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. 0.5 to 6.5 W/m·K

Air: approx. 0.03 W/m·K

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**Product Lineup**

**Sheet Products**

**Thermal Interface Insulating Silicone Rubber Sheets**

**Main Products:** TC-TA Series

- **Features**
  - Easy to use, excellent stability
  - There are a variety of shapes, such as sheets, caps, tubes, etc.
  - Excellent electrical insulation

- **Structure**
  - TC-TA-1: Silicone rubber
  - TC-TA-2: Glass cloth
  - TC-TA-3: Polyimide film

- **Schematic diagram**

**Thermal Interface Silicone Soft Pads**

**Main Products:** TC-CA Series

- **Features**
  - Easy to use
  - Soft, excellent adhesion
  - Excellent electrical insulation

- **Structure**
  - Single layer type
  - Composite type

- **Condensation Cure Type RTV Silicone Rubbers**

- **Addition Cure Type RTV Silicone Rubbers**

- **Hardenable Adhesive/ Potting Materials**

- **Gap Filler SDP Series & CLG Series**

**Main Products:** PCS Series

- **Features**
  - Thermal softening sheet with excellent workability
  - Low contact thermal resistance
  - Available for low BLT

**Double Sided Thermal Interface Silicone Tapes**

**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**

**Main Products:** PCS Series

- **Features**
  - Thermal softening sheet with excellent workability
  - Low contact thermal resistance
  - Available for low BLT

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**Liquid and Grease Products**

**Thermal Interface Oil Compounds**

**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 Thermal Interface Oil Compounds**

**Main Products:** G-1000 Series

- **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

**Soft cured sample of G-1000**

**Soft cured sheet of SDP series**
Suitable Applications
• Substitute for insulating paper
• Thermal dissipation in areas where insulation is to be ensured only by sandwiching a thin sheet

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

![Image of a thin sheet of insulation with text](image)

Thick sheet that ensures insulation

Compatible with the shape of tubes and caps as required

General Properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test method</th>
<th>TC-TAG-1 series</th>
<th>TC-TAG-2 series</th>
<th>TC-TAG-3 series</th>
<th>TC-TAG-6 series</th>
<th>TC-TAG-8 series</th>
<th>TC-BG series</th>
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</table>

Application Examples

![Image of a transistor heat dissipation](image)

Instructions for Use

![Image of a transistor heat dissipation](image)
**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.

**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**
  - Protective film (polyethylene)
  - Silicone soft pad

- **Multi-layer type (TC-SP-1.7 Series)**
  - Non-stick side: Glass cloth containing thermal conductive silicone rubber
  - Protective film (PET)
  - Adhesive side: Silicone soft pad

**Application Examples**

- Radiating heat from uneven heat sources
- Temporary fixation is possible at the time of mounting.

**General Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TC-HSV-1.4 Series</th>
<th>TC-TXS Series</th>
<th>TC-TXS2 Series</th>
<th>TC-SP-1.7 Series</th>
<th>TC-CAS-10 Series</th>
<th>TC-CAB-10 Series</th>
<th>TC-CAD-10 Series</th>
<th>TC-CAT-10 Series</th>
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<td>Dielectric breakdown voltage in oil, kV</td>
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<td>—</td>
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<td>LOI, %</td>
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<td>150</td>
<td>240</td>
<td>220</td>
<td>180</td>
<td>260</td>
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</table>

*Please contact our sales department for details on other thicknesses of the product lineup.
†† Hardness Asker C is measured by scratching a square groove on an object using a stainless steel needle.
‡‡ Hardness Asker C is measured by scratching a square groove on an object using a stainless steel needle.

**Contact**

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

5
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

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

<table>
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<th>Parameter</th>
<th>Test method</th>
<th>TC-10SAS</th>
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<td>Thickness**</td>
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<td>100</td>
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<td>Flame resistance UL94</td>
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</table>

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

Unsuitable Applications
- Heat dissipation in the vertical region

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°C
- When compression is applied in a heat softened state, the BLT becomes low.
- The wettabiltiy is improved by the self-heating of the device even after mounting.
- Excellent pumpout resistance

Application Examples

- Insulation between LED light sources and heatsinks

- Insulation between LED light source and heatsink + Base plate

Model of heat softening

Before softening
- Heatsink
- Phase change material
- Heat source

After softening
- Improved adhesion reduces contact thermal resistance

<table>
<thead>
<tr>
<th>Parameter</th>
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<td>V-0 equivalent</td>
<td>V-0 equivalent</td>
<td>V-0 equivalent</td>
<td>V-0 equivalent</td>
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</tbody>
</table>

*1) After heating and compression at 50 µm/100°C for 1 s
*2) If Bimetallic foil, on the phase change material
*3) Measure at the initial thickness

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

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

Application to the heating element

Model of an application site
- TIM2
- Heatsink
- Heat spreader
- Heating element

Thermal dissipation of LED headlamps for automobiles

General Properties

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<th>G-775</th>
<th>G-777</th>
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* Values of BLT thickness
*1 Tested in accordance with JIS K 2220 "25°C Unworked"

Contact
Sales and Marketing Department
Phone: +81-(0)3-3246-5152
Thermal Interface RTV 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

**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)

**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

**Consistency**
Paste, medium and low-viscosity liquids

---

**Application Examples**

**General Properties**

**Adhesive**

**Thermal dissipation bonding of the notebook PC adapter**

**Model of contents of a notebook PC adapter**

**Thermal Interface RTV Silicone Rubber Adhesive (Red Portion)**

**Metal frame**

---

**Potting Agent**

**Application Examples**

**General Properties**

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

---

**Contact**
Sales and Marketing Department  Phone: +81-(0)3-3246-5152
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

Features
- Usable for a variety of heating element shapes
- SDP Series: Two-component ……………………. Cures into a soft sheet at room temperature to relieve stress room temperature addition cure type Curing time can be shortened by heating.
- CLG Series: One-component uncured 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

Cure data

SDP Series: Two-component Room Temperature Addition Cure Type

Before curing:
Appearance
A: White B: Gray
Graphite white & Black
Graphite white & Black

Viscosity at 23°C Pa-s
A: 103 B:72* A: 181 B:162* A:282 B:288* (\[\text{At} 25^\circ \text{C}\])

Mixed viscosity at 25°C Pa-s
89* 169* 284*

Touch drying time min
360 360 360

Pot life at 23°C min
240 240 240

Specific gravity at 25°C
A:3.08/B:3.07 A:3.25/B:3.26 A:3.3/B:3.20

After curing
Density at 23°C g/cm³
3.09 3.27 3.34

Hardness Shore D
44 42 61

Asker C
17 16 30

Tensile strength MPa
0.1 0.1 0.1

Elongation at break %
40 50 20

Volume resistivity TO-m
0.018 0.031 0.028

Dielectric breakdown strength kV/mm
20 21 20

Flame resistance UL94 V-0 equivalent V-0 equivalent V-0 equivalent

CLG Series: One-component Non-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

General Properties

Parameter
Product name
CLG-2500
CLG-3500
CLG-4500

Thermal conductivity W/m-K
2.9 3.3 4.8

Appearance
White grease

Specific gravity at 25°C
2.9 3.1 3.2

Viscosity at 25°C Pa-s
500 250 550

Dielectric breakdown strength kV/mm
6.2 8.5 4.7

Use temperature limit °C
-40 to 180

Flame resistance UL94 V-0 equivalent

(Not specified values)

Contact: Sales and Marketing Department IV Phone:+81-(0)3-3246-5152
# Thermal Conductive Characteristics List

<table>
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<tr>
<th>Type</th>
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<th>Thermal conductivity, Bulk elastomer W/m·K</th>
<th>Thermal conductivity of products W/m·K</th>
<th>Thermal resistance cm²·K/W</th>
<th>Test method</th>
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*Thermal conductivity of the phase change material

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<th>Test method</th>
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(Note: specified values)
Measurement and Evaluation of Thermal Properties

Two values which represent the thermal properties of thermal interface materials are thermal conductivity (\( \lambda \)) 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.

\[
\text{Thermal Conductivity} \quad \lambda = \frac{Q}{A \cdot L \cdot (T_1 - T_2)}
\]

\[
\text{Thermal Resistance} \quad R = \frac{R_o + R_s}{R_o \cdot R_s}
\]

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
R: The conventional thermal resistance of the substance
R_s: The contact thermal resistance

Measurement of Thermal Conductivity

**Hot-wire method**
JIS R 2616

Measurement method used for RTV 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, 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 \( \text{D_3-D_{10}} \)), 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.*

**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)

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<th>1 mA</th>
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</table>

**Mechanisms of contact failure**

- Cyclic dimethyl polysiloxane vapor

SO_2

- Formation of insulators
- Functions as an abrasive
- Contact failure
- Abrasion

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.
Silicone Division
6-1, Ohtemachi 2-chome, Chiyoda-ku Tokyo, Japan

<Thermal Interface Insulating Silicone Rubber Sheets> <Thermal Interface Silicone Soft Pads>
<Double sided Thermal Interface Silicone Tapes> <Thermal Softening Sheets Phase Change Materials>

Sales and Marketing Department III
Phone : +81-(0)3-3246-5101 Fax : +81-(0)3-3246-5364

<Thermal Interface Oil Compounds> <Thermal Interface RTV Silicone Rubbers> <Gap Fillers>
Sales and Marketing Department IV
Phone : +81-(0)3-3246-5152 Fax : +81-(0)3-3246-5362

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