Al)	MPa	-	-	1.2
Adhesion Strength (PC)	MPa	-	-	0.7
CTE	ppm/K	140	150	-
Volume Resistivity	MΩ·m	$4.8x10^6$	$4.8x10^6$	$2.0x10^6$
Dielectric Strength	kV/mm	20	18	27
Volatile Siloxane (D_4-D_{10})	ppm	<200	<200	-
Flame Retardancy		UL94 V-0	UL94 V-0	UL94 V-0*

[1]Hot wire method *planned

Typical property data values should not be used as specifications



Thermal Conductivity

Thermal Conductivity is a property that describes the intrinsic ability of a material to conduct heat. It is commonly represented by the unit W/m.K, which measures the rate at which heat travels through a material where there is a temperature difference between two points (T1 - T2) over a specific distance (d).

k = thermal conductivity (W/m·K)
q = rate of heat flow (W)
T= temperature
d = distance
A = contact area

$$q = kA \frac{(T_1 \quad T_2)}{d}$$

Thermal Conductivity can be further derived from this formula as follows: A higher k value (W/m.K) indicates that the material is more efficient at conducting heat.

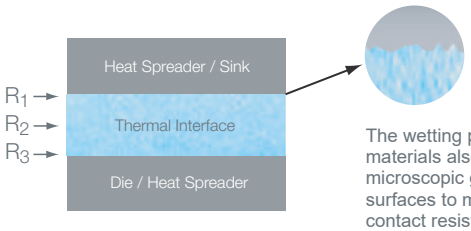
$$k = \frac{q}{A} \cdot \frac{d}{(T_1 \quad T_2)}$$

Thermal Resistance

Thermal Resistance describes the thermal properties of a material and how it resists heat at a specific thickness.

$$R_m = A \frac{(T_1 \quad T_2)}{q}$$

Thermal resistance is proportional to the thickness of the material, but it can be affected by gaps that occur between contact surfaces. These gaps create Contact Resistance, contributing to additional thermal resistance not represented in the above formula. Therefore, total thermal resistance in an application is represented by: $R = R_m + R_C$



Momentive Performance Materials designs its thermal silicones to maximize thermal conductivity of the interface material (R2), and minimize the resistance between R1 and R3 through minimized bond lines.

The wetting properties of these materials also helps them fill microscopic gaps in uneven surfaces to minimize the effects of contact resistance.

Thermal Conductivity Unit Conversion Guide

There are several commonly used measurements of Thermal Conductivity. In addition to W/m·K, other potential units of measurement include cal/cm·s°C and BTU-in/hr·ft²°F.

Original Unit	Multiplier	Final Unit
W/m·K	2.4×10^{-3}	cal/cm·s°C
W/m·K	6.94	BTU-in/hr·ft²°F
cal/cm·s°C	4.2×10^{2}	W/m·K
BTU-in/hr·ft²°F	0.14	W/m·K

Other Electronic Solutions from Momentive Performance Materials



Comprehensive package of adhesion, sealing, coating, and encapsulation / potting solutions for a wide range of silicone applications in electric and electronic devices and component assemblies.

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