



Shin-Etsu Silicone

RTV Silicone Rubber

for Electrical & Electronic Applications



Safe and eco-friendly

RTV Silicone Rubber

Making electrical & electronic equipment more reliable.

Electronic devices and electrical modules are constantly evolving in performance and functionality while becoming smaller and more lightweight.

At the same time, “green design” has become the norm.

These factors have created a demand for materials that offer higher quality, higher functionality and more eco-friendly properties.

- ▶ Boosting the reliability of car electronics, where safety and low environmental impact are key concerns
- ▶ Boosting the reliability of next-generation energy systems including solar cells, wind power, and fuel cells
- ▶ Boosting the reliability of PCUs (Power Control Units), which are essential to making consumer electronics, hybrid vehicles, electric vehicles and railways more energy efficient; and that of power modules including power conditioners, which are critical components of alternative energy systems including solar and wind power
- ▶ Telecommunications and optoelectronics, including eco-friendly LEDs
- ▶ Thermal interface technologies that help protect electronic devices from heat

These and many other leading-edge technologies would not exist without RTV silicone rubber. At Shin-Etsu, we're developing RTV rubber products that contribute to more comfortable living and to advancements in eco-friendly electronics technology.



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Features of silicone

Silicones have an amazing array of properties.

Silicones consist of a main chain of inorganic siloxane linkages (Si-O-Si) plus side chains which contain organic groups. **Silicones are hybrid polymers that contain both inorganic and organic components.**



The main chain of a silicone consists of siloxane linkages which are stable and have a high bonding energy.

Compared to organic polymers, which have a carbon skeleton (C-C/bonding energy: 85 kcal/mol), silicones have superior **heat resistance and weatherability** (UV light, ozone). This is due to the greater stability of siloxane bonds, which have a bonding energy of 106 kcal/mol.

With their long bond length and high bond angle, siloxane bonds have weak intermolecular forces and move freely.

Siloxane bonds have a bond length of 1.64 Å and bond angle of 134°. Compared to carbon bonds (bond distance: 1.54 Å, bond angle: 110°), they have a long bond distance and high bond angle, and a low rotational energy barrier. As a result, siloxane bonds move more freely and intermolecular forces are weak. These characteristics manifest themselves in features of the silicone material, including **softness, gas permeability, cold resistance, and little change in viscosity due to temperature changes.**

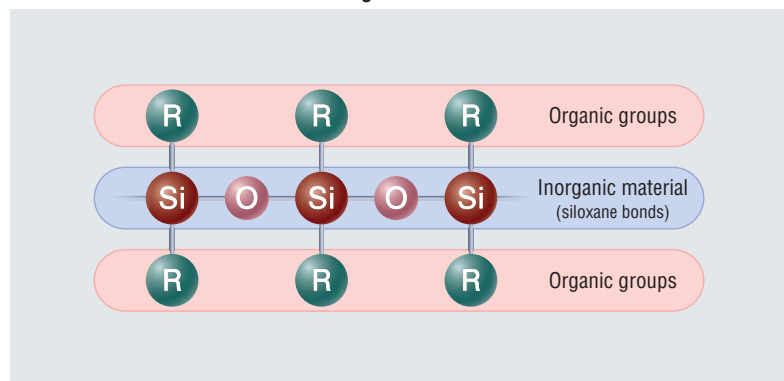
The molecules of silicone polymers are covered by hydrophobic methyl groups, and surface energy is low.

The backbone of a silicone polymer molecule is a twisted helical structure. The molecules are almost completely covered by hydrophobic methyl groups, and surface energy is low. This gives rise to unique properties including **water repellency and easy release.**

Moreover, silicones are low-polarity polymers, so they absorb **little moisture.**

Silicones: compounds which feature a main chain of siloxane bonds

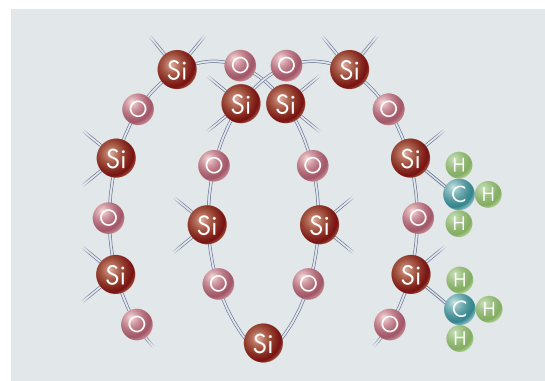
Features attributable to siloxane linkages



- Heat resistance
- Weatherability
- Flame resistance
- Radiation resistance
- Chemical stability
- Electrical properties

Si-O bonds: 106 kcal/mol
C-C bonds: 85 kcal/mol
C-O bonds: 76 kcal/mol

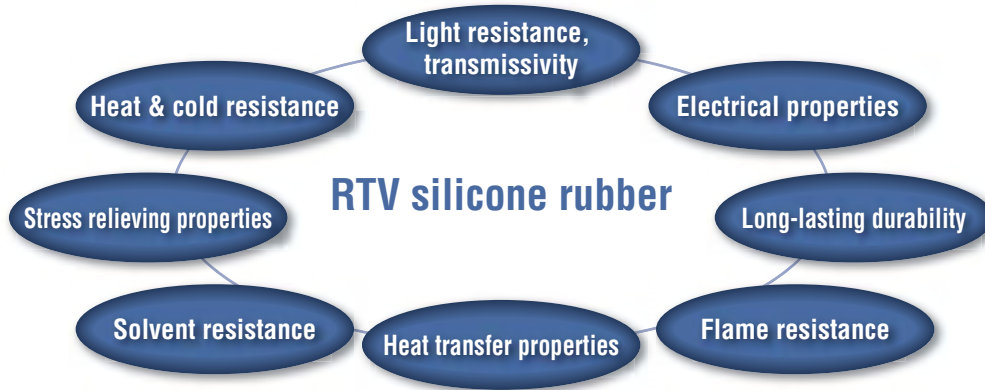
Features attributable to molecular structure



- Water repellency
- Cold resistance
- Release properties
- Compression characteristics

Helical (spiral) structure
Intermolecular forces are weak

Main property requirements for RTV silicone rubbers for electrical & electronic



Feature 1 Light resistance & transmissivity

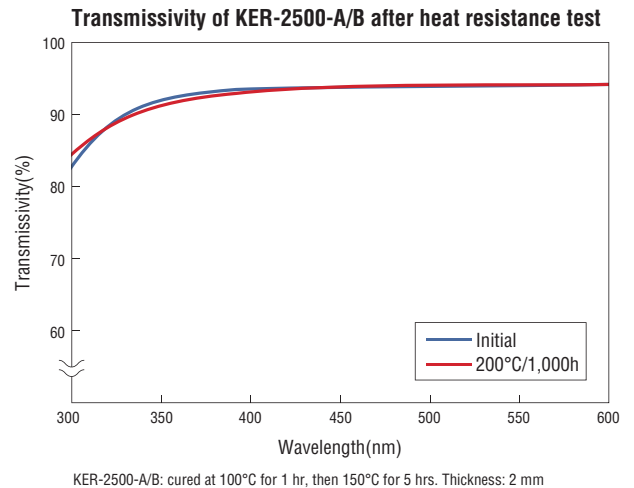
Silicone materials can be used for fastening and encapsulation of LEDs and other light receiving/emitting devices without harming the optical characteristics of the optical device.

Feature 2 Heat & cold resistance

Silicone can be used in temperatures from -50°C to $+250^{\circ}\text{C}$. Even in continuous use, RTV silicone rubber offers stable performance in a wide temperature range (-40°C to $+180^{\circ}\text{C}$) and does not lose its rubber elasticity.

Feature 3 Electrical properties

Silicone exhibits consistent electrical properties even when subjected to environmental changes (temperature, humidity, etc.). This makes silicone a good insulator for high voltage components of transformers and other equipment.



3-1. Tracking resistance of KE-3467 & KE-1867

Product name \ Voltage	300 V	800 V
KE-3467	Pass	Pass
KE-1867	Pass	Pass

How CTI value is measured
 CTI is measured by dripping 50 drops of an electrolyte solution onto an insulating material at a rate of one drop every 30 seconds*, and the CTI value is the maximum voltage at which no tracking failure occurs. The larger the CTI value, the more resistant the material is to tracking.
 *ASTM D 3638-85 (IEC 112)
 Conditions stipulated in "Standard Test Method for Comparative Tracking Index of Electrical Insulating Materials".

(Not specified values)

3-2. Volume resistivity & dielectric breakdown strength of KE-3490 at $85^{\circ}\text{C}/85\% \text{RH}$

	Initial	240h	480h	960h	1,440h
Volume resistivity $\text{T}\Omega\cdot\text{m}$	3.6	21	32	40	53
Relative permittivity 50Hz	3.1	3.2	3.1	3.0	3.1
Dissipation factor 50Hz	5×10^{-3}	4×10^{-3}	3×10^{-3}	3×10^{-3}	3×10^{-3}
Dielectric breakdown strength kV/mm	32	31	31	30	29

Cure conditions: $23^{\circ}\text{C}/50\% \text{RH}$ x 7 days. Durability conditions: $85^{\circ}\text{C}/85\% \text{RH}$ x prescribed time

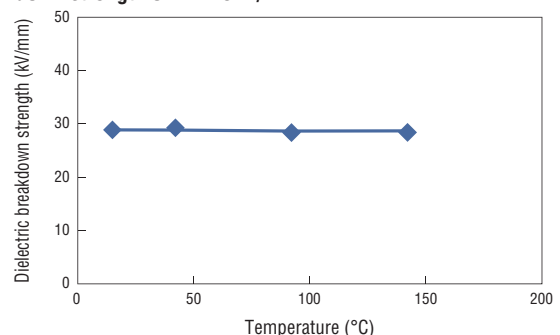
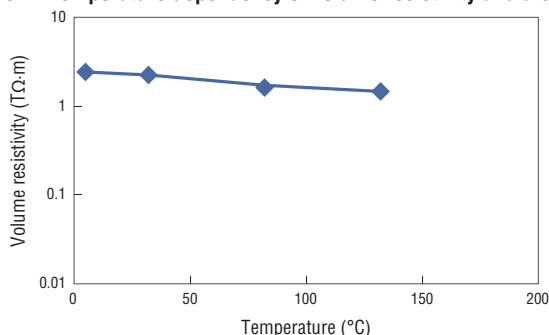
(Not specified values)

3-3. Volume resistivity & dielectric breakdown strength of KE-3490 after 150°C durability test

	Initial	$150^{\circ}\text{C} \times 250\text{h}$	$150^{\circ}\text{C} \times 500\text{h}$	$150^{\circ}\text{C} \times 1,000\text{h}$
Volume resistivity $\text{T}\Omega\cdot\text{m}$	3.6	6.0×10	2.9×10^2	7.0×10^2
Dielectric breakdown strength kV/mm	32	29	30	29

(Not specified values)

3-4. Temperature dependency of volume resistivity and dielectric breakdown strength of KE1204A/B

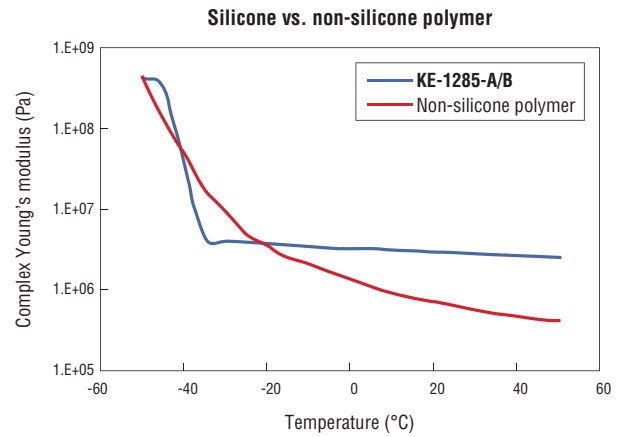
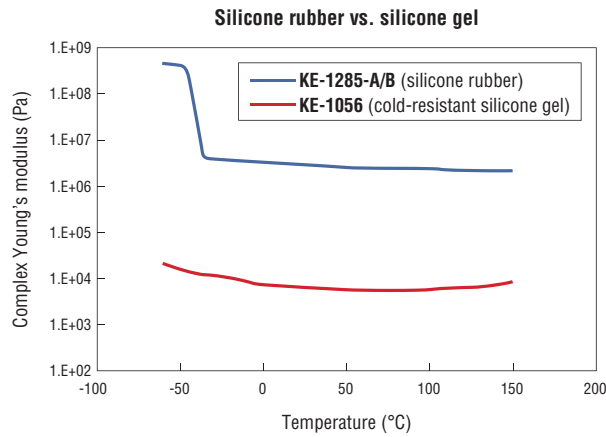


Feature 4

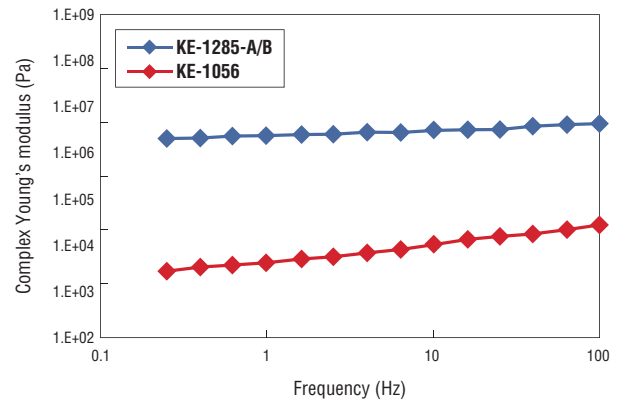
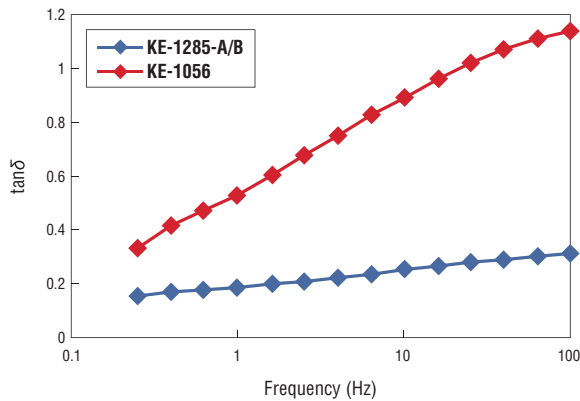
Stress relieving properties

Silicone is used for potting and encapsulation of bonding wires and other components of power semiconductor modules. Silicone protects electronic parts from stress and is effective across a wide temperature range.

4-1. Temperature dependency of complex Young's modulus of RTV silicone



4-2. Tan δ at -20°C / Frequency dependence of complex Young's modulus



Feature 5

Long-lasting durability

5-1. Physical properties of KE-1285 after 150°C durability test

	Initial	150h	300h	500h	650h	800h	1,000h
Hardness Durometer A	56	58	61	63	63	63	64
Elongation at break %	140	120	110	120	110	100	90
Tensile strength MPa	2.8	2.9	3.0	3.3	3.3	3.3	2.8
Density g/cm ³	1.72	1.72	1.73	1.72	1.73	1.73	1.73
Tensile lap-shear strength (Al/Al) MPa	1.5	1.7	1.5	1.7	1.9	1.6	1.8
Volume resistivity TΩ·cm	6.5	8.6x10	9.6x10	1.0x10 ²	1.5x10 ²	8.0x10	1.8x10 ²

(Not specified values)

5-2. Physical properties of KE-1285 after 85°C/85% RH durability test

	Initial	150h	300h	500h	650h	800h	1,000h
Hardness Durometer A	56	56	56	59	59	60	58
Elongation at break %	140	120	130	140	120	130	110
Tensile strength MPa	2.8	2.6	2.6	2.9	2.7	2.8	2.4
Density g/cm ³	1.72	1.72	1.72	1.72	1.72	1.72	1.72
Tensile lap-shear strength (Al/Al) MPa	1.5	1.5	1.4	1.7	1.5	1.4	1.4
Volume resistivity TΩ·cm	6.5	2.0x10	2.7x10	2.6x10	2.9x10	3.8x10	3.0x10

(Not specified values)

Feature 6

Solvent resistance

Change in volume of rubbers caused by various liquids (after 168 hr immersion)

(unit: %)

Liquid	Temperature °C	Nitrile			Chloroprene	Natural rubber	Styrene Butadiene	Butyl	Silicone*	Hypalon
		28%	33%	38%						
Gasoline	50	15	10	6	55	250	140	240	260	85
ASTM #1 oil	50	-1	-1.5	-2	5	60	12	20	4	4
ASTM #3 oil	50	10	3	0.5	65	200	130	120	40	65
Diesel oil	50	20	12	5	70	250	150	250	150	120
Formaldehyde	50	10	10	10	25	6	7	0.5	1	1.2
Ethanol	50	20	20	18	7	3	-5	2	15	5
Glycol	50	0.5	0.5	0.5	2	0.5	0.5	-0.2	1	0.5
Ethyl ether	50	50	30	20	95	170	135	90	270	85
Methyl ethyl ketone	50	250	250	250	150	85	80	15	150	150
Trichloroethylene	50	290	230	230	380	420	400	300	300	600
Carbon tetrachloride	50	110	75	55	330	420	400	275	300	350
Benzene	50	250	200	160	300	350	350	150	240	430
Aniline	50	360	380	420	125	15	30	10	7	70
Phenol	50	450	470	510	85	35	60	3	10	80
Cyclohexanol	50	50	40	25	40	55	35	7	25	20
Distilled water	100	10	11	12	12	10	2.5	5	2	4

* The values above are measured values for common dimethyl silicone rubber. Values will differ depending on the product.

Feature 7

Flame resistance

There are many UL certified products on the market.

A product's UL certification can be checked by referring to the directory at the following page: <http://iq.ul.com/iq/newiq/>

Check the following UL file numbers for details.

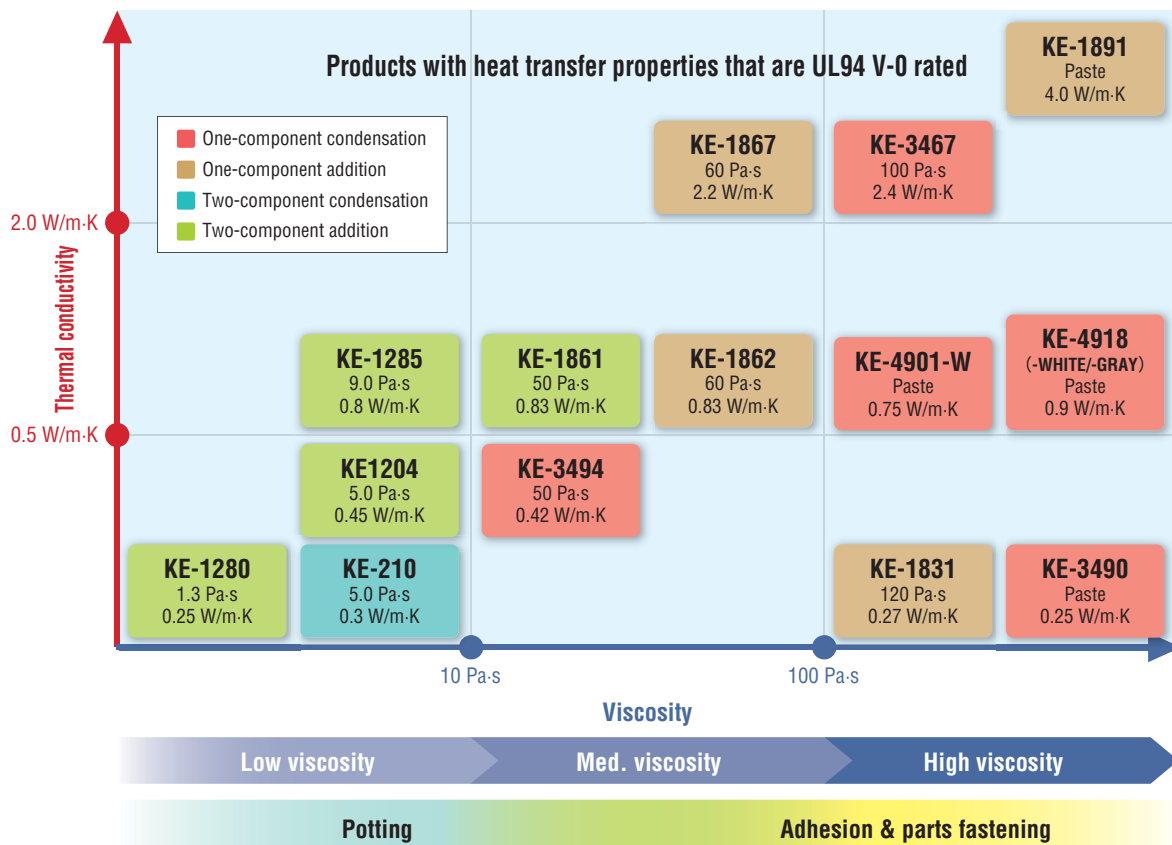
UL file numbers: **E48923, E179895, E174951, E255646, E192980**

Feature 8

Heat transfer properties

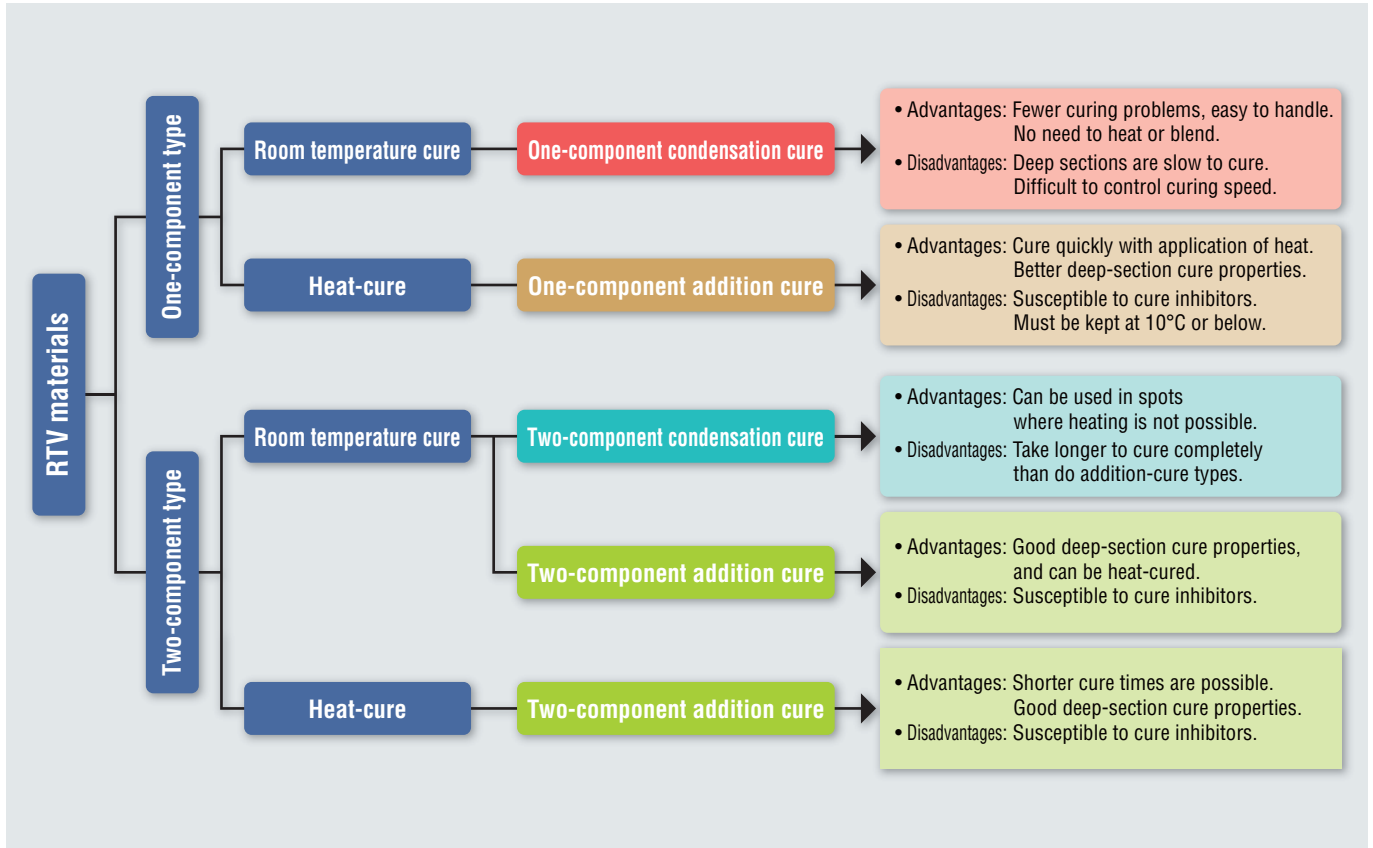
Silicone can help transfer heat generated by electronic devices to heat sinks and housings.

Some Shin-Etsu products that have both flame resistance and heat transfer properties are presented below. Be sure to choose a product suitable for the intended use.



Basic information about RTV silicone rubber

Types of RTV silicone rubber



Viscosity and workability

● Viscosity before curing

Generally speaking, RTV silicone rubber products start as a liquid and cure to become an elastic body. The viscosity values listed in this catalog should provide a guideline as to workability.

Flowable, low viscosity products are suitable for potting and coating.

Medium viscosity products and non-flowable high viscosity products (paste consistency) are suitable for sealing and adhesion or fastening of parts.



Curing reactions

Some RTV silicone rubbers cure at room temperature, while others cure with the application of heat. And in each category, products are available in one-component and two-component formats. Furthermore, the curing reaction may be a condensation reaction or an addition reaction. Each has its own advantages.

● Condensation reaction

These products release reaction byproducts (outgas) as they cure. Based on the type of reaction byproducts they release, products are categorized as alcohol-cure, acetone-cure, or oxime-cure products. One-component condensation cure products cure by reacting with moisture in the air. The cure reaction starts at the surface in contact with the air and proceeds inward.

Curing speed is dependent on temperature and humidity. If thickness is 1 mm, it takes about 24 hours for the material to become a fully cured elastic body.

However, it takes about three days to achieve full mechanical strength,

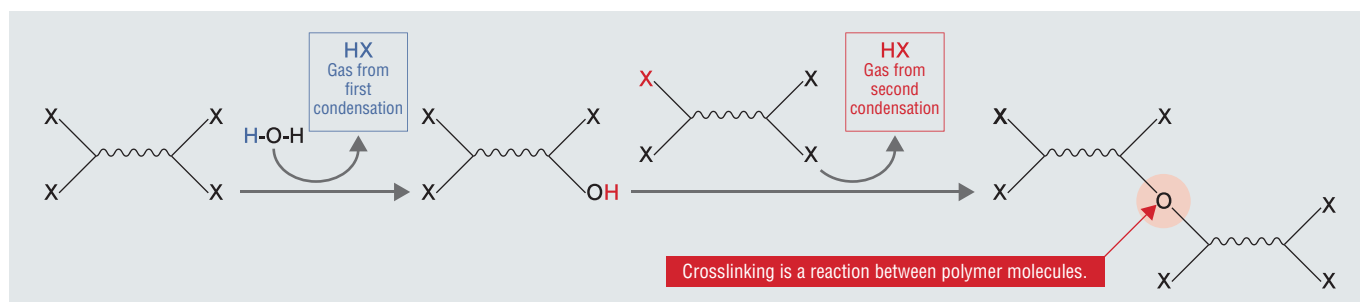
When choosing an RTV silicone rubber product, the user must consider a range of factors. These include elements of workability such as viscosity and curing conditions, performance parameters such as hardness, flame resistance and thermal conductivity; and the advantages and disadvantages of the different types of curing reactions.

and can take up to seven days to achieve the desired electrical properties and other characteristics.

These products are generally not suitable for use as an adhesive for sticking materials together with a large contact area, but may be suitable in certain cases depending on the size and moisture permeability of the substrates.

Two-component condensation cure products cure when the main component and curing agent are mixed together. The reaction occurs throughout the material, and as is the case with one-component products, reaction byproducts are released.

Note: Irrespective of whether it is a one- or a two-component product, condensation-cure RTV silicone rubber products require moisture to cure, and outgas during the curing process. These products are thus not suitable for applications that involve airtight enclosures.

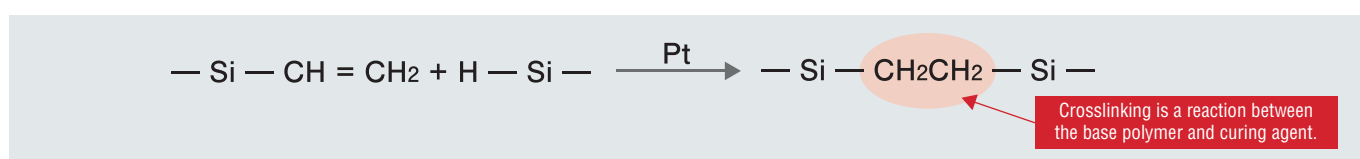


● Addition reaction

The base polymer (a silicone polymer which contains vinyl groups) reacts with the curing agent (a silicone polymer which contains hydrogen groups) with the aid of a platinum catalyst. It is through this hydrosilylation reaction that the material cures.

With addition-cure RTV silicone rubber products, the user has greater control over the cure time, which can be useful in terms of increasing productivity.

Note: However, contact with certain compounds can cause poor curing or adhesion, so these products must be used with a certain amount of care.



Cure inhibition

When using addition-cure RTV silicone rubber products, it is important that the user have a good understanding of the problem of cure inhibition. The substances that can cause cure inhibition do so in one of the two following ways.

Causes of poor curing

1. The platinum catalyst forms complexes with certain other compounds, and the catalytic action is inhibited.
2. The curing agent becomes contaminated with substances it can react with, and the curing agent is consumed.

Cure inhibitors

- Organic compounds that contain elements which include nitrogen, phosphorus and sulfur.
- Ionic compounds of heavy metals such as tin, lead, mercury, bismuth and arsenic.
- Organic compounds that contain unsaturated groups, such as acetylene groups.

Substances that can react with curing agents

- Alcohol, water.
- Organic acids such as carboxylic acid.

Specific examples of cure inhibition

- Organic rubber: vulcanized rubber, anti-aging agent (e.g. gloves).
- Epoxy & urethane resin: amine- and isocyanate-based curing agents.
- Condensation-cure RTV silicone rubber: use of tin-based catalysts in particular.
- Soft PVC: plasticizers, stabilizers.
- Solder flux.
- Engineering plastics: flame retardants, heat resistance improvers, UV absorbers.
- Moisture that has been absorbed by materials which are in contact with the uncured material.
- Outgassing from solder resist or PCB (caused by heating when curing the silicone).

Low-molecular-weight siloxane and electrical contact failures

● What is low-molecular-weight siloxane?

Low-molecular-weight (LMW) siloxane is shown in the chemical formula on the right. It is non-reactive cyclic dimethyl polysiloxane (generally D₃-D₁₀) that is volatile, meaning it will vaporize into the air during the cure process and even after curing.

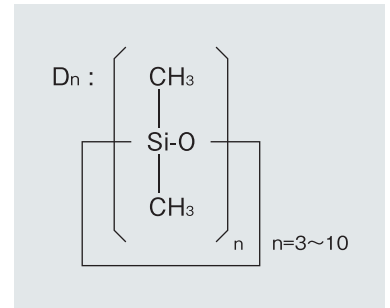
It has been reported that, in certain conditions (described below), LMW siloxane can cause electrical contact failures.

● Reduced LMW siloxane products (designed to reduce incidence of electrical contact failures)

These are products in which LMW siloxane has been reduced to a prescribed level. LMW siloxane is known to cause electrical contact failures in certain conditions.

For most Shin-Etsu products, this means a ΣD_n (n=3-10) of 300 ppm or less, or 500 ppm or less.

The risk of electrical contact failures is also affected by the conditions described below, so these products do not represent an absolute solution. Nonetheless, reduced LMW siloxane products are still recommended for electrical and electronic applications.



Amounts of LMW siloxane in regular products and reduced LMW siloxane products (sample data on uncured material)

D _n	KE-45 (Regular product)	KE-3490 (Reduced LMW siloxane product)
3	10 >	10 >
4	500	10 >
5	260	10 >
6	240	10 >
7	220	10 >
8	160	50
9	170	50
10	220	60
ΣD_n (n=3-10)	1,770	160

KE-3490 is a reduced LMW siloxane product with ΣD_n (n=3-10) controlled to 300 ppm or less.

(Not specified values)

[GC conditions] GC: gas chromatography
 Device Capillary gas chromatograph, Shimadzu model GC-14A
 Column DURABOND DB-1701
 Column Temp. 50°C → 300°C (15°C/min)
 Inj. Temp. 300°C
 Carrier Gas He (30cm/sec)
 Detector: FID
 Injection volume: 2 μl
 Extraction solvent: acetone

● Electrical contact failures

A number of substances have been reported to cause contact failures. Contact failures may be caused by organic materials such as human body oils and organic gases, or inorganic materials such as hydrogen

sulfide and ammonia gas.

Manufacturers of electrical and electronic equipment report that LMW siloxane can also cause contact failure at low voltages and low currents.

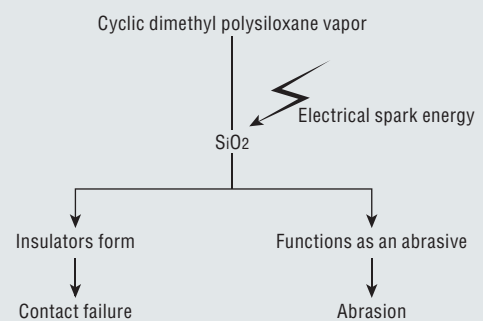
■ Relationship between load conditions and contact reliability

Effects of load on contact reliability (micro-relay)

Load			Si present on contact surfaces (Y/N)	Contact resistance
1	DC1V	1mA	N	No increase observed
2	DC1V	36mA	N	Increase of several ohms
3	DC3.5V	1mA	N	No increase observed
4	DC5.6V	1mA	Y	No increase observed
5	DC12V	1mA	Y	Increase of several ohms, some readings of infinity
6	DC24V	1mA	Y	Readings of infinity were seen at around 1,500 cycles; at 3,000 cycles, all were infinity
7	DC24V	35mA	Y	Readings of infinity were seen at around 3000 cycles; at 4,500 cycles, all were infinity
8	DC24V	100mA	Y	No increase observed
9	DC24V	200mA	Y	No increase observed
10	DC24V	1A	Y	No increase observed
11	DC24V	4A	Y	No increase observed

[Test conditions] Switching frequency: 1 Hz, Temp.: room temperature, Contact force: 13 g
 Source: The Institute of Electronics, Information and Communication Engineers, Yoshimura and Itoh EMC76-41 Feb. 18, 1977.

■ Mechanism of contact failure



The main ingredient of RTV silicone rubber is dimethyl polysiloxane HO-[Si(CH₃)₂O]_n-H, which has a degree of polymerization between 200 and 1,000. The dimethyl polysiloxane obtained in the normal manufacturing process does contain small amounts of cyclic products. This cyclic dimethyl polysiloxane is nonreactive and volatile, and thus will vaporize into the air during the cure process and even after curing. Under certain conditions, this vaporized cyclic dimethyl polysiloxane can cause contact failures, according to the mechanism shown above.

Product lists

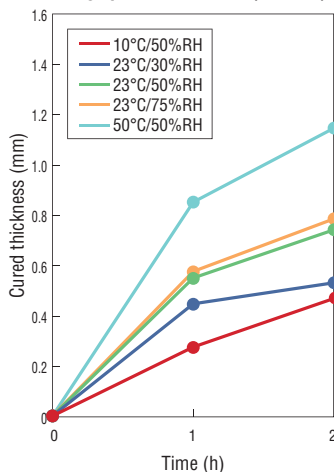
Adhesives & Sealants

Cure system	One-component condensation									
Product name	KE-3490	KE-3493	KE-3494	KE-3497	KE-3498	KE-3466	KE-3467	KE-3412	KE-4806-W	KE-4901-W
Brief description	Flame resistant, for fastening of power supply components	Low specific gravity, heat transfer properties	Flame resistant	—	—	Flame resistant, enhanced heat transfer properties	Flame resistant, enhanced heat transfer properties	High heat resistant	For filling*	Flame resistant, heat transfer properties, for fastening of power supply components
Byproduct gas	Acetone	Acetone	Acetone	Acetone	Acetone	Acetone	Acetone	Acetone	Alcohol	Alcohol
Before curing										
Consistency	Paste	Paste	Med. viscosity	Med. viscosity	Paste	Med. viscosity	High viscosity	Med. viscosity	High viscosity	Paste
Appearance	Gray	White	Gray	White, Milky white translucent	White	White	White	Black	White	White
Viscosity Pa·s	—	—	50	40	—	50	100	90	150	—
Density 23°C g/cm ³	1.18	1.46	1.40	1.07	1.07	2.80	2.90	1.06	1.05	1.59
Tack-free time min	3	1	8	13	1	7	4	6	7	8
Curing conditions & standard cure time	23±2°C/50±5% RH×7days									
After curing										
Hardness Durometer A	43	73	35	35	45	88	91	40	24	53
Tensile strength MPa	2.5	2.0	2.5	3.5	3.9	3.1	3.6	2.7	1.5	2.6
Elongation at break %	350	30	250	250	480	30	30	270	350	120
Volume resistivity TΩ·m	3.0	1.0	3.0	2.0	1.0	2.9	5.9	6.0	40.0	3.4
Dielectric breakdown strength kV	28	35	25	24	25	24	25	28	24	30
Relative permittivity 50Hz	3.3	4.2	3.5	3.0	3.0	5.9	4.6	3.1	3.1	3.8
Dissipation factor 50Hz	1×10 ⁻²	2×10 ⁻³	1×10 ⁻²	3×10 ⁻³	1×10 ⁻³	4.7×10 ⁻³	4.0×10 ⁻³	1×10 ⁻²	1×10 ⁻³	0.18
Thermal conductivity W/m·K	0.25	1.60	0.42	0.21	0.21	1.90	2.40	0.21	—	0.75
Tensile lap-shear strength (Al/Al) MPa	1.5	0.8	1.5	0.7	1.5	0.5	0.5	1.0	—	1.3
LMW siloxane content ΣD ₃ -D ₁₀ ppm	< 300	< 300	< 300	< 300	< 300	< 300	< 300	< 300	< 500	< 300
Flame resistance UL94	V-0	—	V-0	HB	—	V-1	V-0	—	—	V-0

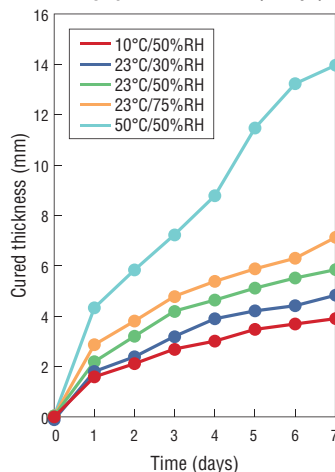
* Does not inhibit curing of addition-cure RTV silicone rubber.

(Not specified values)

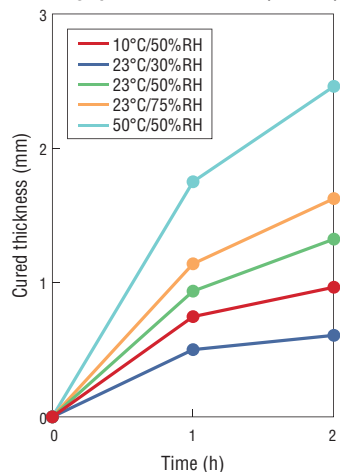
Effect of temperature & humidity on curing speed of KE-3490 (2 hours)



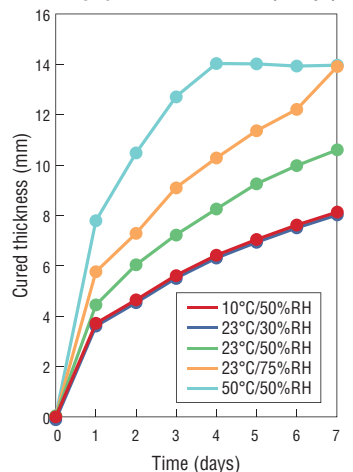
Effect of temperature & humidity on curing speed of KE-3490 (7 days)



Effect of temperature & humidity on curing speed of KE-3495-W (2 hours)



Effect of temperature & humidity on curing speed of KE-3495-W (7 days)



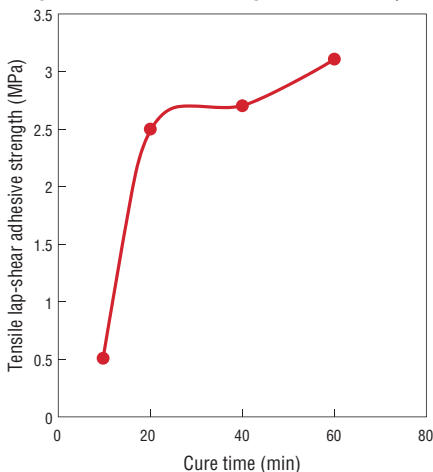
Adhesives & Sealants

Cure system	One-component addition									
Product name	KE-1828	KE-1831	KE-1833	KE-1850	KE-1854	KE-1855	KE-1880	KE-1884	KE-1885	IO-SEAL-300
Brief description	Fluorescent bulb sealant	Flame resistant	High heat resistant	High heat resistant	High heat resistant, Thixotropic	High adhesive strength	High heat resistant	Low-temperature cure	Low-temperature cure	Low-temperature cure
Before curing										
Consistency	Paste	Paste	High viscosity	Paste	Paste	Paste	Med. viscosity	Med. viscosity	High viscosity	Paste
Appearance	White	Black	Reddish brown	Black	Black	Grayish white	Reddish brown	White	White	White
Viscosity Pa·s	—	120	140	85	260	66	90	55	100	50
Density 23°C g/cm ³	1.08	1.28	1.36	1.26	1.25	1.28	1.25	1.22	1.14	1.23
Curing conditions & standard cure time	120°C×1h						100°C×1h			120°C×1h
After curing										
Hardness Durometer A	55	30	33	29	30	66	33	35	36	31
Tensile strength MPa	5.0	3.9	3.4	2.6	3.5	6.7	4.3	3.5	2.9	2.8
Elongation at break %	180	400	330	320	480	150	350	230	230	270
Volume resistivity TΩ·m	—	2.0	2.0	—	—	5.0	—	10.0	10.0	—
Dielectric breakdown strength kV	—	25	25	—	—	25	—	25	25	—
Relative permittivity 50Hz	—	3.5	3.5	—	—	3.5	—	3.1	3.1	—
Dissipation factor 50Hz	—	5×10 ⁻³	5×10 ⁻³	—	—	5×10 ⁻³	—	1×10 ⁻³	1×10 ⁻³	—
Thermal conductivity W/m·K	—	—	—	—	—	0.27	—	—	—	—
Tensile lap-shear strength (Al/Al) MPa	3.0 (glass/glass)	2.3	1.8	1.2	1.8	3.5 (PPS/PPS) 3.6 (PBT/PBT)	2.3	1.6 (PBT/PBT)	2.0	1.5 (PPS/PPS) 1.3 (PC/PC)
LMW siloxane content ΣD ₃ -D ₁₀ ppm	—*	—*	—*	—*	—*	—*	—*	< 100	< 100	—*
Flame resistance UL94	—	V-0	—	—	—	—	—	—	—	HB

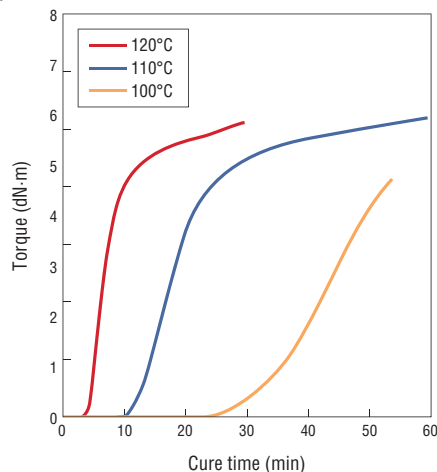
* Not a reduced LMW siloxane product.

(Not specified values)

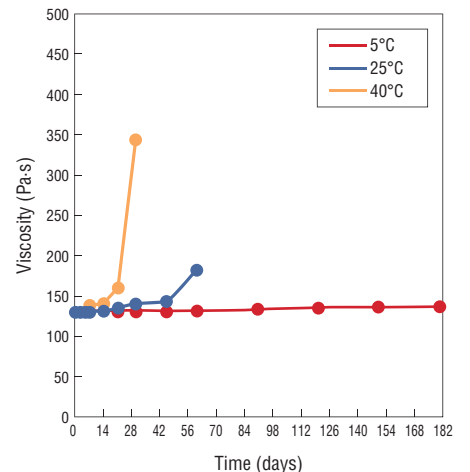
Relationship between cure speed and lap-shear adhesive strength of KE-1833 (120°C)



Cure speed and temperature of KE-1833



Storage stability of KE-1833



■ Potting agents (rubber)

Cure system	Two-component condensation		Two-component addition							
	KE-200	KE-210	KE1204 A/B	KE-1280-A/B	KE-1282-A/B	KE-1283-A/B*1	KE-1285-A/B	KE-109E-A/B	KE-1031-A/B	KE-106
Brief description	Fast cure, good deep-section cure properties, for PV (photovoltaic) applications.	Flame resistant, fast cure, good deep-section cure properties, for PV (photovoltaic) applications.	Flame resistant	Flame resistant, low specific gravity	Low stress, low volatile content.	For LED displays	Flame resistant, heat transfer properties, low viscosity	Low-temperature cure, for LED lighting	Low-temperature cure, for LED lighting	High strength
Byproduct gas	Acetone	Acetone	—	—	—	—	—	—	—	—
Before curing										
Consistency	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Low viscosity
Appearance	Colorless translucent	Black	A:Reddish brown B:Grayish white	A:Black B:Translucent	A:Black B:Grayish white	A:Black B:Milky white	A:Gray B:Grayish white	A/B: Transparent	A/B: Transparent	Transparent
Viscosity Pa·s	2.8	5.0	A:6/B:4	A:2/B:1.3	A:3.5/B:1.4	A:2.6/B:1.3	A:2.5/B:5	A/B:1	A:1/B:0.7	3.5
Mix ratio	100:10	100:10	100:100	100:100	100:100	100:100	100:100	100:100	100:100	100:10
Mixed viscosity Pa·s	2.2	4.5	5.0	1.7	2.6	1.5	9.0	1.0	0.8	3.3
Density 23°C g/cm ³	1.01	1.24	1.54	1.01	1.32	0.96	1.72	1.00	0.97	1.02
Pot life min	35*2	25*2	480*3	480*3	240*3	300*3	900*3	240*3	240*3	120*3
Curing conditions & standard cure time	23±2°C/50±5%RH×3days		100°C×15min	120°C×1h	90°C×2h	80°C×2h	120°C×1h	100°C×1h	80°C×2h	150°C×30min
Curing agent	CX-200	CAT-210	—	—	—	—	—	—	—	CAT-RG
After curing										
Hardness Durometer A	25	32	70	24	11	12 (Asker C)	56	25	20	56
Tensile strength MPa	0.4	0.7	3.5	0.6	0.7	0.2	2.8	1.3	0.4	8
Elongation at break %	100	100	70	140	160	300	140	140	150	100
Volume resistivity TΩ·m	60.0	7.7	1.0	1.0	1.0	1.0	6.5	6.0	0.1	3.0
Dielectric breakdown strength kV	20	25	27	25	24	25	26	23	20	23
Relative permittivity 50Hz	2.9	3.8	3.2	4.1	3.2	4.0	4.0	2.8	3.1	3.1
Dissipation factor 50Hz	3×10 ⁻³	1×10 ⁻²	1×10 ⁻³	1×10 ⁻³	1×10 ⁻³	1×10 ⁻³	1×10 ⁻²	6×10 ⁻⁴	1×10 ⁻³	5×10 ⁻³
Thermal conductivity W/m·K	0.21	0.30	0.45	0.25	0.40	0.25	0.80	0.15	0.15	0.15
Tensile lap-shear strength (Al/Al) MPa	0.4	0.8	—	0.2	0.4	0.2	1.5	0.2	0.1	—
LMW siloxane content ΣD ₃ -D ₁₀ ppm	< 300	—*4	< 500	—*4	< 500	—*4	< 500	—*4	—*4	—*4
Flame resistance UL94	V-1	V-0	V-0	V-0	—	V-1	V-0	—	—	—

*1 C Agent can be added to produce a matte finish. *2 Time to non-flow state *3 Time to double viscosity *4 Not a reduced LMW siloxane product.

(Not specified values)

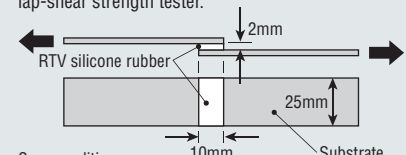
KE-1282-A/B: Effects of cure temperature and time on physical properties

Item	Temperature, time	80°C		85°C		90°C		95°C		105°C	
		60min	90min	60min	90min	60min	90min	60min	90min	15min	30min
Hardness Durometer A		7	9	9	10	9	11	11	11	8	10
Tensile lap-shear strength (Al/Al) MPa		0.35	0.34	0.34	0.34	0.35	0.30	0.32	0.31	0.34	0.40

(Not specified values)

Tensile lap-shear strength test method

RTV silicone rubber samples were cured as described in the figure, then tested using a lap-shear strength tester.



Cure conditions:
 Condensation-cure type 23±2°C/50±5% RH × 7 days
 Addition-cure type 120°C × 1 h
 RTV silicone rubber thickness: 2 mm
 Bonding surface: 10 × 25 mm
 Pull rate: 50 mm/min

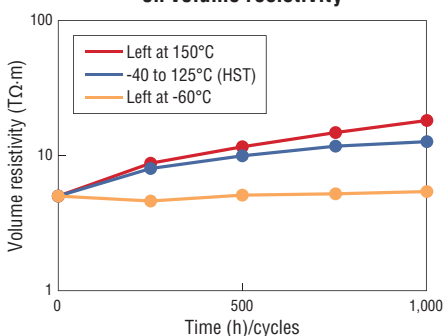
■ Potting agents (gel)

Cure system	One-component addition					Two-component addition				
Product name	KE-1014	KE-1056	KE-1062	KE-1151	KE-1869	KE-1011-A/B	KE-1012-A/B	KE-1013-A/B	KE-1051J-A/B	KE-1063-A/B
Brief description	—	Cold resistant	High heat resistant, cold resistant	Cold resistant, thixotropic	Heat transfer properties, cold resistant	—	—	For use as a binder	Room-temperature cure, high adhesion	High heat resistant, cold resistant, high adhesion
Before curing										
Consistency	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Med. viscosity	A/B: Low viscosity	A/B: Low viscosity	A/B: Low viscosity	A/B: Low viscosity	A/B: Low viscosity
Appearance	Pale yellow transparent	Cloudy	Pale yellow cloudy	Translucent	Grayish white	A/B: Colorless transparent	A/B: Colorless transparent	A/B: Colorless transparent	A/B: Colorless transparent	A/B: Pale yellow cloudy
Viscosity mPa·s	500	800	700	2,500	30,000	A:1,000/ B:800	A:1,000/ B:800	A:400/ B:380	A:800/ B:600	A:900/ B:600
Mix ratio	NA	NA	NA	NA	NA	100:100	100:100	100:100	100:100	100:100
Mixed viscosity	NA	NA	NA	NA	NA	900	900	400	700	800
Specific gravity 25°C	0.97	0.99	0.99	1.00	2.52	A/B:0.97	A/B:0.97	A/B:0.97	A/B:0.97	A/B:0.99
Pot life min	—	—	—	—	—	180	240	500	180	240
Curing conditions & standard cure time	120°C×30min	130°C×30min	120°C×30min	130°C×30min	120°C×1h	100°C×1h	110°C×30min	120°C×1h	23°C×24h	23°C×24h
After curing										
Penetration 1/4 cone	60	90	40	90	30	20	50	60	65	60
Tensile strength MPa	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Elongation at break %	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volume resistivity TΩ·m	2.0	8.0	2.0	8.0	3.0	10.0	8.0	5.0	10.0	8.0
Dielectric breakdown strength kV	14	14	14	18	24	14	14	14	14	14
Relative permittivity 50Hz	3.0	3.0	3.0	3.0	5.3	3.0	3.0	3.0	3.0	3.0
Dissipation factor 50Hz	5×10 ⁻⁴	5×10 ⁻⁴	5×10 ⁻⁴	5×10 ⁻⁴	2×10 ⁻³	5×10 ⁻⁴	5×10 ⁻⁴	5×10 ⁻⁴	5×10 ⁻⁴	5×10 ⁻⁴
Thermal conductivity W/m·K	0.2	0.2	0.2	0.2	1.1	0.2	0.2	0.2	0.2	0.2
Complex shear modulus 10Hz Pa	8,000	2,200	15,000	620*1	39,000	9,000	6,500	—	23,000	13,000
LMW siloxane content ΣD3-D10 ppm	—*2	—*2	—*2	—*2	—*2	—*2	—*2	< 300	—*2	—*2

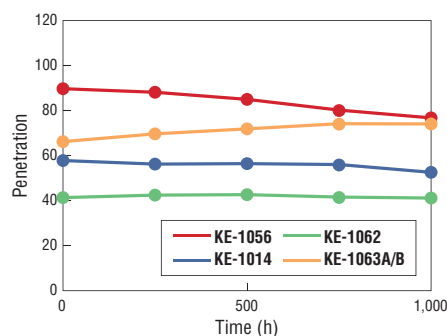
*1 Measured at 1Hz. *2 Not a reduced LMW siloxane product.

(Not specified values)

KE-1056: Effects of various types of aging on volume resistivity



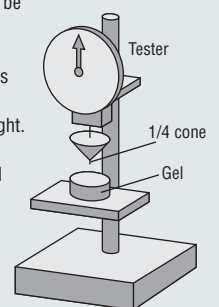
Heat resistance of silicone gels (180°C)



Hardness (penetration)

Silicone gels have moduli of elasticity of 10⁵ Nm/m² or less, and thus cannot be measured with a regular rubber hardness tester. Hardness (penetration) is normally measured as shown in the figure at right. There is a correlation between penetration and modulus of elasticity.

Measurement method
Penetration test:
JIS K 2220, 1/4 cone
Total load: 9.38 g



* HST (Heat Shock Test) conditions: -40°C (30 min) ↔ 125°C (30 min) /cycle

Coating agents

Cure system	One-component condensation							One-component addition	
Product name	KE-3421	KE-3423	KE-3495	KE-4920-T	KE-4920	KE-4921-B	KE-4921-W	KE-1842	KE-1886
Brief description	UV luminous	—	—	For protection of electrodes in flat-panel displays	For protection of electrodes in flat-panel displays	For protection of electrodes in flat-panel displays	For protection of electrodes in flat-panel displays	—	Low-temperature cure
Byproduct gas	Acetone	Acetone	Acetone	Alcohol	Alcohol	Alcohol	Alcohol	—	—
Before curing									
Consistency	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Low viscosity	Low viscosity
Appearance	Colorless transparent	Pale yellow, cloudy	Milky white translucent, white	Pale yellow transparent	White, black	Black	White	White	Milky white
Viscosity Pa·s	0.4	0.6	5.5	1.5	4.0	0.8	0.9	4.0	12.0
Density 23°C g/cm ³	0.98	0.98	1.03	0.98	1.00	0.98	1.01	1.00	1.03
Tack-free time min	4	5	11	7	7	5	5	—	—
Curing conditions & standard cure time	23±2°C/50±5%RH×7days							120°C×1h	100°C×1h
After curing									
Hardness Durometer A	30	20	30	25	27	34	30	13	29
Tensile strength MPa	—	0.5	1.1	0.5	1.0	0.4	0.5	0.4	2.9
Elongation at break %	—	140	200	150	200	60	70	200	160
Volume resistivity TΩ·m	97.0	60.0	4.0	12.0	10.0	0.3	—	1.0	10.0
Dielectric breakdown strength kV	27	25	20	23	22	25	—	20	25
Relative permittivity 50Hz	3.0	3.0	2.8	2.9	3.0	3.0	—	3.5	3.1
Dissipation factor 50Hz	3×10 ⁻³	3×10 ⁻³	3×10 ⁻³	4×10 ⁻³	5×10 ⁻³	5×10 ⁻³	—	5×10 ⁻³	1×10 ⁻³
Thermal conductivity W/m·K	—	0.17	0.21	0.17	0.20	—	—	—	—
Tensile lap-shear strength (Al/Al) MPa	—	0.3	0.3	—	—	0.3*1	0.2*1	0.2	0.8
LMW siloxane content ΣD ₃ -D ₁₀ ppm	—*2	< 300	< 300	< 300	< 300	< 300	< 300	—*2	< 100

*1 Measured using glass/glass *2 Not a reduced LMW siloxane product.

(Not specified values)

Silicone materials for high-definition transfer printing

Cure system	Two-component addition		
Product name	SIM-240	SIM-260	SIM-360
Brief description	For nanoprining, low-hardness	For nanoprining, standard hardness	For nanoprining, fast cure
Before curing			
Consistency	Low viscosity	Low viscosity	Low viscosity
Appearance	Transparent	Transparent	Transparent
Viscosity mPa·s	7,000	7,000	7,000
Mix ratio	10:1	10:1	10:1
Density 23°C g/cm ³	1.02	1.02	1.02
Workable time 23°C min	> 24h	> 24h	100
Curing conditions & standard cure time	150°C×30min		
Curing agent	CAT-240	CAT-260	CAT-360
After curing			
Hardness Durometer A	40	60	58
Tensile strength MPa	6.3	7.8	7.8
Elongation at break %	160	100	100
Volume resistivity TΩ·m	200	200	200
Dielectric breakdown strength kV	24	26	26
Relative permittivity 50Hz	2.9	2.9	2.9
Dissipation factor 50Hz	7×10 ⁻³	7×10 ⁻³	7×10 ⁻³
Thermal conductivity W/m·K	0.15	0.15	0.15
LMW siloxane content ΣD ₃ -D ₂₀ ppm	< 200	< 200	< 200

(Not specified values)

LED die-bond adhesives and dam materials

Cure system	One-component addition				One-component addition	
Product name	KER-3000-M2	KER-3010-M6	KER-3100-U2	KER-3200-T1	KER-2000-DAM	KER-2010-DAM
Brief description	Transparent	High bonding strength	White reflective	Heat transfer properties	For dams in high density packaging applications	For dams in high density packaging applications, highly thixotropic.
Category	Die-bond adhesive				Dam material	
	Dielectric, transparent	Dielectric, high transparency	Dielectric, white	Dielectric, low thermal resistance	Methyl rubber	Methyl rubber
Before curing						
Appearance	Milky white translucent	Milky white translucent	White	White	White	White
Viscosity 23°C	mPa·s	40	17	20	20	Non-flow
Density 23°C	g/cm ³	—	—	—	—	1.10
Solvent	Solvent-free	Solvent-free	Isoparaffin	Isoparaffin	Solvent-free	Solvent-free
Nonvolatile content	wt%	99	99	97	95	—
Standard cure time	100°C×1h+ 150°C×2h	100°C×1h+ 150°C×5h	100°C×1h+150°C×2h		120°C×1h	
After curing						
Hardness	Shore D	56	60	68	68	NA
	Durometer A	NA	NA	NA	NA	56
Flexural modulus	MPa	270	270	940	330	—
Tensile strength	MPa	NA	NA	NA	NA	6.1
Elongation	%	NA	NA	NA	NA	140
Light reflectivity 450nm/2mm	%	NA	NA	95	NA	95
Density	g/cm ³	1.15	1.15	2.04	2.54	—
Coefficient of linear expansion	ppm	—	—	—	—	—
		α1	—	—	—	—
		α2	220	220	130	150
Thermal conductivity	W/m·K	0.2	0.2	0.6	0.6	—
Thermal resistance	mm ² /K/W	15 (4μ)	15 (4μ)	35 (20μ)	8 (5μ)	—
Volume resistivity	TΩ·m	100	100	12	20	—
Dielectric breakdown strength	kV	25	25	24	27	—
Lap-shear strength (Al/Al)	MPa	3.9	3.9	3.8	3.6	1.1
Die-shear strength*		2,100	2,900	2,300	2,000	NA
Suitable processes		Stamping/ dispensing	Stamping/ dispensing	Stamping/ dispensing	Stamping/ dispensing	Dispensing/ screen printing

* Adhesion of Si chip (1×1mm, 0.35mm thick) to silver plating. Cure conditions: 100°C/1 h, then 150°C/2h

(Not specified values)

LED encapsulants

Cure system		Two-component addition						
Product name		ASP-1111-A/B	ASP-1031-A/B	ASP-1120-A/B	SCR-1012A/BR	SCR-1016A/B	KER-6110-A/B	KER-2500-A/B
Brief description		High refractive index, for side view LEDs, resin type	High refractive index, for TVs, for compression molding	High refractive index, low stress, rubber type	Low gas permeability	Low gas permeability	For compression molding	High heat resistant
Category		Phenyl resin	Phenyl resin	Phenyl rubber	Modified silicone	Modified silicone	Phenyl resin	Methyl rubber
Before curing								
Appearance		A:From colorless transparent to pale yellow transparent B:From colorless transparent to milky white translucent	A:From colorless transparent to pale yellow transparent B:From colorless transparent to milky white translucent	A:From colorless transparent to pale yellow transparent B:From colorless transparent to milky white translucent	A/BR: From colorless transparent to pale yellow	A/B: From colorless transparent to pale yellow	A:From colorless transparent to milky white translucent B:Colorless transparent	A/B:Colorless transparent
Viscosity 23°C mPa·s		A:1,560/ B:340	A:1,600/ B:2,500	A:1,600/ B:160	A:10,000/ BR:1,000	A:10,000/ B:50	A:1,000/ B:20,000	A:8,300/ B:2,700
Mix ratio		100:100	20:80	100:100	100:100	100:100	30:70	100:100
Mixed liquid viscosity 23°C mPa·s		760	2,000	450	3,000	350	7,000	4,300
Density 23°C g/cm ³		A:1.12/B:1.13	A:1.12/B:1.14	A:1.12/B:1.10	A:0.99/BR:1.03	A:0.99/B:1.05	A:1.16/B:1.11	A/B:1.06
Refractive index 23°C, 589nm		A:1.58/B:1.54	A:1.57/B:1.55	A:1.58/B:1.53	A:1.54/BR:1.47	A:1.54/B:1.51	A:1.52/B:1.54	A/B:1.41
Pot life 23°C		24h	24h	24h	8h	8h	24h	24h
Standard cure time		100°C×2h+150°C×5h			100°C×1h+150°C×5h		100°C×2h+150°C×5h	100°C×1h+150°C×2h
After curing								
Hardness	Shore D	55	50	NA	75	70	38	NA
	Durometer A	NA	NA	65	NA	NA	88	70
Flexural modulus MPa		—	—	—	1,800	1,400	—	—
Flexural strength MPa		—	—	—	55	25	—	—
Tensile strength MPa		6.2	6.6	2.5	—	—	5.4	10.0
Elongation %		45	90	65	NA	NA	50	100
Transmissivity 400nm/2mm		89	90	89	88	88	88	92
Softening point °C		25	25	20	75	40	20	NA
Coefficient of linear expansion ppm	α1	70	60	80	72	70	70	—
	α2	240	440	250	190	220	190	250
Volume resistivity TΩ·m		—	—	—	300	160	260	16
Dielectric breakdown strength kV		—	—	—	30.6	32.4	30.0	25.0
Relative permittivity 50Hz		—	—	—	2.6	2.8	3.0	3.2
Dissipation factor 50Hz		—	—	—	3×10 ⁻³	2×10 ⁻³	4×10 ⁻³	7×10 ⁻³
Adhesion MPa	PPA	1.8	1.9	1.1	5.5 (substrate destroyed)	5.6 (substrate destroyed)	2.0	3.0
	Silver	3.1	3.7	1.3	5.1	10.0	4.0	1.4
Moisture absorption 85°C/85%RH/24h %		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Water absorption 40°C/24h%		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Oxygen permeability cc/m ² ·day		210 (0.9mm)	260 (0.94mm)	320 (0.88mm)	250 (0.92mm)	150 (0.92mm)	880 (0.92mm)	31,000 (0.92mm)

(Not specified values)

■ LED encapsulants

Cure system		Two-component addition						One-component addition	
Product name		KER-2500N-A/B	KER-2600-A/B	KER-2700-A/B	KER-6000-A/B	KER-6150-A/B	KER-6200-A/B	KER-6075-F	KER-6020-F
Brief description		For compression molding	Med. hardness, for lighting	Low hardness, for lighting	Low hardness, high refractive index	Med. refractive index	High refractive index, gel	Thixotropic	For gold wire protection
Category		Methyl rubber			Phenyl rubber		Phenyl gel	Phenyl rubber	
Before curing									
Appearance		A/B: Colorless transparent	A/B: Colorless transparent	A/B: Colorless transparent	A:From colorless to pale yellow transparent B:From colorless transparent to milky white translucent	A:From colorless to pale yellow transparent B:From colorless transparent to milky white translucent	A/B: Pale yellow transparent	Milky white translucent	Milky white translucent
Viscosity 23°C mPa·s		A:8,500/ B:2,900	A:6,500/ B:5,500	A:5,200/ B:4,500	A:4,400/ B:2,000	A:5,000/ B:2,000	A:1,600/ B:1,400	Non-flow (Thixotropy)	Non-flow (Thixotropy)
Mix ratio		100:100	100:100	100:100	100:100	100:100	100:100	—	—
Mixed liquid viscosity 23°C mPa·s		5,000	6,000	4,900	2,800	3,000	1,400	34,000	33,000
Density 23°C g/cm ³		A/B:1.06	A/B:1.02	A:1.07/B:1.06	A:1.09/B:1.08	A/B:1.08	A/B:1.08	1.14	1.05
Refractive index 23°C, 589nm		A/B:1.41	A/B:1.41	A/B:1.41	A:1.52/B:1.50	A/B:1.44	A/B:1.50	1.44	1.43
Pot life 23°C		24h	24h	24h	24h	24h	24h	—	—
Standard cure time		100°C×1h+150°C×2h					50°C×4h	100°C×1h+150°C×2h	
After curing									
Hardness	Shore D	NA	NA	NA	NA	NA	NA	NA	NA
	Durometer A	70	47	35	22	50	30*1	80	21
Flexural modulus MPa		—	—	—	—	—	—	—	—
Flexural strength MPa		—	—	—	—	—	—	—	—
Tensile strength MPa		10.0	6.0	5.0	0.1	5.7	NA	3.0	1.0
Elongation %		110	150	220	20	70	NA	30	180
Transmissivity 400nm/2mm		92	92	91	89	92	98*2	90	76
Softening point °C		—	—	—	-40	NA	-40	NA	NA
Coefficient of linear expansion ppm	α1	—	—	—	—	—	—	—	—
	α2	250	390	400	500	—	350	250	240
Volume resistivity TΩ·m		14	10	13	100	—	0.5	580	400
Dielectric breakdown strength kV		25.0	26.0	24.0	31.0	—	15.0	24.0	25.0
Relative permittivity 50Hz		3.3	3.2	3.2	2.9	—	3.1	3.2	3.1
Dissipation factor 50Hz		7×10 ⁻³	5×10 ⁻³	6×10 ⁻³	2×10 ⁻⁴	—	4×10 ⁻⁴	5×10 ⁻³	5×10 ⁻³
Adhesion MPa	PPA	3.0	2.4	2.0	0.1	0.8	NA	0.8	0.3
	Silver	2.5	2.0	2.3	0.1	0.7	NA	0.9	0.3
Moisture absorption 85°C/85%RH/24h %		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	—	< 0.1	< 0.1
Water absorption 40°C/24h %		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	—	< 0.1	< 0.1
Oxygen permeability cc/m ² ·day		31,000 (0.92mm)	35,000 (0.92mm)	38,000 (0.92mm)	5,500 (0.91mm)	19,600 (0.95mm)	—	17,000 (0.92mm)	—

*1 Penetration *2 Optical path length: 10 mm. Measured in a quartz cell.

(Not specified values)

Flame-resistant silicones & thermal interface silicones

Cure system	One-component condensation						Two-component condensation	
Product name	KE-3466	KE-3467	KE-3490	KE-3493	KE-3494	KE-4901-W	KE-200	KE-210
Brief description	Flame resistant, enhanced heat transfer properties	Flame resistant, enhanced heat transfer properties	Flame resistant, for fastening of power supply components	Low specific gravity, heat transfer properties	Flame resistant	Flame resistant, heat transfer properties, for fastening of power supply components	Fast cure, good deep-section cure properties, for PV applications	Flame resistant, Fast cure, good deep-section cure properties, for PV applications
Byproduct gas	Acetone	Acetone	Acetone	Acetone	Acetone	Alcohol	Acetone	Acetone
Before curing								
Consistency	Med. viscosity	Med. viscosity	Paste	Paste	Med. viscosity	Paste	Low viscosity	Low viscosity
Appearance	White	White	Gray	White	Gray	White	Colorless translucent	Black
Viscosity Pa·s	50	100	—	—	50	—	2.8	5.0
Mix ratio	—	—	—	—	—	—	100:10	100:10
Mixed viscosity 23°C Pa·s	—	—	—	—	—	—	2.2	4.5
Density 23°C g/cm ³	2.80	2.90	1.18	1.46	1.40	1.59	1.01	1.24
Tack-free time min	7	4	3	1	8	8	35*1	25*1
Curing conditions & standard cure time	23±2°C/50±5% RH×7days						23±2°C/50±5% RH×3days	
Curing agent	—	—	—	—	—	—	CX-200	CAT-210
After curing								
Hardness Durometer A	88	91	43	73	35	53	25	32
Tensile strength MPa	3.1	3.6	2.5	2.0	2.5	2.6	0.4	0.7
Elongation at break %	30	30	350	30	250	120	100	100
Volume resistivity TΩ·m	2.9	5.9	3.0	1.0	3.0	3.4	60.0	7.7
Dielectric breakdown strength kV	24	25	28	35	25	30	20	25
Relative permittivity 50Hz	5.9	4.6	3.3	4.2	3.5	3.8	2.9	3.8
Dissipation factor 50Hz	4.7×10 ⁻³	4.0×10 ⁻³	1×10 ⁻²	2×10 ⁻³	1×10 ⁻²	0.18	3×10 ⁻³	1×10 ⁻²
Thermal conductivity W/m·K	1.90	2.40	0.25	1.60	0.42	0.75	0.21	0.30
Tensile lap-shear strength (Al/Al) MPa	0.5	0.5	1.5	0.8	1.5	1.3	0.4	0.8
LMW siloxane content ΣD3-D10 ppm	< 300	< 300	< 300	< 300	< 300	< 300	< 300	—*2
Flame resistance UL94	V-1	V-0	V-0	—	V-0	V-0	V-1	V-0

*1 Time to non-flow state. *2 Not a reduced LMW siloxane product.

(Not specified values)

Heat resistance evaluation & test method

Thermal conductivity (λ) and thermal resistance (R) are two values which describe the thermal properties of thermal interface materials. The higher its thermal conductivity and lower its thermal resistance, the more effective a material will be as a thermal interface. Heat dissipation from a heat-generating component is influenced not only by the thermal conductivity of the thermal interface silicone placed between the heat-generating part and the heatsink (etc.). It is also influenced to a large extent by thermal resistance, which is a function of the contact thermal resistance at the interfaces between the heat generator, silicone and heat sink and the thickness of the silicone itself.

At a given temperature, thermal conductivity is a value intrinsic to a particular substance. According to Fourier's Law, in a steady state, the proportionality constant is the thermal conductivity.

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

λ : Thermal conductivity
 Q : heat flow rate A: cross-sectional surface area T1: temperature at high side T2: temperature at low side

Thermal resistance is the sum of contact resistance plus the resistance as heat flows (Q) from T1 to T2.

$$R_0 = \frac{T_1 - T_2}{Q} = \frac{L}{\lambda A} \quad \text{In reality} \quad R = R_0 + R_s$$

R : Thermal resistance
 R_0 : Material's intrinsic thermal resistance R_s : contact thermal resistance

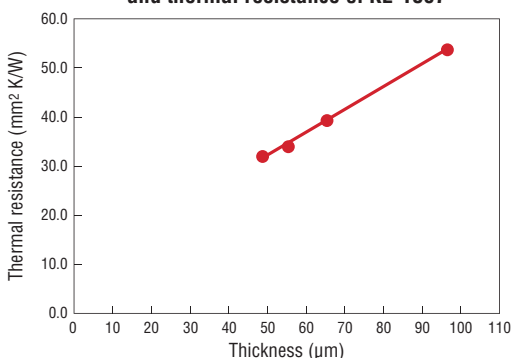
■ Flame-resistant silicones & thermal interface silicones

Cure system	One-component addition					Two-component addition				
Product name	KE-1862	KE-1867	KE-1891	KE-1869	KE-1831	KE-1285-A/B	KE-1861-A/B	KE-1204 A/B	KE-1280-A/B	KE-1283-A/B*2
Brief description	Flame resistant, heat transfer properties	Flame resistant, enhanced heat transfer properties	Flame resistant, enhanced heat transfer properties	Heat transfer properties, cold resistant	Flame resistant	Flame resistant, heat transfer properties, low viscosity	Flame resistant, heat transfer properties	Flame resistant	Flame resistant, low specific gravity	For LED displays
Before curing										
Consistency	Med. viscosity	Med. viscosity	Paste	Med. viscosity	Paste	Low viscosity	Med. viscosity	Low viscosity	Low viscosity	Low viscosity
Appearance	Gray	Gray	Gray	Grayish white	Black	A:Gray B:Grayish white	A/B: Grayish white	A:Reddish brown B:Grayish white	A:Black B:Translucent	A:Black B:Milky white
Viscosity Pa·s	60	60	—	30	120	A:25/B:5	A/B:50	A:6/B:4	A:2/B:1.3	A:2.6/B:1.3
Mix ratio	NA	NA	NA	NA	NA	100:100	100:100	100:100	100:100	100:100
Mixed viscosity 23°C Pa·s	NA	NA	NA	NA	NA	9.0	5.0	5.0	1.7	1.5
Density 23°C g/cm ³	2.22	2.92	3.06	2.52	1.28	1.72	2.22	1.54	1.01	0.96
Pot life 23°C min	—	—	—	—	—	900*3	300*3	480*3	480*3	300*3
Curing conditions & standard cure time	120°C×1h							100°C×15min	120°C×1h	80°C×2h
After curing										
Hardness Durometer A	83	75	96	30*1	30	56	75	70	24	12 (Asker C)
Tensile strength MPa	6.0	2.1	4.8	NA	3.9	2.8	6.4	3.5	0.6	0.2
Elongation at break %	80	60	10	NA	400	140	80	70	140	300
Volume resistivity TΩ·m	10.0	1.2	3.4	3.0	2.0	6.5	10.0	1.0	1.0	1.0
Dielectric breakdown strength kV	25	23	25	24	25	26	25	27	25	25
Relative permittivity 50Hz	4.0	6.7	—	5.3	3.5	4.0	4.0	3.2	4.1	4.0
Dissipation factor 50Hz	1.6×10 ⁻³	4.5×10 ⁻³	—	2×10 ⁻³	5×10 ⁻³	1×10 ⁻²	1.6×10 ⁻³	1×10 ⁻³	1×10 ⁻³	1×10 ⁻³
Thermal conductivity W/m·K	0.83	2.20	4.00	1.10	—	0.80	0.83	0.45	0.25	0.25
Tensile lap-shear strength (Al/Al) MPa	1.3	1.0	0.8	—	2.3	1.5	1.0	—	0.2	0.2
Complex shear modulus 10Hz Pa	—	—	—	39,000	—	—	—	—	—	—
LMW siloxane content ΣD ₃ -D ₁₀ ppm	—*4	< 300	< 500	—*4	—*4	< 500	—*4	< 500	—*4	—*4
Flame resistance UL94	V-0	V-0	V-0	—	V-0	V-0	V-0	V-0	V-0	V-1

*1 Penetration: 1/4 cone *2 C Agent can be used to produce a matte finish. *3 Time to double viscosity *4 Not a reduced LMW siloxane product.

(Not specified values)

Relationship between application thickness and thermal resistance of KE-1867



UL94 flammability ratings criteria

Rating	Criteria
94V-0*	A set of 5 specimens is tested; the flaming combustion time of each specimen must not exceed 10 seconds, and total time of the set must not exceed 50 seconds.
94V-1*	A set of 5 specimens is tested; the flaming combustion time of each specimen must not exceed 30 seconds, and total time of the set must not exceed 250 seconds.
94HB	In this horizontal burning test, combustion must cease before the 100 mm reference mark.

* A rectangular test strip (width: 13.0 mm, length: 125 mm, thickness: as thin as is practical) is suspended vertically. A 20 mm flame is applied to the bottom for 10 seconds. The flame is then removed and the flaming combustion time is measured. When combustion ceases, the flame is again applied in the same manner and combustion time is measured again.



Flammability test Left: Silicone rubber Right: Organic rubber

Packaging formats & product index

Product name	Syringe	Glass bottle	Tube	Cartridge	Round can/ Square can	PE bottle (ratchet locking cap)	JP can	RoHS*	Page
ASP-1031-A/B		A:20g/B:80g				A:100g×2(Glass bottle) B:800g		○	P16
ASP-1111-A/B		A/B:50g				A/B:1kg		○	P16
ASP-1120-A/B		A/B:50g				A/B:1kg		○	P16
IO-SEAL-300					1kg		20kg	○	P11
KE-1011-A/B					A/B:1kg(Square can)		A/B:16kg(Square can)	○	P13
KE-1012-A/B					A/B:1kg(Square can)		A:16kg(Cylindrical can) B:16kg(Square can)	○	P13
KE-1013-A/B					A/B:1kg(Square can)		A/B:16kg(Square can)	○	P13
KE-1014					1kg(Square can)		16kg(Square can)	○	P13
KE-1031-A/B					A/B:1kg		A/B:16kg	○	P12
KE-1051J-A/B					A/B:1kg(Square can)		A/B:16kg(Square can)	○	P13
KE-1056						1kg	15kg(Square can)	○	P13
KE-106					1kg		18kg	○	P12
CAT-RG (KE-106 curing agent)		100g			1kg(Square can)			○	P12
KE-1062					1kg(Square can)		16kg(Square can)	○	P13
KE-1063-A/B					A/B:1kg(Square can)		A/B:16kg(Square can)	○	P13
KE-109E-A/B					A/B:1kg		A/B:18kg	○	P12
KE-1151					1kg		16kg	○	P13
KE-1204A/B					A/B:1kg		A/B:25kg	○	P12, 19
KE-1280-A/B					A/B:1kg		A/B:18kg	○	P12, 19
KE-1282-A/B					A/B:1kg		A/B:20kg	○	P12
KE-1283-A/B					A/B:1kg		A/B:9kg, 18kg	○	P12, 19
KE-1285-A/B					A/B:1kg		A/B:20kg	○	P12, 19
KE-1828				330ml			20kg	○	P11
KE-1831			100g		1kg		20kg	○	P11, 19
KE-1833				330ml	1kg		20kg	○	P11
KE-1842			100g		1kg		18kg	○	P14
KE-1850				330ml			18kg	○	P11
KE-1854					1kg		18kg	○	P11
KE-1855					1kg		18kg	○	P11
KE-1861-A/B					A/B:1kg		A/B:20kg	○	P19
KE-1862			200g		1kg		20kg	○	P19
KE-1867		200g		330ml	2kg		20kg	○	P19
KE-1869					1kg, 5.5kg			○	P13, 19
KE-1880				330ml	1kg		16kg	○	P11
KE-1884			100g		1kg		20kg	○	P11
KE-1885			100g		1kg		20kg	○	P11
KE-1886			100g	330ml	1kg		20kg	○	P14
KE-1891		300g			1kg, 3kg		20kg	○	P19
KE-200					1kg*2		18kg*3	○	P12, 18
CX-200 (KE-200 curing agent)		100g			900g(Square can)			○	P12, 18
KE-210					1kg*2		18kg*3	○	P12, 18
CAT-210 (KE-210 curing agent)		100g			900g(Square can)			○	P12, 18

Product name	Syringe	Glass bottle	Tube	Cartridge	Round can/ Square can	PE bottle (ratchet locking cap)	JP can	RoHS*	Page
KE-3412				330ml				○	P10
KE-3421					1kg(Square can)		17kg	○	P14, 18
KE-3423					1kg(Square can)		16kg	○	P14
KE-3466			250g	330ml				○	P10, 18
KE-3467			250g	330ml				○	P10, 18
KE-3490			100g, 110g*1, 200g	330ml				○	P10, 18
KE-3493			130g	330ml				○	P10, 18
KE-3494			100g, 110g*1	330ml				○	P10, 18
KE-3495			100g	330ml				○	P14
KE-3497			100g	330ml				○	P10
KE-3498			100g	330ml				○	P10
KE-4806-W			100g	330ml				○	P10
KE-4901-W				330ml				○	P10, 18
KE-4920				330ml				○	P14
KE-4920-T			90g	330ml			16kg	○	P14
KE-4921				330ml				○	P14
KER-2000-DAM	30g							○	P15
KER-2010-DAM	30g							○	P15
KER-2500-A/B		A/B:100g				A/B:1kg		○	P16
KER-2500N-A/B		A/B:100g				A/B:1kg		○	P17
KER-2600-A/B		A/B:100g				A/B:1kg		○	P17
KER-2700-A/B		A/B:100g				A/B:1kg		○	P17
KER-3000-M2	6g, 10g							○	P15
KER-3010-M6	10g							○	P15
KER-3100-U2	8g, 15g							○	P15
KER-3200-T1	10g							○	P15
KER-6000-A/B		A/B:100g				A/B:1kg		○	P17
KER-6020-F	30g							○	P17
KER-6075-F	30g							○	P17
KER-6110-A/B		A:30g/B:70g				A:300g/B:700g		○	P16
KER-6150-A/B		A/B:100g				A/B:1kg		○	P17
KER-6200-A/B		A/B:100g				A/B:1kg		○	P17
SCR-1012A/BR		A/BR:100g				A/BR:1kg		○	P16
SCR-1016A/B		A/B:100g				A/B:1kg		○	P16
SIM-240		100g				1kg		○	P14
CAT-240 (SIM-240 curing agent)		10g, 100g						○	P14
SIM-260		100g				1kg		○	P14
CAT-260 (SIM-260 curing agent)		10g, 100g						○	P14
SIM-360		100g				1kg		○	P14
CAT-360 (SIM-360 curing agent)		10g, 100g						○	P14

★ The circle mark indicates that none of the six substances regulated under the RoHS directive (Cd, Hex-Cr, Hg, Pb, PBB, and PBDE) have been used intentionally in the manufacture of the product.

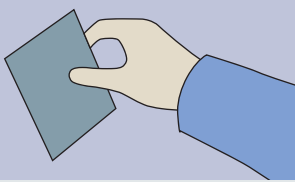
*1 Laminated tube *2 1kg, for Japanese market: round metal cans; for overseas market: plastic containers *3 18kg, for overseas market: UN cans

- One-component condensation
- One-component addition
- Two-component condensation
- Two-component addition

Instructions for use

Usage instructions for one-component RTV silicone rubbers

Clean the application surface



Clean the surface of all rust, oil, dirt, grime and other substances that may interfere with adhesion using sandpaper or a solvent (toluene, xylene, other). When cleaning plastics with solvents, use caution as some solvents may damage plastics.

To save for later use


Tubes

Remove the nozzle and seal tightly. Clean residue out of the nozzle using a solvent.

Cartridges


Product should be used all at once if possible. If product remains, seal tightly before storage. If tightly sealed, the product can be kept for several days.

Tubes



Open the tube and load it into the dispenser cartridge.

Cartridges



Cut the nozzle tip and load the cartridge into the dispenser cartridge.

Application can be done by machine or by hand






Photo provided by Musashi Engineering Inc.

Usage instructions for two-component RTV silicone rubbers

Before use


Check the mix ratio carefully when using two-component RTV silicone rubber products. All ratios are given in parts by weight. Put the base polymer (A) into a container, followed by the curing agent (B). Mix thoroughly until evenly mixed throughout.

Be sure to deaerate the product after mixing. When using a planetary-centrifugal type mixer/deaerator, friction within the product can cause a sharp rise in temperature. Also be aware that with certain low viscosity products, there may be some settling of the fillers during storage. Before use, first agitate well to disperse the fillers and then proceed to mixing the two components.


To store

Be sure to seal the product tightly before storage. Use a solvent or other cleaning agent to clean stirrers, containers and other tools used in the mixing process after use.

Stir before use




Use




After mixing and deaeration, immediately pour into place.

Ball mill: mfd. by Asahi Rika Seisakusho



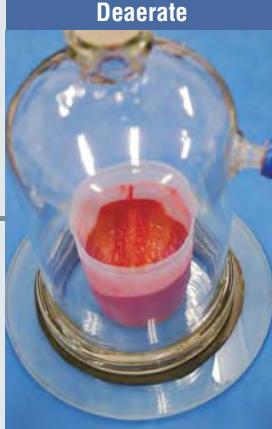
Fillers may settle to the bottom of the container, so be sure to stir thoroughly with a suitable implement prior to use.

Weigh




Weigh out both the base polymer and curing agent.


Deaerate



Combine



Mix



Combine the base polymer and curing agent, and mix until color is uniform and consistent.

Handling precautions

Handling precautions

1. One-component condensation-cure RTV silicone rubbers cure by reacting with moisture in the air, and curing starts at the surface. Curing speed is affected by temperature, humidity and other conditions. These products do not have particularly good deep-section cure properties, and are thus not suitable for adhesive applications in which the contact area is large. Additionally, if the product is used when humidity is above 100% and water droplets form on the rubber during the cure process, a hydrolysis reaction will proceed ahead of the crosslinking curing reaction, in which case the rubber may have reduced strength or exhibit surface tack after curing.
2. Some types of one-component condensation-cure RTV silicone rubbers, such as acetic acid-cure and oxime-cure types, may corrode metals. Acetic acid-cure types can cause rust, while oxime-cure types can corrode copper-containing metals when used in airtight conditions. It is thus important to do a test with samples prior to use to determine whether the silicone product is suitable for the application.
3. Condensation-cure RTV silicone rubbers will show a temporary decline in dielectric properties during the cure process. In most cases, however, the rubber will recover and exhibit its intrinsic dielectric properties when fully cured.
4. Contact with flux may interfere with proper curing.
5. Do not use condensation-cure products in spots that will be completely enclosed (i.e. not exposed to air).
6. Addition-cure products may not cure properly if they are contaminated or come in contact with cure inhibitors (e.g. sulfur, phosphorus, nitrogen compounds, water and organometallic salts). For information on cure inhibitors, see page 8.
7. Addition-cure products should not be used in high humidity conditions, as this may result in curing problems or poor adhesion.
8. Be aware that addition-cure products release tiny amounts of hydrogen gas as they cure.
9. One-component condensation-cure RTV silicone rubbers may exhibit yellowing over time, but the product's other characteristics are not affected.

Precautions when using

1. Please contact your sales representative if you have any questions regarding the handling and use of these products.
2. Be sure to clean the substrate to remove dirt, grime, moisture and oil from the surface.
3. When using two-component products, be sure to mix, stir and deaerate thoroughly. If these steps are not done properly, it may adversely affect the properties of the rubber.
4. When using an air gun applicator, be sure to set the pressure at a safe and suitable level, around 0.2–0.3 MPa MAX.
5. KE-200 and KE-210 cure quickly at room temperature. When applying these products, use of a special dispenser is recommended.
6. The curing agents for KE-200 and KE-210 undergo hydrolysis when exposed to moisture, meaning it is best to use the entire contents of the container soon after opening. Moreover, if the dispenser tank is being pressurized with air, be sure to use a dry air supply.

Safety and hygiene

1. Be sure there is adequate ventilation when using condensation-cure RTV silicone rubber products. As they cure, acetic acid-cure products release acetic acid; alcohol-cure products release methanol; oxime-cure products release methyl ethyl ketoxime (MEKO); and acetone-cure products release acetone. If you experience unpleasant symptoms when using these products, move to an area with fresh air.
2. Uncured RTV rubber may irritate skin and mucous membranes. Take care to avoid eye contact or prolonged contact with the skin. In case of accidental eye contact, immediately flush with water for at least 15 minutes and then seek medical attention. In case of skin contact, wipe off immediately with a dry cloth and then wash thoroughly with soap and water. Contact lens wearers must take special care when using RTV silicone rubber: if uncured RTV rubber enters the eye, the contact lens may become stuck to the eye.
3. Never touch or rub the eyes while working with these products. Users should wear safety glasses and take other appropriate steps to protect their safety.
4. These RTV silicone rubber products are classified as Class 4 Hazardous Materials or Designated Combustibles (combustible solids and synthetic resins) under the Fire Service Act of Japan. In your country, other laws may apply. Be sure that storage of these products is done in accordance with local laws with regard to labeling and other issues.
5. Keep out of the reach of children.
6. Be sure to read the Material Safety Data Sheets (MSDS) for these products before use. MSDS are available from the Shin-Etsu Sales Department.

Precautions related to storage

1. Store at room temperature (1°C–30°C), out of direct sunlight. Note that certain products must be kept at 1°C–25°C. If the product label says “keep refrigerated”, it should be kept at temperatures of 10°C or below. Note that KER-3000-M2 and KER-3000-M6 must be kept at between -10°C and 10°C.
2. Once a cartridge has been opened, the entire contents should be used at one time whenever possible. If some remains, be sure to seal the cartridge completely.

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