Shin-Etsu Silicone

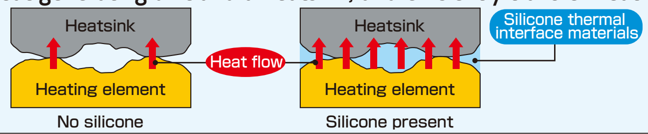
Silicone Thermal Interface Materials

What are Silicone Thermal Interface Materials?

Silicone thermal interface materials are compound materials which contain a high ratio of thermally conductive fillers. They exhibit outstanding thermal conductivity because they fit snugly in the gap between the heating element and the heatsink. Shin-Etsu Silicone offers an optimal heat dissipation solution tailored to the required usage and performance from a wide range of product lineups.

■ Model of Improved Thermal Conductivity

Silicone thermal interface materials fill a fine gap between a heat-generating unit and a heatsink, and efficiently transfer heat.



Thermal conductivity

Silicone thermal interface materials : approx. 0.8 to 9.5 W/m·K

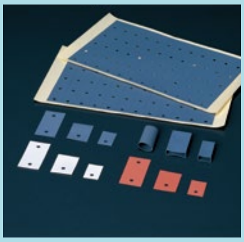
Air : approx. 0.03 W/m·K

Product Lineup

Sheet Products

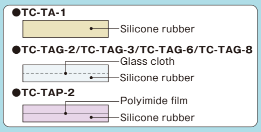
Thermal Interface Insulating Silicone Rubber Sheets — P4

Main Products: TC-TA Series

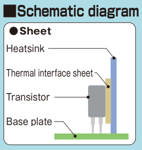


■Features
·Easy to use, excellent stability
·There are a variety of shapes, such as sheets, caps, tubes, etc.
·Excellent electric insulation

■Structure

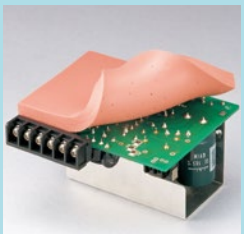


■Schematic diagram



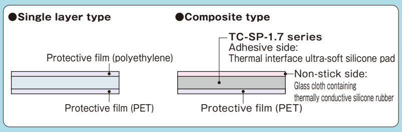
Thermal Interface Silicone Soft Pads — P5

Main Products: TC-CA Series



■Features
·Easy to use
·Soft, excellent adhesion
·Excellent electrical insulation

■Structure

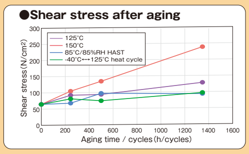


Double Sided Thermal Interface Silicone Tapes — P6

Main Products: TC-SAS Series

■Features
·High tackiness
·Wide use temperature range (-40°C to +150°C)
·Excellent reworkability

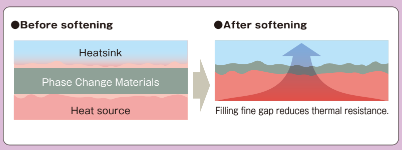
■Reliability test data



Thermal Softening Sheets Phase Change Materials — P6

Main Products: PCS Series

■Features
·Thermal softening sheet with excellent workability
·Low contact thermal resistance
·Available for low BLT



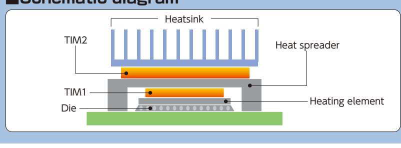
Liquid and Grease Products

Thermal Interface Oil Compounds — P7

Main Products: G-XXX Series

■Features
·Thin film coating is possible (low BLT is possible)
·Lower contact thermal resistance
·Optimal for the application of uneven adherends

■Schematic diagram



Condensation Cure Type Liquid Silicone Rubbers — P8

■Features
·Cure by reaction with moisture under room temperature
·Bonding and fixing of electronic components are possible.
·Optimal for the application of uneven adherends

Example of using adhesive fixation of parts

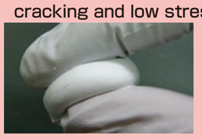
Addition Cure Type Liquid Silicone Rubbers Adhesives/ Potting Materials — P8

■Features
·The product can be cured for a short time by heating
*2 component room temperature cure type is also available.
·Bonding and fixing of electronic components are possible.
·Optimal for the application of uneven adherends

Application example of thermal interface potting agent

Condensation Cure Type Thermal Interface Oil Compound G-1000 — P7
Thermal Interface Gap Filler SDP Series & Pre-cured Gel Series — P9

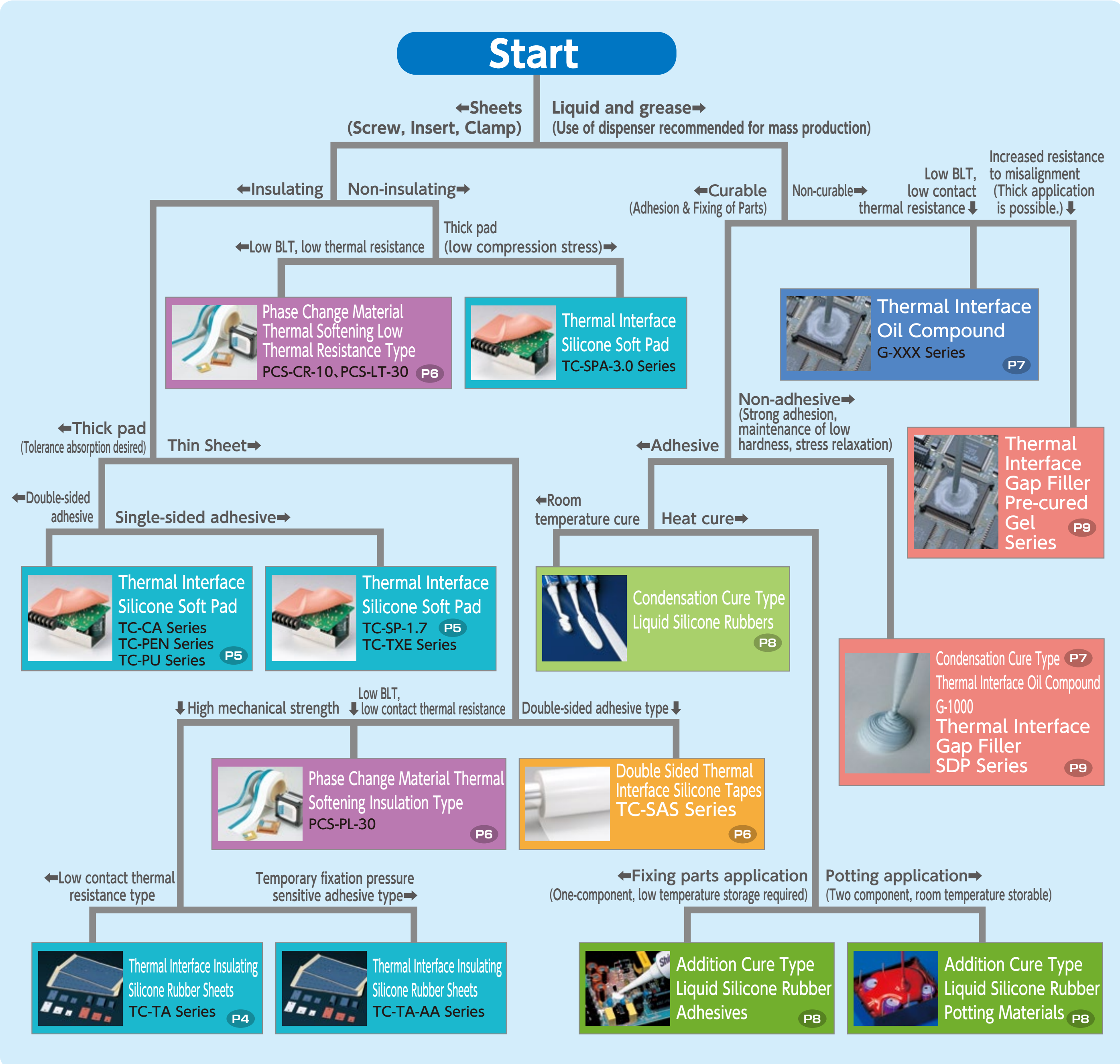
■Features
·Thick application is possible.
·Optimal for the application of uneven adherends
·Balancing resistance to misalignment and cracking and low stress



Soft cured sample of G-1000

Soft cured sheet of SDP series

Product Selection Flow chart

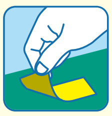


Product Selection Guide Line

Application Heating Elements with Unevenness or Steps

- P5 Thermal Interface Silicone Soft Pads
- P6 Phase Change Materials (Heat Cure)
- P7 Thermal Interface Oil Compounds
- P8 Condensation Cure Type Liquid Silicone Rubbers
- P8 Addition Cure Type Liquid Silicone Rubbers
- P9 Thermal Interface Gap Filler SDP Series & Pre-cured Gel Series

Ensuring Reworkability

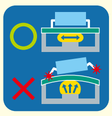


- P4 Thermal Interface Insulating Silicone Rubber Sheets
- P5 Thermal Interface Silicone Soft Pads
- P6 Double Sided Thermal Interface Silicone Tapes
- P7 Thermal Interface Oil Compounds

In Addition to Heat Dissipation Performance, Fix Parts

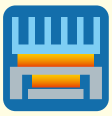
- P6 Double Sided Thermal Interface Silicone Tapes
- P8 Condensation Cure Type Liquid Silicone Rubbers
- P8 Addition Cure Type Liquid Silicone Rubbers Adhesives (Heat Cure)

Maintaining Low Hardness to Relieve Stress on Parts



- P5 Thermal Interface Silicone Soft Pads
- P7 Thermal Interface Oil Compounds
- P9 Thermal Interface Gap Filler SDP Series & Pre-cured Gel Series

Achieving Low BLT and High Thermal Conductivity



- P6 Phase Change Materials (Heat Cure)
- P7 Thermal Interface Oil Compounds

In addition to Heat Dissipation Performance, Sealing Heating Elements

- P8 Addition Cure Type Liquid Silicone Rubbers Potting Materials (Heat Cure)

Thermal Interface Insulating Silicone Rubber Sheets

Suitable Applications

- Substitute for insulating paper
- Thermal dissipation in areas where insulation is to be ensured only by sandwiching a thin sheet

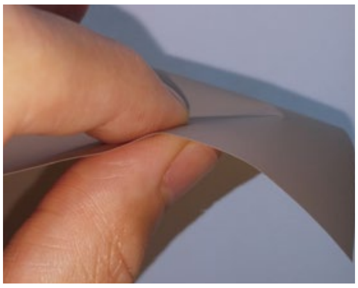
Unsuitable Applications

- Heat dissipation of heat sources with large irregularities

Features

- With thermal conductivity, heat dissipation from heating elements
- Insulation can be guaranteed by ensuring creepage distance.
- Excellent workability, stability, and electrical insulation
- There are a variety of shapes, such as sheets, caps and tubes, etc.

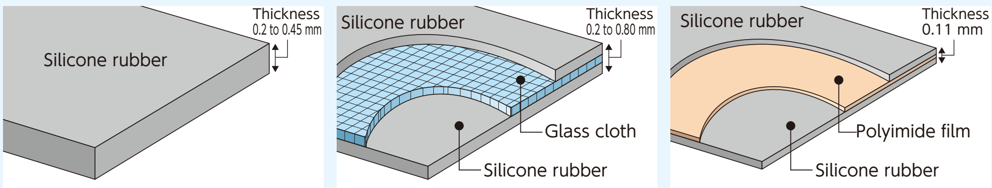
Structure



Thin sheet that ensures insulation

●Excellent insulating structure

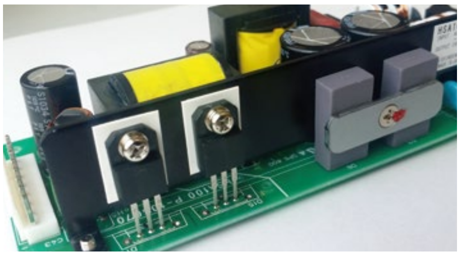
TC-TA-1 | TC-TAG-2/TC-TAG-3/TC-TAG-6/TC-TAG-8 | TC-TAP-2



●Silicone rubber single layer type ●Glass cloth reinforced type ●Polyimide film reinforced type (triple insulated)

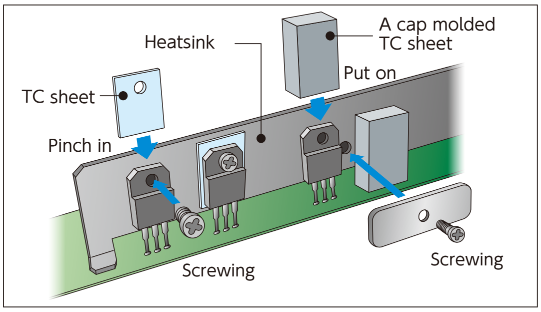
Compatible with the shape of tubes and caps as required

Application Examples



Transistor heat dissipation

Instructions for Use



General Properties

Parameter	Test method	TC-TA-1 series	TC-TAG-2 series	TC-TAP-2 series	TC-TAG-3 series	TC-TAG-6 series	TC-TAG-8 series	TC-BG series
Color		Black brown	Purple	Light purple	Dark Gray	Pink	Light gray	White
Reinforcement layer		None	Glass cloth	Polyimide film	Glass cloth	Glass cloth	Glass cloth	Glass cloth
Standard size mm		300×1,000	300×1,000 Roll	320×1,000 Roll	300×1,000 Roll	420×500	420×500	210×270
Thickness mm		0.20, 0.30, 0.45	0.20, 0.30, 0.45, 0.80	0.11	0.20, 0.30, 0.45	0.20, 0.30, 0.45	0.20, 0.30, 0.45	0.20, 0.30, 0.45
Representative product properties	**Test method**	TC-30TA-1 (Thickness: 0.30 mm)	TC-30TAG-2 (Thickness: 0.30 mm)	TC-11TAP-2 (Thickness: 0.11 mm)	TC-30TAG-3 (Thickness: 0.30 mm)	TC-30TAG-6 (Thickness: 0.30 mm)	TC-30TAG-8 (Thickness: 0.30 mm)	TC-30BG (Thickness: 0.30 mm)
Thermal conductivity of rubber W/m·K	ISO 22007-2*1	**1.0**	**1.8**	**1.8**	**3.4**	**6.0**	**8.0**	**7.3**
Thermal conductivity of products W/m·K	ISO 22007-2*1	**1.1**	**1.4**	**0.9**	**2.1**	**4.0**	**4.7**	**4.0**
Thermal resistance 50℃/100 psi cm²·K/W	ASTM D5470	**3.8**	**2.5**	**2.0**	**1.7**	**1.2**	**1.0**	**1.9**
Density at 23℃ g/cm³	JIS K 6249	1.70	1.86	1.65	2.84	1.63	1.56	1.66
Hardness Durometer A	JIS K 6249	70	91	87	90	88	83	91
Dielectric breakdown voltage Air atmosphere kV	JIS K 6249	15	10	8	9	9	8	15
Dielectric strength Air atmosphere kV	JIS C 2110	15	7	6	7	7	7	13
Volume resistivity TΩ·m	JIS K 6249	5.4	3.5	14.0	0.9	6.4	5.4	68.0
Flame retardance UL94	—	V-0 (UL file No. E48923)						
Low-molecular weight siloxane content ΣD_3-D_{10} ppm	Shin-Etsu method*2	40	30	<10	<10	<10	20	<0

*1 Hot disk method
*2 Acetone extraction method
※We provide not only sheet, but also cap or tube shapes. So if you need them, please contact our sales department.

(Not specified values)

Contact→ Sales and Marketing Department Ⅲ Phone:+81-(0)3-3246-5101

Thermal Interface Silicone Soft Pads

Suitable Applications

- Heat radiation from uneven heat sources*
- Attaching multiple heating elements together
- Ensuring the space distance as an insulator

*By absorbing gaps generated by tolerances on the heat source side and the heatsink side, voids between the heat generating elements, pads, and heat sink are eliminated, and the heat radiation effect is maximized.

Unsuitable Applications

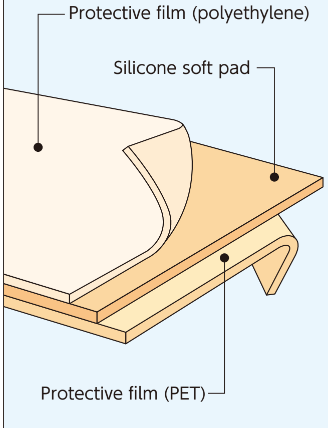
- Use in areas where thinness is required (Guideline: 0.3 mm or less)

Features

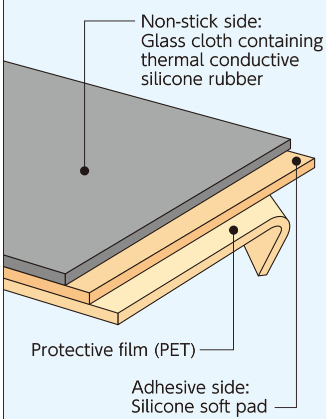
- Maximize heat dissipation effect by adhering well to heat generating parts and reducing thermal resistance
- Easy attachment/detachment to/from the heat generating part and temporary fixation, and excellent workability
- Dissipate heat from each heating element to the overall housing and heatsink
- High cost performance and thermal conductivity

Structure

●Single layer type



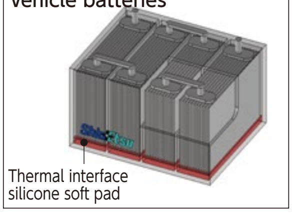
●Multi-layer type (TC-SP-1.7 Series)



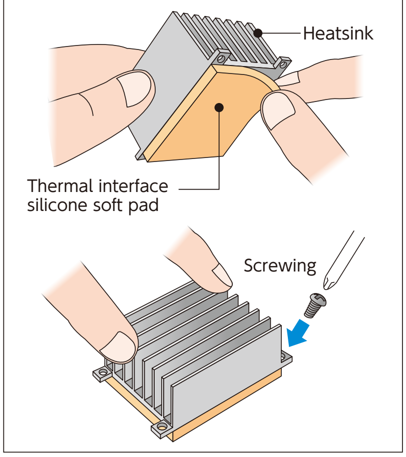
Application Examples

Radiating heat from uneven heat sources

Heat dissipation of electric vehicle batteries



Temporary fixation is possible at the time of mounting.



General Properties

Type		Ultra-soft Multi-layer	General-purpose					Low density		Ultra High Thermal Conductivity
Parameter / **Series**		TC-SP-1.7 Series	TC-CAS-10 Series	TC-CAB-10 Series	TC-CAD-10 Series	TC-CAT-20 Series	TC-CAF-40 Series	TC-PEN3-10 Series	TC-PEN5-20 Series	TC-UP8 Series
Color		Light blue/gray	Dark gray	Pale reddish brown	Pale red purple	Gray	Light purple	Light purple	Blue	Gray
Standard size mm		300×400	300×400	300×400	300×400	300×400	300×400	300×400	300×400	300×400
Thickness*1 mm		0.5、1.0 1.5、2.0 2.5、3.0 4.0、5.0	0.5、1.0 1.5、2.0 2.5、3.0 4.0、5.0 6.0、7.0 8.0、9.0 10.0	0.5、1.0 1.5、2.0 2.5、3.0 4.0、5.0	0.5、1.0 1.5、2.0 2.5、3.0 4.0、5.0	0.5、1.0 1.5、2.0 2.5、3.0 4.0、5.0	0.5、1.0 1.5、2.0 2.5、3.0 4.0、5.0	0.5、1.0 1.5、2.0 2.5、3.0 4.0、5.0	0.5、1.0 1.5、2.0 2.5、3.0 4.0、5.0	0.5、1.0 1.5、2.0
Representative product properties	**Test method**	TC-SP-1.7 (Thickness: 1.0 mm)	TC-CAS-10 (Thickness: 1.0 mm)	TC-CAB-10 (Thickness: 1.0 mm)	TC-CAD-10 (Thickness: 1.0 mm)	TC-CAT-20 (Thickness: 1.0 mm)	TC-CAF-40 (Thickness: 1.0 mm)	TC-PEN3-10 (Thickness: 1.0 mm)	TC-PEN5-20 (Thickness: 1.0 mm)	TC-UP8 (Thickness: 1.0 mm)
Thermal conductivity of rubber W/m·K	ISO 22007-2*3	**1.5**	**1.8**	**2.3**	**3.2**	**4.5**	**5.2**	**3.2**	**5.2**	**8.0**
Thermal resistance 50℃/40 psi cm²·K/W	ASTM D5470	**8.2**	**3.3**	**2.4**	**2.2**	**1.6**	**1.5**	**2.34**	**1.27**	**0.45**
Density at 23℃ g/cm³	JIS K 6249	2.3	1.9	2.2	3.0	3.2	3.3	2.6	2.9	3.2
Hardness Asker C*2	JIS K 6249	2	10	10	10	20	40	10	20	15
Dielectric breakdown voltage in oil kV	JIS K 6249	20	22	22	15	15	16	21	20	10
Dielectric strength in oil kV	JIS C 2110	16	10	11	11	11	11	16	16	8
Flame retardance UL94	—	V-0 (UL file No. E48923)						V-0 equivalent		
Low-molecular weight siloxane content ΣD_3-D_{10} ppm	Shin-Etsu method*2	20	70	90	90	200	90	<10	<10	<10

(Not specified values)

*1 Please contact our sales department for details on other thickness of the product lineup.
*2 Hardness (Asker C): Measured by stacking two thermal interface sof/ultra soft silicone pads with a thickness of 6 mm.
*3 Hot disk method
*4 Acetone extraction method

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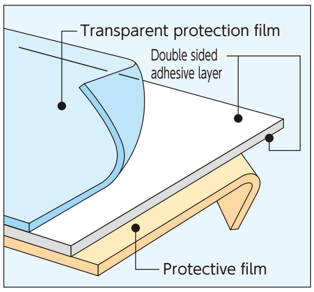
Double Sided Thermal Interface Silicone Tapes
TC-SAS Series

Suitable Applications
•Insulating heat dissipation of the part to be fixed by adhesive

Unsuitable Applications
•Heat dissipation in areas requiring high thermal conductivity

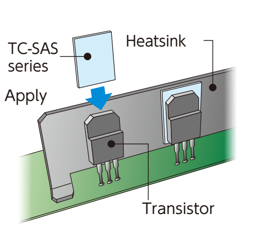
Structure



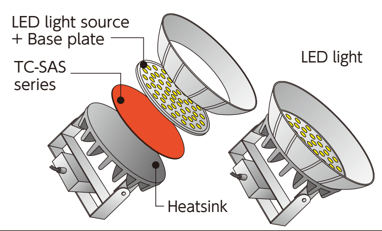
Features
•Threadless with strong and stable adhesion
•Stable thermal resistance over a wide range of temperatures
•Good workability in large areas

Application Examples

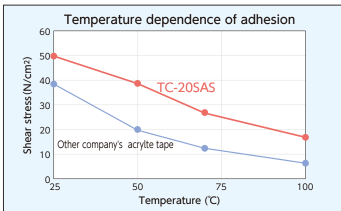
•Insulation + Heat dissipation + Adhesive Fixing for Transistor

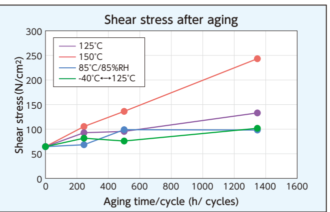


•Insulation between LED light source and heatsink + Heat dissipation + Adhesive fixation



Reliability test data





General Properties

Parameter		Product name / Test method	TC-10SAS	TC-20SAS
Thermal conductivity W/m·K		ASTM E1461*3	**1.0**	**1.0**
Thermal resistance cm²·K/W		ASTM E1461*3	**2.0**	**2.9**
Color		-	White	White
Standard size mm		-	300×400	300×400
Thickness*1 μm		-	100	200
Dielectric breakdown voltage Air atmosphere kV		JIS K 6249	3	6
Peeling strength*2	Aluminum	-	6.0	6.4
	SUS	-	7.0	7.6
	Glass epoxy	-	7.6	8.1
Flame resistance UL94		-	V-0 (UL file No. E48923)	

*1 Please contact our sales department for details on other thickness of the product lineup.
*2 After sticking a tape on a test plate, then pressed down using a 2kg roller.
After 10 minutes, the tape was then peeled off in the 180-degree direction and measurements taken. (Temp.: 23℃, peeling speed: 300 mm / min)
*3 Laser flash method

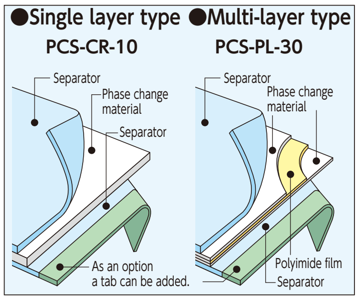
(Not specified values)

Thermal Softening Sheets
Phase Change Materials

Suitable Applications
•Heat dissipation at the site requiring the thinness (low BLT*)
*BLT=Bond Line Thickness

Unsuitable Applications
•Heat dissipation in the vertical region

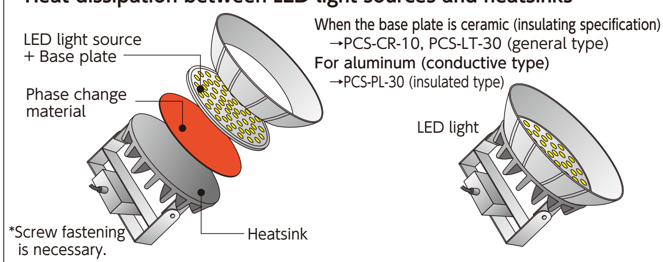
Structure



Features
•Handling of sheets and heat dissipation performance of grease are compatible.
•Adhesion and insertion are possible in determinate quantities with adhesion comparable to grease.
•Softened to grease at about 50℃
•When compression is applied in a heat softened state, the BLT becomes low.
•The wettability is improved by the self-heating of the device even after mounting.
•Excellent pumpout resistance

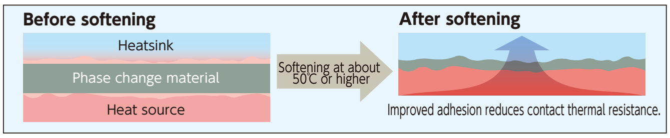
Application Examples

•Heat dissipation between LED light sources and heatsinks



•Heat dissipation of server CPU

Model of heat softening



General Properties

Parameter	Product name / Test method	PCS-CR-10	PCS-LT-30	PCS-PL-30
Thermal conductivity W/m·K	ASTM E1461*2	**2.0**	**3.0**	**1.7***3
Thermal resistance*1 cm²·K/W	ASTM E1461*2	**0.08**	**0.11**	**0.73**
Type	-	Non-insulated	Non-insulated	Insulator
Color	-	White	Gray	White
Initial thickness μm	-	200	120	120
Thickness after compression*1 μm	Microgauge	10	28	30
Reinforcement layer	-	None	None	Polyimide film
Density at 23℃ g/cm³	JIS K 6249	2.9	2.4	2.7
Dielectric breakdown voltage Air atmosphere kV	JIS K 6249	-	-	5.5*4
Softening point ℃	Shin-Etsu method	About 50	About 50	About 50
Standard size mm	-	300×400, Roll	300×400, Roll	320×400, Roll
Flame resistance UL94	-	V-0 equivalent	V-0 equivalent	V-0 equivalent

*1 After heating and compression at 50 psi/100°C for 1 h
*2 Laser flash method
*3 Thermal conductivity of the phase change material
*4 Measure at the initial thickness

(Not specified values)

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Thermal Interface Oil Compounds

Suitable Applications

- Thermal dissipation in areas where thin film application (low BLT*) is required (thermal resistance can be reduced by using thin film)
- Thermal dissipation in areas with fine irregularities
- Thermal dissipation in areas where reworkability is required

*BLT=Bond Line Thickness

Unsuitable Applications

- Use in parts that cannot be screwed (Thermal interface oil compound is not adhesive.)

Features

- Among thermal interface silicone products, it has high thermal conductivity and low contact thermal resistance.
- Since it is grease-like, it can be used for low BLT by wetting and crushing heat-generating parts well.
- A lineup of high performance products with resistance to pumping out and misalignment

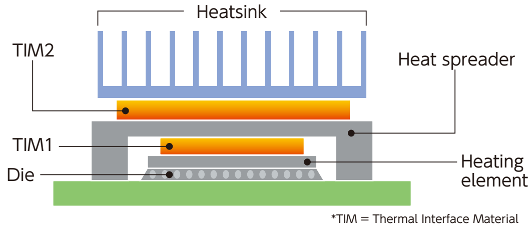
Consistency

Soft grease

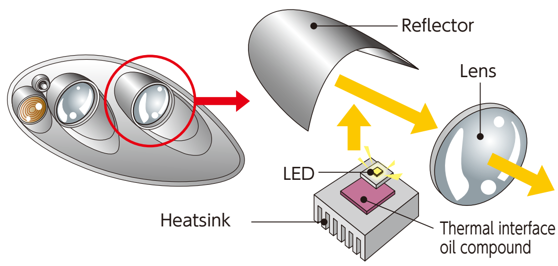
Application Examples

Application to the heating element

Model of an application site



Thermal dissipation of LED headlamps for automobiles



General Properties

Parameter / Product name	G-775	G-777	G-779	Condensation Cure Type G-1000	Solvent Diluted Type G-776	Solvent Diluted Type G-787	Solvent Diluted Type G-790
Appearance	White Grease						
Thermal conductivity W/m·K	**3.6**	**3.3**	**3.0**	**2.4**	**1.3**[*2]	**4.0**[*2]	**3.2**[*2]
Thermal resistance[*1] mm²·K/W	**25**	**21**	**10**	**29**	**7**	**10**	**3**
BLT μm	**75**	**56**	**25**	**50**	**10**	**30**	**10**
Specific gravity at 25℃	3.4	3.2	3.2	3.04	2.9	3.48	3.3
Viscosity at 25℃ Pa·s	500	140	160	80	60[*3]	70[*3]	90[*3]
Hardness after curing Asker C	-	-	-	40	-	-	-
Dielectric breakdown strength 0.25 mm kV	2.5	3.2	3.2	3.6	2.9	2.4	2.5
Use temperature range ℃	-40 - +150	-40 - +200	-40 - +200	-40 - +180	-40 - +200	-40 - +200	-40 - +200
Low-molecular weight siloxane content ΣD_3-D_{10} ppm	<300	<100	<100	<100	<100	<100	<100

*1 Values of BLT thickness *2 After solvent evaporation *3 Before solvent evaporation

(Not specified values)

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Thermal Interface Liquid Silicone Rubbers Adhesives & Potting Materials

Suitable Applications

- ・Heat dissipation at heat-generating sites with complicated shapes to which no sheet can be attached
- ・Bonding and fixing of heating element
- ・Heat dissipation in uneven areas

Unsuitable Applications

- ・Heat dissipation in areas where reworkability is required
- ・Condensation cure type: heat dissipation and lamination of moisture-free confined area
- ・Addition cure type: heat dissipation of parts that cannot be heated due to low heat resistance of peripheral components

Features

- ・Pastes and liquids can be used in various heating element shapes.
- ・React with moisture or cure to rubber elastics by heating
- ・In addition to radiating heat from heat-generating elements, it is possible to bond and fix them, and to pot and seal them for insulation and moisture-proof purposes.
- ・UL certified products (UL94 V-0)

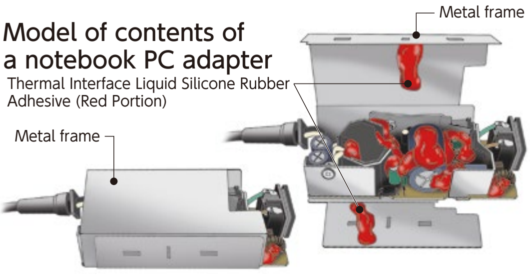
Consistency

Paste, medium and low-viscosity liquids

Adhesive

Application Examples

Thermal dissipation bonding of the notebook PC adapter



General Properties

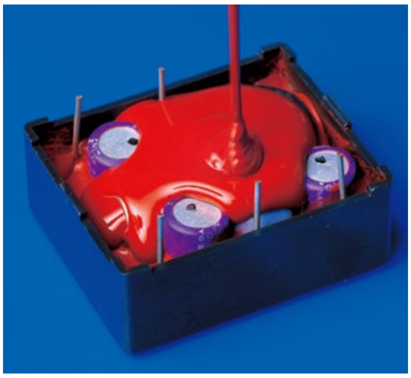
Parameter / Product name		KE-4918-WF	KE-4961-W	KE-4962-W	KE-1867	KE-1891
Thermal conductivity	W/m·K	0.85	1.6	2.4	2.2	4.0
Curing method		One-component condensation			One-component addition	
Before curing						
Appearance		White paste	White paste	White paste	Gray medium viscosity liquid	Grayish white paste
Byproduct gas		Alcohol	Alcohol	Alcohol	NA	NA
Viscosity at 23℃	Pa·s	-	-	-	70	-
Tack-free time	min	3	1	2	NA	NA
Standard curing conditions		23℃ ± 2℃/50 ± 5% RH × 7 days			120℃×1h	
After curing						
Density at 23℃	g/cm³	1.68	2.34	2.65	2.92	3.06
Hardness durometer A		80	80	88	75	96
Tensile strength	MPa	3.5	3.9	4.4	2.1	5.3
Elongation at break	%	50	60	30	60	10
Volume resistivity	TΩ·m	4.5	1.0	1.0	1.2	3.4
Dielectric breakdown strength	kV/mm	27	24	25	23	25
Tensile lap-shear strength (Al/Al)	MPa	1.0 (Cu/Cu)	0.7	0.8	0.8	0.8
Low-molecular weight siloxane content ΣD3-D10	ppm	<300	<300	<300	<300	<300
Flame resistance	UL94	V-0	V-0	V-0	V-0	V-0

(Not specified values)

Potting Agent

Application Examples

Heat-dissipation, insulation, and moisture-proof potting of terminal boxes



General Properties

Parameter / Products name		KE-1897S-A/B	KE-8006-A/B	KE-1899-A/B	KE-8001-A/B
Thermal conductivity	W/m·K	2.1	2.2	3.0	3.2
Curing method		Two-component, addition			
Before curing					
Appearance	Pa·s	A : Gray / B : White	A : Gray / B : White	A : Gray / B : White	A : Gray / B : White
Viscosity at 23℃	h	A : 13 / B : 7	A : 12 / B : 7.5	A : 26 / B : 17	A : 33 / B : 20
Workable time (reference) at 23℃		48	2	48	48
Recommended curing conditions		120℃×1 h	23℃×24 h	120℃×1 h	120℃×1 h
After curing					
Density at 23℃	g/cm³	2.78	2.75	2.99	3.04
Hardness Durometer A	MPa	15	23	16	53
Tensile strength	MPa	0.3	0.4	0.3	1.0
Elongation at break	%	80	39	60	30
Volume resistivity	TΩ·m	0.1	0.1	0.3	0.28
Dielectric breakdown strength	kV/mm	17	17	17	19
Tensile lap-shear strength (Al/Al)	MPa	0.2	0.3	0.2	0.5
Low-molecular weight siloxane content ΣD3-D10	ppm	<300	<300	<300	<300
Flame resistance UL94		V-0	V-0 equivalent	V-0	V-0

(Not specified values)

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Thermal Interface Gap Filler SDP Series & Pre-cured Gel Series

Suitable Applications

- Heat dissipation in areas where thick coating is required (When the clearance of the parts is large)
- Heat dissipation in areas where stress relaxation is required using cushioning properties of materials
- Heat dissipation in uneven areas (excellent compliance)
- Heat dissipation in areas where reworkability is required

Unsuitable Applications

- Use in parts that cannot be screwed (Gap filler is not adhesive.)

Features

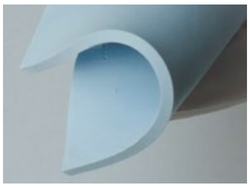
- Usable for a variety of heating element shapes
- SDP Series: Two-component room temperature addition cure type ··· Cures into a soft sheet at room temperature to relieve stress. Curing time can be shortened by heating.
- Pre-cured Series : One component Pre-cured type ··· It can be applied thickly and is excellent in pumpout resistance and misalignment resistance.

SDP Series: Two-component Room Temperature Addition Cure Type

Consistency

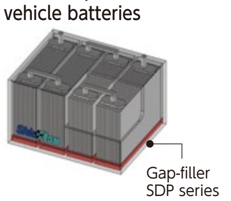
Before curing: Grease-like and wet well to the substrate surface

After curing: Cures into a soft sheet

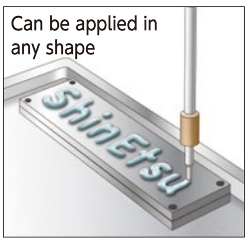


Application Examples

Heat dissipation of electric vehicle batteries



Can be applied in any shape



General Properties

Parameter / Product name	SDP-3560-A/B	SDP-5040-A/B	SDP-6560-A/B	SDP-8070-A/B	SDP-9550-A/B
Thermal conductivity W/m·K	**3.5**	**5.1**	**6.5**	**8.0**	**9.5**
Curing method	Two-component, addition				
Standard curing conditions	25℃×24h				
Before curing					
Appearance	A:White, B:Sky blue	A:Grayish white B: Pink	A:Grayish white B: Pink	A:Grayish white, B:Pink	A:Gray, B:Pale Pink
Viscosity at 23℃ Pa·s	A:107 B:112*	A:181 B:162*	A:282 B:288*	A:196 B:203*	A:293 B:330*
Mix ratio	100 : 100				
Mixed viscosity at 25℃ Pa·s	110*	169*	284*	201*	320*
Pot life at 23℃ min	240	240	240	240	240
Specific gravity at 25℃	A:3.09/B3.10	A:3.25/B3.26	A/B:3.20	A/B:3.14	A/B:3.05
After curing					
Density at 23℃ g/cm³	3.1	3.27	3.34	3.18	3.05
Hardness Shore OO	65	42	61	69	54
Hardness Asker C	35	16	30	42	24
Tensile strength MPa	0.2	0.1	0.1	0.2	0.1
Elongation at break %	50	30	20	20	40
Volume resistivity TΩ·m	0.015	0.031	0.028	0.016	0.014
Dielectric breakdown strength kV/mm	20	21	20	16	14
Low-molecular weight siloxane content ΣD_3-D_{10} ppm	<300	<300	<300	<300	<300
Flame resistance UL94	V-0 equivalent	V-0	V-0	V-0 equivalent	V-0 equivalent

* Marcom viscometer 10 rpm

(Not specified values)

Pre-cured Gel Series: One-component Pre-cured Type Products with Improved Pumpout and Misalignment Resistance

Consistency

Soft grease

Application Examples

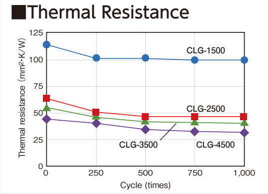
- ECU heat dissipation
- Heat dissipation of components subject to vibration, such as in-vehicle components

Pumpout test results

Test condition / Product name	CLG-1500	CLG-2500	CLG-3500	CLG-4500	G-800
Initial					
1,000 cycles later					

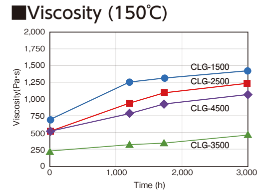
Test method
1 A sample is sandwiched between a microscope slide (glass) and an aluminum plate, which are separated by a 2.0mm spacer. 0.5mm spacer is used only for G-800.
2 This test piece is stood vertically, and a heat cycle test is conducted (cycling between -40℃ × 30 min and + 125℃ × 30 min).

■Thermal Resistance



It exhibits stable thermal resistance even after heat cycle testing.
Test conditions:-40℃ × 30 min. +125℃ × 30 min. cycle

■Viscosity (150℃)



General Properties

Parameter / Product name	CLG-1500	CLG-2500	CLG-3500	CLG-4500	G-800
Thermal conductivity W/m·K	**1.5**	**2.9**	**3.5**	**4.8**	**4.0**
Appearance	White				
Specific gravity at 25℃	2.6	2.9	3.1	3.2	4.4
Viscosity at 25℃ Pa·s	500	500	250	550	170
Dielectric breakdown strength KV/mm	9.6	6.2	8.9	4.7	3.2
Use temperature limit ℃	-40 - +180				
Low-molecular weight siloxane content ΣD_3-D_{10} ppm	<300	<300	<300	<300	<200

(Not specified values)

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Thermal Conductive Characteristics List

Type	Series Product name	Thermal conductivity, Bulk elastomer W/m·K	Thermal conductivity of products W/m·K	Thermal resistance cm^2·K/W	Test method
Thermal Interface Insulating Silicone Rubber Sheets	TC-TA-1 Series	1.0	1.1	3.8	**Thermal conductivity of products :** ISO 22007-2 Hot disk method **Thermal resistance :** ASTM D5470 50°C/100 psi
	TC-TAG-2 Series	1.8	1.4	2.5	
	TC-TAP-2 Series	1.8	0.9	2.0	
	TC-TAG-3 Series	3.4	2.1	1.7	
	TC-TAG-6 Series	6.0	4.0	1.2	
	TC-TAG-8 Series	8.0	4.7	1.0	
	TC-BG Series	7.3	4.0	1.9	

Type	Series Product name	Thermal conductivity, Bulk elastomer W/m·K	Thermal resistance cm^2·K/W	Test method
Thermal Interface Silicone Soft Pads	TC-PEN3-10 Series	3.2	2.3	**Thermal conductivity, Bulk elastomer :** ISO 22007-2 Hot disk method **Thermal resistance :** ASTM D5470 50°C/40 psi
	TC-PEN5-20 Series	5.2	1.3	
	TC-UP8 Series	8.0	0.5	
	TC-SP-1.7 Series	1.5	8.2	
	TC-CAS-10 Series	1.8	3.3	
	TC-CAB-10 Series	2.3	2.4	
	TC-CAD-10 Series	3.2	2.2	
	TC-CAT-20 Series	4.5	1.6	
	TC-CAF-40 Series	5.2	1.5	

Type	Series Product name	Thermal conductivity W/m·K	Thermal resistance cm^2·K/W	Test method
Double Sided Thermal Interface Silicone Tapes TC-SAS series	TC-10SAS	1.0	2.0	**Thermal Conductivity & Thermal Resistance:** ASTM E 1461 Laser Flash Method
	TC-20SAS	1.0	2.9	
Thermal Softening Sheets Phase change materials	PCS-CR-10	2.0	0.08	**Thermal conductivity :** ASTM E 1461 Laser Flash Method **Thermal resistance :** ASTM E 1461 Laser Flash Method After Heating and Compressing at 50 psi/100°C for 1 h
	PCS-LT-30	3.0	0.11	
	PCS-PL-30	1.7*	0.73	

*Thermal conductivity of the phase change material

Type	Product name	Thermal conductivity W/m·K	Thermal resistance mm^2·K/W	Dielectric breakdown strength kV/0.25mm	Test method
Thermal Interface Oil Compounds	G-775	3.6	25 (75µm)	2.5	**Thermal conductivity :** ISO 22007-2 **Thermal resistance :** Shin-Etsu method **Dielectric breakdown strength :** JIS K 6249
	G-777	3.3	21 (56µm)	3.2	
	G-779	3.0	10 (25µm)	3.2	
	G-1000	2.4	29 (50µm)	3.6	
	G-776	1.3	7 (10µm)	2.9	
	G-787	4.0	10 (30µm)	2.4	
	G-790	3.2	3 (10µm)	2.5	

Type	Product name	Thermal conductivity W/m·K	Dielectric breakdown strength kV/mm	Test method
Thermal Interface Liquid Silicone Rubbers Adhesives	KE-4918-WF	0.85	27	**Thermal conductivity :** JIS R 2616 **Dielectric breakdown strength :** JIS K 6249
	KE-4961-W	1.6	24	
	KE-4962-W	2.4	25	
	KE-1867	2.2	23	
	KE-1891	4.0	25	
Thermal Interface Liquid Silicone Rubbers Potting Materials	KE-1897S-A/B	2.1	17	
	KE-8006-A/B	2.2	17	
	KE-1899-A/B	3.0	17	
	KE-8001-A/B	3.2	19	
Gap Filler	SDP-3560-A/B	3.5	20	**Thermal conductivity :** ISO 22007-2 **Dielectric breakdown strength :** JIS K 6249
	SDP-5040-A/B	5.1	21	
	SDP-6560-A/B	6.5	20	
	SDP-8070-A/B	8.0	16	
	SDP-9550-A/B	9.5	14	
Pre-cured Gel Series	CLG-1500	1.5	9.6	**Thermal conductivity :** ISO 22007-2
	CLG-2500	2.9	6.2	
	CLG-3500	3.5	8.9	
	CLG-4500	4.8	4.7	
	G-800	4.0	3.2	

(Not specified values)

Measurement and Evaluation of Thermal Properties

Two values which represent the thermal properties of thermal interface materials are thermal conductivity (λ) and thermal resistance (R). Heat-dissipation performance is directly proportional to thermal conductivity and inversely proportional to thermal resistance. Heat-dissipation is affected not only by the thermal conductivity of the silicone itself, but is also largely dependent on the contact thermal resistance of the interface between the heat generator and the heat dissipator.

If temperature is constant, thermal conductivity is a value inherent to a particular substance. According to Fourier's Law, in a static state, the proportionality constant is thermal conductivity.

Thermal Conductivity λ

$$Q = \lambda \frac{(T_1 - T_2)A}{L} \Rightarrow \lambda = \frac{Q}{A} \times \frac{L}{(T_1 - T_2)}$$

Q:Quantity of heat transmission A:Cross sectional area of test piece L:Thickness of test piece
T1:Temperature of high temperature side T2:Temperature of low temperature side

Thermal resistance is the sum of contact resistance plus the resistance present as a quantity of heat (Q) flows between temperatures at T1 and T2.

Thermal Resistance

$$R_o = \frac{T_1 - T_2}{Q} = \frac{L}{\lambda A} \Rightarrow R = R_o + R_s$$

Ro:The conventional thermal resistance of the substance Rs: The contact thermal resistance

Measurement of Thermal Conductivity

Hot-wire method
JIS R 2616

Measurement method used for liquid silicone rubbers. A probe (hot wire and thermocouple) is placed on top of a sample, and temperature change, voltage, amperage and thermal conductivity over time are measured.

Hot disc method
ISO 22007-2

Measurement method used for rubber finished products and oil compounds.
A constant current is supplied to a sensor sandwiched between samples.
The sensor is heated to a constant temperature, and the rise in temperature is measured by the change in impedance to the sensor, from which thermal conductivity is calculated.

Laser flash method
ASTM E-1461

Measurement method used for double sided thermal interface silicone tapes TC-SAS series and phase change materials.
A sample is illuminated with a laser, and the thermal diffusivity of the sample is derived from the rise in temperature of the sample. This is used to calculate thermal conductivity.

Low-molecular-weight (LMW) Siloxane

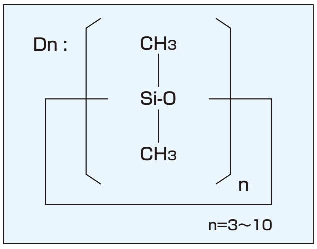
What is LMW siloxane?

The figure shows the chemical formula of low-molecular-weight siloxane, a nonreactive cyclic dimethyl polysiloxane (generally D_3-D_{10}), which is volatile and therefore sublimates into the atmosphere both during and after curing. As shown below, LMW siloxane has been reported to cause electrical contact failure under certain conditions.

* Almost all of products in this catalog reduce low molecular siloxane content.

LMW siloxane content in TC Series

Grade	ΣDn(ppm) (n=3-10)
TC-TA-1	40
TC-TAG-2	30
TC-TAG-3	10 >
TC-TAP-2	10 >
TC-30BG	10 >
TC-30C-CP	10 >
TC-30S2-CP	10 >



Electrical Contact Failure

It has already been noted that various substances may lead to contact failure. Contact failure may be caused by organic materials such as human body oils and organic gases, or inorganic materials such as hydrogen sulfide and ammonia gas. Electric and electronic manufacturers report that LMW siloxane can cause contact failure in the low-voltage, low-current range.

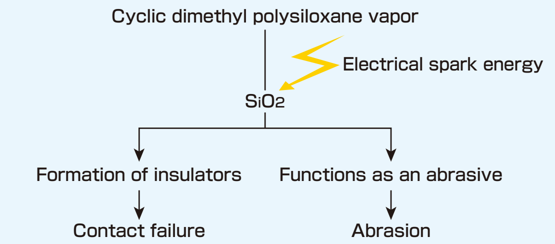
Relationship of load conditions to contact reliability

*Effects of load on contact reliability(micro-relay)

	Load		Presence of Si accretion at point of contact(Y/N)	Contact resistance
1	DC1V	1mA	N	No increase measured
2	DC1V	36mA	N	Occasional increase of several ohms
3	DC3.5V	1mA	N	No increase measured
4	DC5.6V	1mA	Y	No increase measured
5	DC12V	1mA	Y	Increase of several ohms, up to infinity
6	DC24V	1mA	Y	Around 1500 times, readings of infinity were seen; at 3000 times, all were infinity
7	DC24V	35mA	Y	Around 3000 times, readings of infinity were seen; at 4500 times, all were infinity
8	DC24V	100mA	Y	No increase measured
9	DC24V	200mA	Y	No increase measured
10	DC24V	1mA	Y	No increase measured
11	DC24V	4mA	Y	No increase measured

[Test conditions] Switching frequency1 Hz, temp:. room temperature, contact force13 g
Presented by The Institute of Electronics, Information and Communication Engineers(corporation), Yoshimura and Itoh EMC76-41 Feb. 18, 1977.

Mechanisms of contact failure



The prime ingredient of RTV silicone rubbers is dimethyl polysiloxane which derives from the normal manufacturing process containing ring structures in trace amounts. Because this cyclic dimethyl polysiloxane is nonreactive and volatile, it sometimes vaporizes in the air after curing. As shown in the figure above, this sublimated cyclic dimethyl polysiloxane can be a mechanism of contact failure under certain conditions.

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Gunma Complex	ISO 9001 (JCQA-0004	ISO 14001 JCQA-E-0002)
Naoetsu Plant	ISO 9001 (JCQA-0018	ISO 14001 JCQA-E-0064)
Takefu Plant	ISO 9001 (JQA-0479	ISO 14001 JQA-EM0298)

MS CM003
MS CM009

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This is an edited version of the product data released on Mar. 2025.

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