UV Cure
Liquid Silicone Rubbers

Shin-Etsu Silicone

Improved reliability for electrical and electronic devices, shorter processing times, and heating-free processes with UV cure liquid silicone rubbers.

Shin-Etsu offers a wide variety of UV cure liquid silicone rubbers, including a fast curing radical-polymerization type, a UV addition type that is irradiated with UV light and then cures fully at room temperature or with heating, and a combination of radical and condensation types that cures via condensation reaction in sections where the UV rays can't reach.

With products based on silicone polymers, fluorosilicone polymers and polyimide silicone polymers, we can provide the right product for specific requirements and applications.

CONTENTS

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 backbone (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, 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 small changes in viscosity due to temperature changes**.

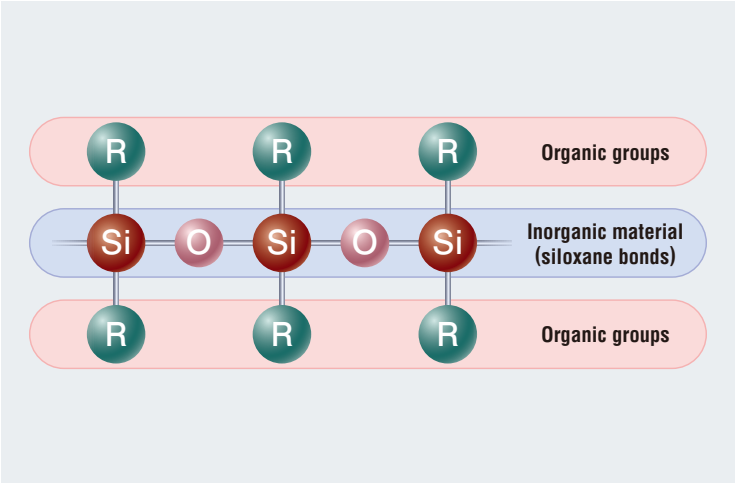
The molecules of silicone polymers are covered by hydrophobic methyl groups, and surface energy is low.

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**.

Furthermore, silicones are low-polarity polymers so they exhibit **low moisture absorption**.

Silicones: compounds which feature a main chain of siloxane bonds

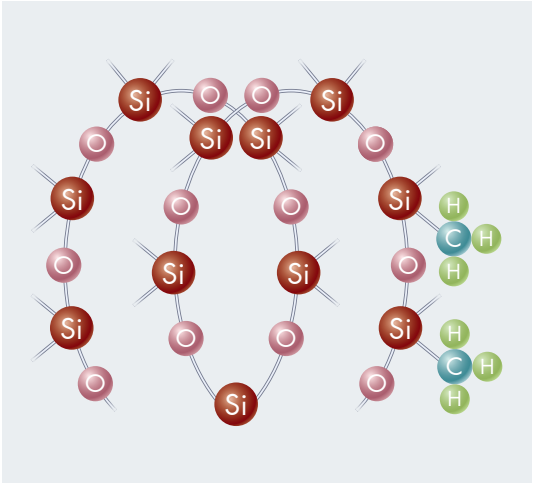
Features attributable to siloxane linkages



- Heat resistance
- Flame resistance
- Chemical stability
- Weatherability
- Radiation resistance
- 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
- Release properties
- Cold resistance
- Compression characteristics

Helical (spiral) structure
Intermolecular forces are weak

Three Cure Types

Shin-Etsu offers a wide variety of UV cure liquid silicone rubbers, including a fast curing radical-polymerization type, a UV addition type that is irradiated with UV light and then cures fully at room temperature or with heating, and a combination of radical and condensation types that cures via condensation reaction in sections where the UV rays can't reach.
Therefore, it is possible to select an appropriate curing type depending on the usage and application.

Radical Polymerization Type
Feature: Rapid cure

UV Cure Liquid Silicone Rubbers

UV Addition Type
Feature: Delayed cure

Combination of Radical and Condensation Type
Feature: Shaded section cure (dual cure)

■ Types and features of UV cure liquid silicone rubbers

Parameter \ Type		Radical polymerization	UV addition	Combination of radical and condensation
Features		Rapid cure, Low to high hardness Both silicone and polyimide silicone available	Parts can be laminated after UV irradiation (process reversal). Ultra-low shrinkage with room temperature curing Shortened cure time with low-temperature heating	Cures by condensation reaction in sections where UV light won't reach
By-product		—	—	Alcohol or acetone
Curability	UV	Rapid	Slow	Rapid
	Heating	NA	Room temperature to 80°C × 1 h	NA
	Moisture	NA	NA	> 1 day*1
Cure-inhibition	Oxygen	Inhibits curing	No effect	Inhibits curing*2
	S·N·P compound	No effect	Inhibits curing	No effect
	Acid, alcohol etc.	No effect	Inhibits curing	Inhibits curing

*1 The time required for curing depends on the thickness.
For curing properties of condensation reaction type, please refer to the catalog of liquid silicone rubbers for electrical & electronic applications.
*2 Oxygen-inhibited areas are cured by condensation reaction.

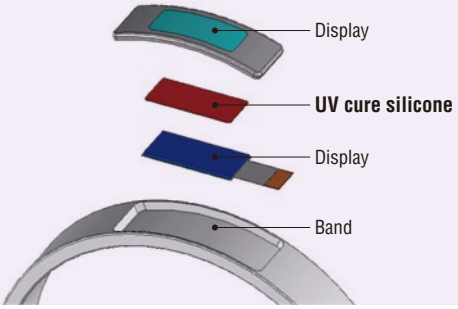
Application Examples of UV Cure Liquid Silicone Rubbers

LOCA (Liquid Optical Clear Adhesive)

■**Application**
Laminating touch panel

■**Applicable products**
Optical bonding silicone
(P13)

■**Cure type**
UV addition




Car navigation system touch panels

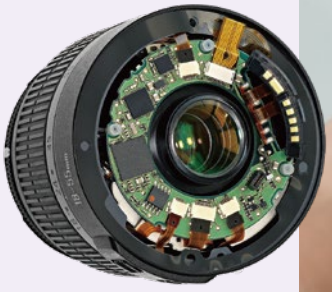
Fixing of precision components

■**Application**
Fixing of various sensors and wearable parts

■**Applicable products**
UV cure silicone products

■**Cure type**
Radical polymerization
UV addition
Combination of radical and condensation

Digital single lens reflex



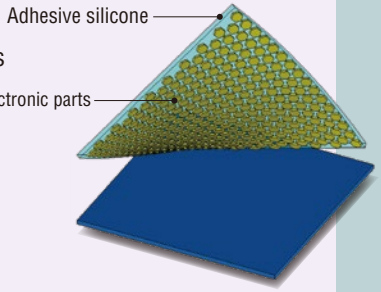

Wearable devices

Micro Transfer Printing Pad

■**Application**
μ-LED chips and adhesive pads for
transporting ultra-fine electronic components

■**Applicable products**
UV cure temporary adhesive silicones
(P10)

■**Cure type**
Radical polymerization




Display

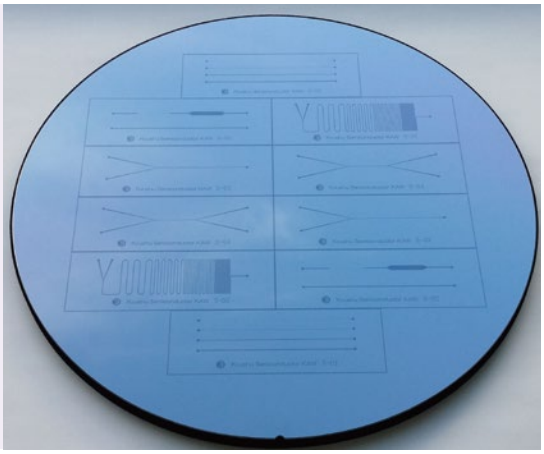
PDMS

■**Application**
Transfer and high-precision molding materials

■**Applicable products**
KER-4690-A/B, KER-4691-A/B

■**Cure type**
UV addition

Kyushu Semiconductor KAW Co., Ltd. provides a photo of
microfluidic wafers made of UV-PDMS.

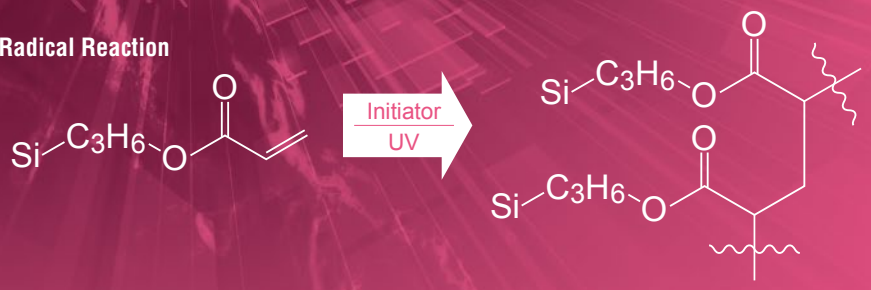


Radical Polymerization Type Silicone

- Silicone polymers with acrylic groups are cured by radical polymerization of acrylic groups under a photopolymerization initiator.
- Since it cures immediately after UV irradiation, processing time can be shortened.
- Broad lineup of sealing materials that exhibit excellent moisture absorption reflow resistance, black type, polyimide silicone, temporary adhesive silicone, etc.

Rapid Cure Type

■ Radical Reaction



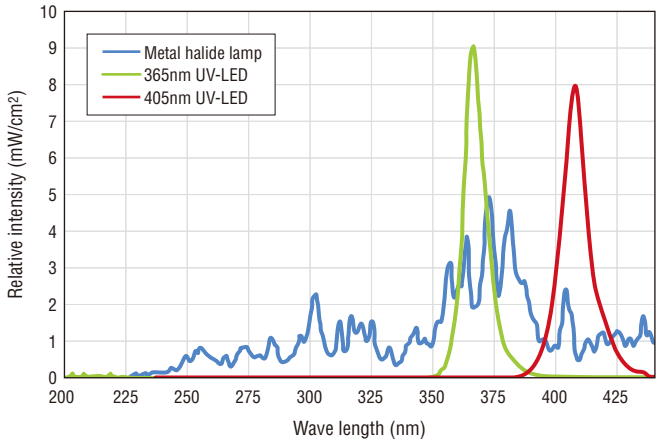
Precautions when using

- Because the radical polymerization type is susceptible to oxygen inhibition, please irradiate UV light under an inert gas (nitrogen atmosphere) or through a transparent release film.
- Recommended UV lamps vary depending on the product.

■ Application example: under nitrogen atmosphere

Shin-Etsu simple nitrogen replacement system

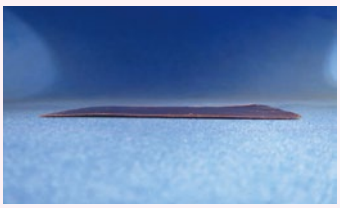
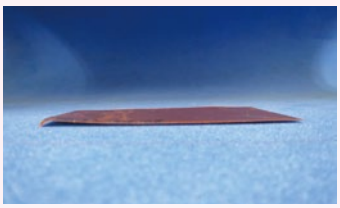
■ UV-LED & metal halide lamp wavelength



✻ Wavelength required for curing is 365 nm.

■ Comparison of cure shrinkage

Point Cure shrinkage and internal stress of the UV cure liquid silicone rubbers is low compared to the heat cure type.

Parameter \ Type	Radical polymerization type	UV addition type	Heat cure epoxy material (third-party product)
Curing conditions	UV light source: Metal halide lamp	UV light source: LED-UV (365 nm)	150°C × 1 h
	Illuminance: 100 mW/cm²	Illuminance: 300 mW/cm²	
	Irradiation time: 40 s	Irradiation time: 10 s + room temperature × 24 h	
Appearance after curing			
Internal stress during curing	Low	Low	High

Radical Polymerization Type Silicone Materials

- We offer a wide range of products, including high hardness, low refractive index, and black types.
- They can be selected according to various applications such as coating, parts fixing, and potting.

■ General properties

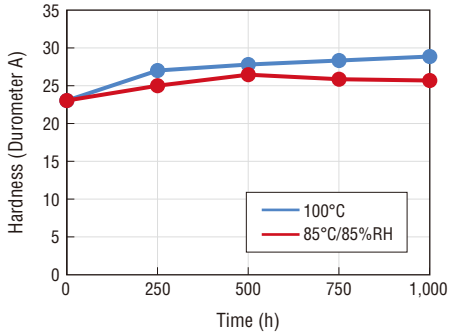
Parameter \ Product name		KUV-3433-UV	KER-4000-UV	KER-4700-UV	KER-4800-UV	KER-4700BK-UV	KER-4910-UV	FE-90-UV
Brief description		Coating	High hardness	High hardness	High hardness	High hardness, black color	Gel	Gel, fluorinated silicone rubber
Reaction mechanism		Radical	Radical	Radical	Radical	Radical	Radical	Radical
Appearance		Translucent	Colorless transparent	Pale yellow transparent	Pale yellow transparent	Black	Colorless transparent	Colorless transparent
Viscosity mPa·s		860	2,500	50	110	6,700	3,000	640
Refractive index		NA	1.43	1.51	1.53	1.51	1.45	1.39
Recommended curing conditions	UV light source	Metal halide lamp						
	Illuminance* mW/cm²	100	100	100	100	100	100	100
	Irradiation time s	40	20	10	10	40	20	50
	Estimated light intensity mJ/cm²	4,000	2,000	1,000	1,000	4,000	2,000	5,000
Density at 23°C g/cm³		1.01	1.14	1.10	1.11	1.15	1.03	1.23
Hardness	Shore D	NA	68	70	41	68	NA	NA
	Durometer A	25	NA	92	67	85	NA	NA
	Penetration	NA	NA	NA	NA	NA	90	65
Tensile strength MPa		0.62	4.8	18.6	4.1	NA	NA	NA
Elongation at break %		140	1	9	53	NA	NA	NA
Tensile lap-shear strength (glass/glass) t=2.0 mm MPa		—	—	7.9	1.9	NA	NA	NA
Light transmissivity 400 nm, t=2.0 mm %		NA	89	2	2	NA	—	—
LED-UV (365 nm) applicability		Applicable	Applicable	Applicable	Applicable	Applicable	Not applicable	Not applicable
Atmospheric air cure		Possible	Impossible	Impossible	Impossible	Impossible	Possible	Possible
Refrigeration storage		Unnecessary	Unnecessary	Unnecessary	Unnecessary	Unnecessary	Unnecessary	Unnecessary

* Illuminance at 365 nm

(Not specified values)

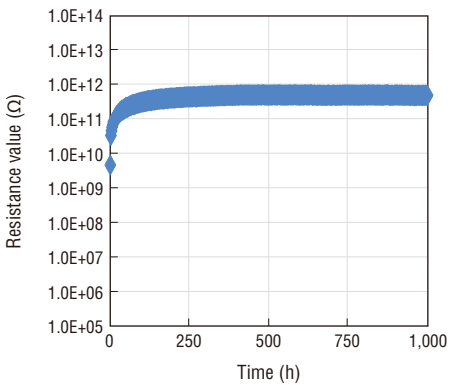
■ KUV-3433-UV reliability test data

Heat and moisture resistance
(UV irradiation condition: 4,000 mJ/cm², durability test result after 7 days)
Heat resistance condition: 100°C, moisture resistance test 85°C/85% RH



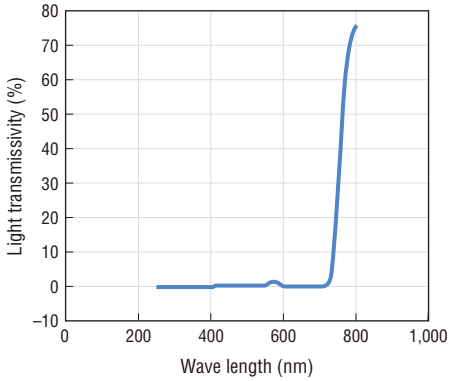
■ KUV-3433-UV migration data

Measurement result of coating thickness of 200 µm



■ KER-4700BK-UV optical transmittance

Thickness: 2 mm



■ Adhesion reliability data of KUV-3433-UV

Adhesion (Crosscut method)	Substrate (epoxy)				
	Initial	250 h	500 h	750 h	1,000 h
100°C	25/25	25/25	25/25	25/25	25/25
85°C/85%RH	25/25	25/25	25/25	25/25	25/25

(Not specified values)

■ Cure properties of FE-90-UV according to light source, atmosphere and estimated light intensity

Light source \ Atmosphere \ Estimated light intensity		2,000 mJ/cm² (100 mW/cm² × 20 s)*		5,000 mJ/cm² (100 mW/cm² × 50 s)*		10,000 mJ/cm² (100 mW/cm² × 100 s)*	
		Penetration	Surface condition	Penetration	Surface condition	Penetration	Surface condition
Metal halide lamp	Nitrogen	68	Cured	63	Cured	61	Cured
	Atmospheric air	70	Cured	64	Cured	63	Cured
UV-LED (365 nm)	Nitrogen	71	Cured	63	Cured	61	Cured
	Atmospheric air	69	Uncured	64	Uncured	63	Uncured

* Illuminance at 365 nm

(Not specified values)

Radical Polymerization Type High-reliablity Silicone Adhesives

- **Long-term reliability is excellent and the cure shrinkage rate is <0.1%, so there are a wide variety of uses.**
- **They can be selected according to the purpose, such as transparency, thixotropy, and exceptional moisture absorption reflow resistance.**
- **The KER-4300-UV series has higher heat resistance reliability and moisture absorption reflow resistance than conventional UV radical types, and can be used in automotive applications and in products requiring reflow mounting.**

■ General properties

Parameter \ Product name		KER-4301-UV	KER-4302-UV	KER-4303-UV	KER-4304-UV	KER-4320-UV
Brief description		Transparent, flowable	Transparent, thixotropic	Resistant to oxygen inhibition, hygroscopic reflow resistance, flowable	Resistant to oxygen inhibition, hygroscopic reflow resistance, thixotropic	Moisture absorption reflow resistance, thixotropic
Reaction mechanism		Radical	Radical	Radical	Radical	Radical
Appearance		Colorless transparent	Colorless transparent	Yellow transparent	Yellow transparent	Yellow transparent
Viscosity	mPa·s	7,000	20,900	5,500	20,400	15,000
Refractive index		1.44	1.44	1.44	1.44	1.44
Recommended curing conditions	UV light source	Metal halide lamp				
	Illuminance* mW/cm²	100	100	100	100	100
	Irradiation time s	40	40	80	40	40
	Estimated light intensity mJ/cm²	4,000	4,000	4,000	4,000	4,000
Density at 23°C	g/cm³	1.10	1.13	1.10	1.12	1.13
Hardness Durometer A		41	54	41	56	16
Tensile strength	MPa	4.0	4.0	2.6	3.8	2.1
Elongation at break	%	110	100	100	80	320
Tensile lap-shear strength (glass/glass) t=460 µm	MPa	1.2	1.3	0.9	1.2	0.9 (t=80 µm)
Cure shrinkage	%	< 0.1	< 0.1	< 0.1	< 0.1	—
Light transmissivity 400 nm, t=2.0 mm	%	90	81	39	34	—
Moisture transmissivity 40°C x 24 h t=1.3 mm	g/cm²	46.6	46.6	52	46.1	51.8
LED-UV (365 nm) applicability		Applicable	Applicable	Applicable	Applicable	Applicable
Atmospheric air cure		Impossible	Impossible	Possible	Possible	Impossible
Refrigeration storage		Unnecessary	Unnecessary	Unnecessary	Unnecessary	Unnecessary

* Illuminance at 365 nm

(Not specified values)

■ Curability of KER-4301 by light source/estimated light intensity

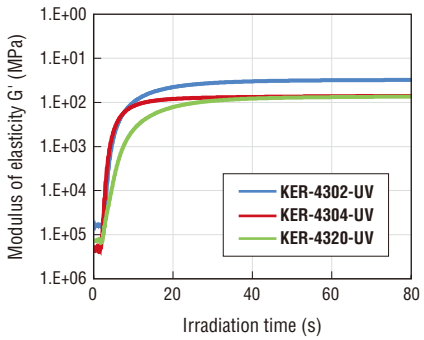
Light source \ Estimated light intensity	Tensile lap-shear strength (glass/glass) t=460 µm MPa		
	4,000 mJ/cm² (100 mW/cm² × 40 s)*	12,000 mJ/cm² (100 mW/cm² × 120 s)*	30,000 mJ/cm² (100 mW/cm² × 300 s)*
Metal halide lamp	1.2	1.0	1.3
UV-LED (365 nm)	1.0	1.0	1.1

* Illuminance at 365 nm

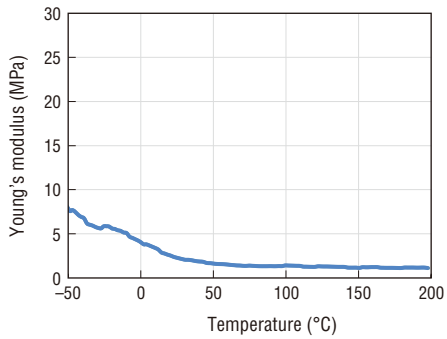
(Not specified values)

■ Curability of the KER-4300 series

UV light source: UV-LED, Illuminace: 100 mW/cm², Thickness: 500 µm

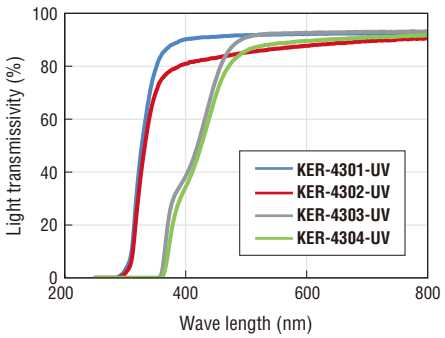


■ Young's modulus of KER-4301



■ Light transmissivity of the KER-4300 series

Thickness: 2 mm

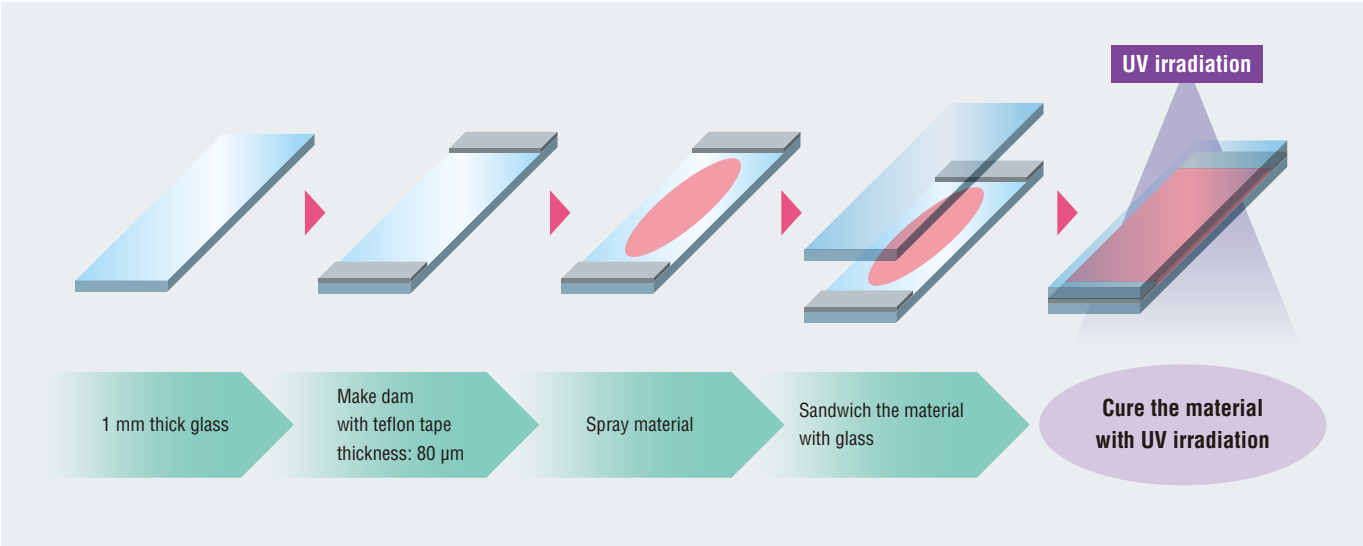


■ Reliability data for the KER-4300 series

Parameter \ Test conditions	KER-4301-UV			KER-4302-UV			KER-4303-UV			KER-4304-UV		
	Initial	150°C × 1,000 h	85°C/85% × 1,000 h	Initial	150°C × 1,000 h	85°C/85% × 1,000 h	Initial	150°C × 1,000 h	85°C/85% × 1,000 h	Initial	150°C × 1,000 h	85°C/85% × 1,000 h
Hardness	41	74	70	54	81	65	43	75	71	54	77	76
Elongation %	110	60	60	100	50	50	110	60	70	100	60	70
Tensile lap-shear strength (glass/glass) MPa	1.2	0.8	1.5	1.3	2.1	1.5	0.9	3.2	1.2	1.2	3.8	0.7

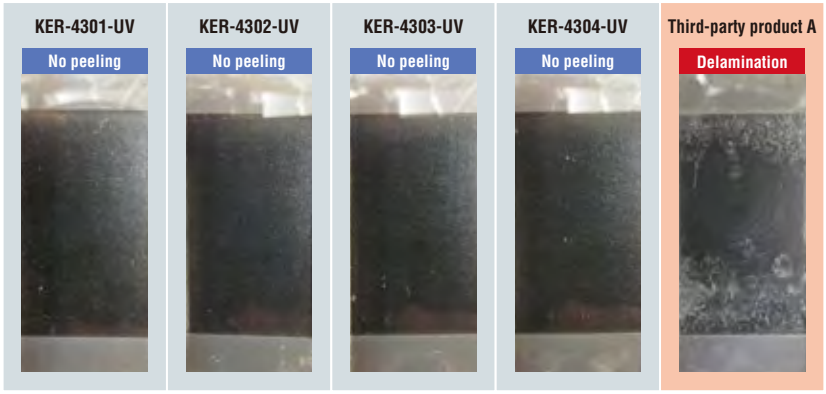
(Not specified values)

■ Test piece preparation flow



■ Appearance after reflow test

Test conditions: 275°C × 1 min



■ Appearance after moisture absorption reflow test

Test conditions: 85°C/85%RH × 168 h → 260°C × 1 min × 3 cycles

Radical Polymerization Type Temporary Adhesive Silicones

- **A wide range of sticky force and hardness is available.**
- **They have stable sticky force and resilience (excellent repeat durability).**
- **Excellent in holding sticky force even after heat aging.**

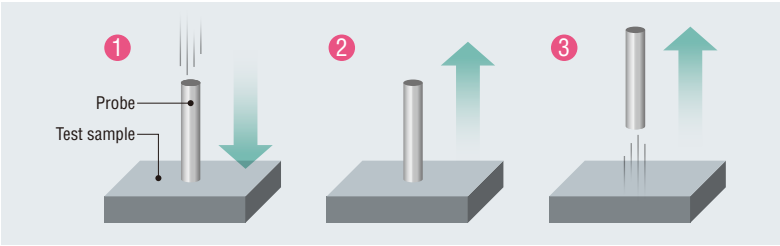
■ General properties

Parameter \ Product name		STP-102-UV	STP-103-UV	STP-104-UV	STP-106T-UV
Brief description		Medium sticky force	Medium sticky force, ultra low viscosity	High sticky force	Low sticky force, thixotropic
Reaction mechanism		Radical	Radical	Radical	Radical
Appearance		Pale yellow transparent	Pale yellow transparent	Pale yellow transparent	Pale yellow translucent
Viscosity	mPa·s	1,650	170	290	250,000
Recommended curing conditions	UV light source	UV-LED (365 nm)*			
	Illuminance mW/cm²	100	100	100	100
	Irradiation time s	80	80	80	80
	Estimated light intensity mJ/cm²	8,000	8,000	8,000	8,000
Density at 23°C	g/cm³	1.08	1.05	1.08	1.14
Hardness Durometer A		24	28	37	33
Tensile strength	MPa	2.8	2.8	4.1	1.9
Elongation at break	%	250	210	240	170
Sticky force 200 mm/min	MPa	1.30	0.62	2.07	0.40
Tensile lap-shear strength (glass/glass) t=230 µm	MPa	8.5	7.0	10.8	5.9
Atmospheric air cure		Impossible	Impossible	Impossible	Impossible
Refrigeration storage		Unnecessary	Unnecessary	Unnecessary	Unnecessary

✻ When cured with a high-pressure mercury lamp, no adhesive strength develops.

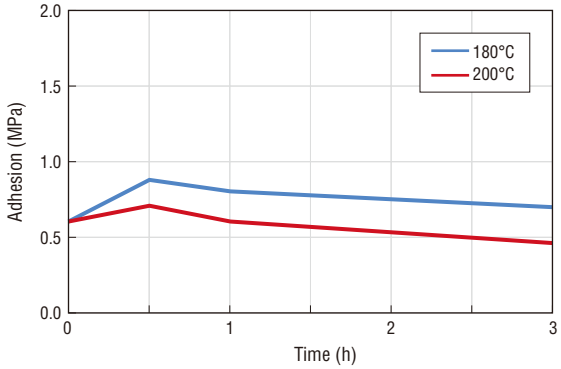
(Not specified values)

■ Sticky force measurement method

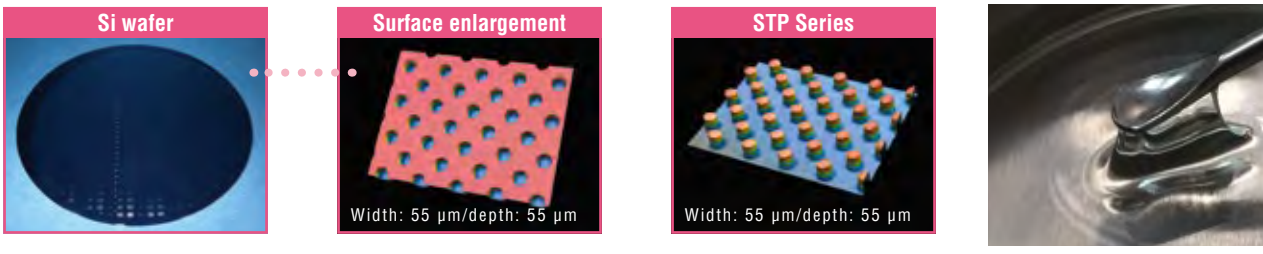


Test method:
1. The tip of the probe is pressed against the sample of silicone with a force of 1.0 MPa for 15 seconds.
2. The probe is then peeled off at a rate of 200 mm/min. Sticky force calculates the maximum strength taken to pull a part the probe from material sample. Surface area of the probe (that makes contact with material sample) needs to be calculated by unit area and this value is the sticky force.

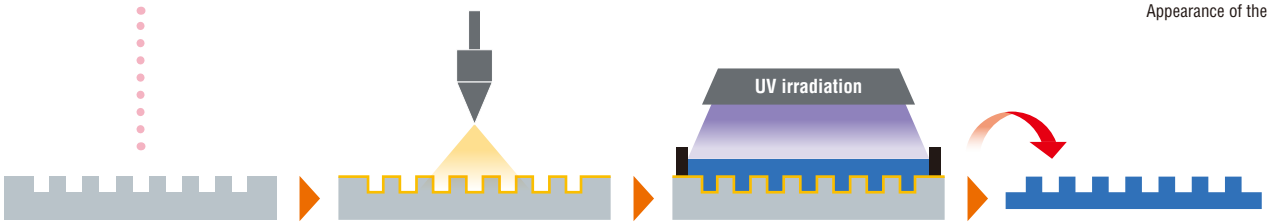
■ Sticky force of STP-103-UV after heat aging



■ Transcriptional properties of the STP series



Appearance of the cured product



Fine irregularities are formed on a Si wafer.

Fluorinated mold release agent applied

Apply STP Series on Si Wafer
Remove air bubbles from fine holes by evacuation.
Cure by UV irradiation (8,000 mJ/cm²)

Remove the STP series from the Si wafer

Radical Polymerization Type Polyimide Silicone

- **The SMP-7000 series is a UV-curable polyimide silicone.**
- **This is an environmentally friendly product that is a solvent-free type and does not contain halogen.**
- **It can be used as a coating or adhesive.**

■ General properties

Parameter \ Product name		SMP-7004	SMP-7014	SMP-7015	SMP-7004-3S	SMP-7014-3S	SMP-7015-3S
Brief description		Polyimide silicone			Polyimide silicone, oxygen inhibition reduced product		
Reaction mechanism		Radical			Radical		
Appearance		Pale yellow transparent			Pale yellow slightly cloudy		
Viscosity	mPa·s	2,000	10,000	160,000	2,000	10,000	160,000
Recommended curing conditions	UV light source	Metal halide lamp (365 nm)					
	Illuminance*1 mW/cm²	100	100	100	100	100	100
	Irradiation time s	20	20	20	20	20	20
	Estimated light intensity mJ/cm²	2,000	2,000	2,000	2,000	2,000	2,000
Density at 23°C	g/cm³	1.00	1.01	1.07	1.00	1.01	1.07
Modulus of elasticity	MPa	180	180	600	190	200	800
Tensile strength	MPa	18.8	6.0	19.5	18.2	19.5	18.0
Elongation at break	%	110	60	50	120	90	50
Moisture transmissivity 40°C x 24 h t=0.8 mm	g/cm²	9.70*2	8.70	6.80	9.90	4.00	6.10
LED-UV (365 nm) applicability		Not applicable	Not applicable	Not applicable	Applicable	Applicable	Applicable
Atmospheric air cure		Impossible	Impossible	Impossible	Possible	Possible	Possible
Refrigeration storage		Unnecessary	Unnecessary	Unnecessary	Unnecessary	Unnecessary	Unnecessary

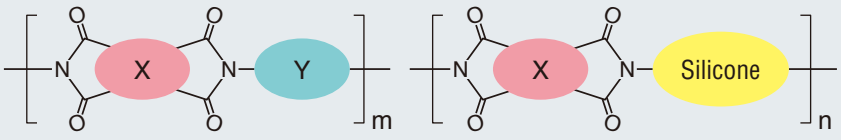
*1 Illuminance at 365 nm *2 t=1.0 mm

(Not specified values)

■ Polyimide silicone

Next-generation super engineering plastics are available only from Shin-Etsu, based on a combination of polyimide resin and silicone resin.

■ Structure



(Copolymer of m and n)

Mechanical toughness combined with flexibility

Cured sheet of SMP-7014

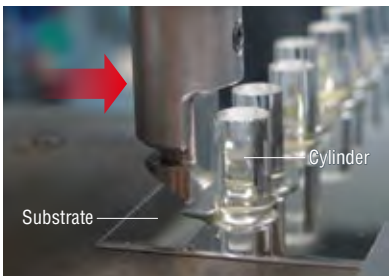
■ Die share strength test

Parameter \ Product name		SMP-7004-3S	SMP-7014-3S	SMP-7015-3S
Curing condition*	UV light source	Metal halide lamp (100 mW)		
	Estimated light intensity	2,000 mJ/cm²		
Die shear MPa	Glass substrate/glass cylinder	18.6	19.1	10.7
	PET substrate/glass cylinder	—	—	8.0

* At room temperature and open to the atmosphere

(Not specified values)

Test piece preparation method:
1. The substrate is coated with 15 mg of product.
2. Place the cylinder on it and press it with a finger from above.
3. UV curing is carried out in a metal halide lamp under atmospheric opening.
4. Die shear strength is measured.



Test method

■ Reliability test data of SMP-7014-3S

Parameter \ Test conditions		Initial	High temperature exposure test	Constant humidity and constant temperature test	Heat cycle test
			150°C × 500 h	60°C/90%RH × 500 h	−30↔70°C (30 min each) 200 cycle
Die shear MPa	Glass substrate/aluminum cylinder	9.1	20.3*	10.3	14.4
	Aluminum substrate/glass cylinder	9.1	20.0	17.3	13.2
	SUS304 substrate/glass cylinder	7.6	20.3*	18.1	11.9

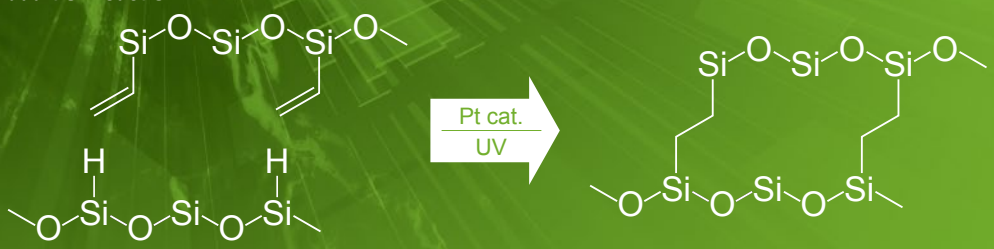
* Detection limit

(Not specified values)

UV Addition Type Silicone

- A silicone polymer with a vinyl group and a silicone polymer with a H group are cured by a hydrosilylation reaction under a photoactivated catalyst.
- After UV irradiation, curing starts gradually after several minutes to several tens of minutes in a room temperature environment.
- It is best suited for applications where UV-cure radical polymerization reactions, condensation reactions that react with moisture in the air and cure, and addition reactions that react with heat and cure are not available.

■ UV addition reaction



Delayed Cure Type

Precautions when using

- It does not cure immediately after UV irradiation.
- Contact with certain compounds may cause poor cure or adhesion, so caution should be exercised when using the product.

Cure inhibition

When using addition-cure liquid silicone rubber products, it is important that the user have a good understanding of the problems 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

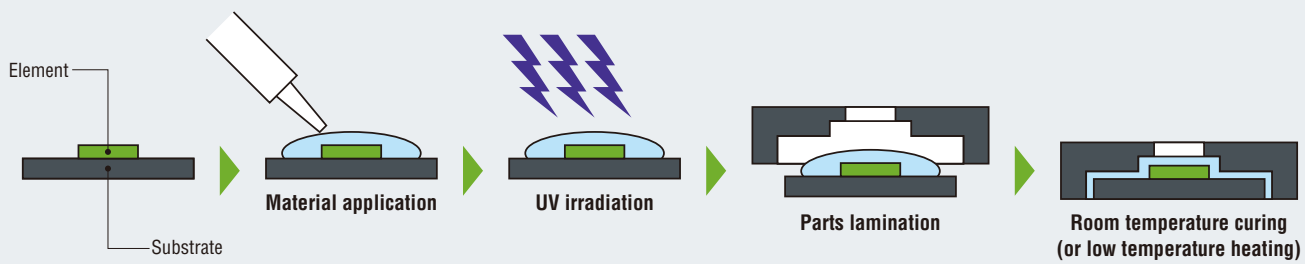
- Alcohol, water.
- Organic acids such as carboxylic acid.

Specific examples of cure inhibition

- Organic rubber: vulcanized rubber, anti-aging agent (e.g. rubber gloves)
- Epoxy & urethane resin: amine- and isocyanate-based curing agents
- Condensation-cure liquid 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)

■ Use of UV addition type (process reversal is possible)

Point By utilizing a property that does not cure immediately after UV irradiation, it is possible to laminate and fix parts after UV irradiation. After that, it is cured at room temperature, which is expected to reduce the heating stress compared to the heat cure type.



UV Addition Type Optical Bonding Silicones (LOCA)

- **Lamination after UV irradiation is possible.**
- **LOCA curability can be ensured even in areas not irradiated with UV rays.**

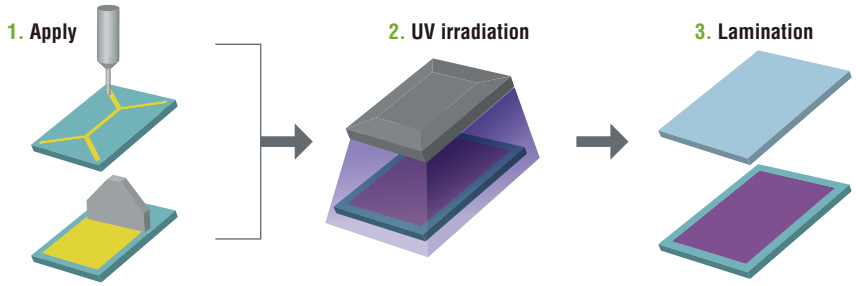
■ General properties

Parameter \ Product name		KER-4530	KER-4551	KER-4531	KER-4532	KER-4580
Brief description		Low viscosity, gel	Medium viscosity, gel	Medium viscosity, gel	High viscosity, gel	Thixotropic, gel
Reaction mechanism		Addition	Addition	Addition	Addition	Addition
Appearance		Colorless transparent	Colorless transparent	Colorless transparent	Colorless transparent	Colorless slightly cloudy
Viscosity mPa·s		4,000	10,000	25,000	95,000	4,000
Refractive index		1.41	1.40	1.41	1.41	1.44
Recommended curing conditions	UV light source	UV-LED (365 nm)				
	Illuminance mW/cm²	100	100	100	100	100
	Irradiation time s	30	30	30	30	10
	Estimated light intensity mJ/cm²	3,000	3,000	3,000	3,000	1,000
Curing conditions after UV irradiation		23°C × 24 h				
Density at 23°C g/cm³		0.97	0.97	0.97	0.97	1.04
Hardness	Durometer A	5	NA	NA	NA	NA
	Penetration	NA	30	30	35	37
Tensile strength MPa		0.3	NA	NA	NA	0.2
Elongation at break %		550	1,200	NA	NA	660
Cross adhesion strength t=230 µm MPa		0.5	0.3	0.3	0.3	0.4
Light transmissivity 400 nm, t=310 µm %		> 99	> 99	> 99	> 99	94
LED-UV (365 nm) applicability		Applicable	Applicable	Applicable	Applicable	Applicable
Atmospheric air cure		Possible	Possible	Possible	Possible	Possible
Refrigeration storage		Necessary	Necessary	Necessary	Necessary	Necessary

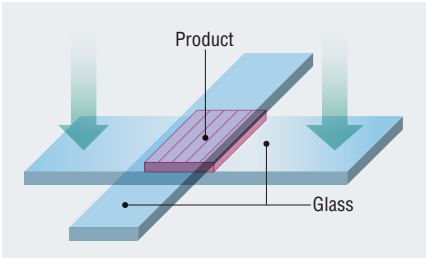
(Not specified values)

■ Lamination process using the "delayed curing" property of the UV addition type

Point When UV addition (delayed cure) type is used, UV irradiation is performed first, and lamination can be done later. As a result, LOCA curability can be ensured even in areas not irradiated with UV rays.



■ Measurement method of cross adhesion strength



Test method:
Two sheets of glass are stuck together in a cross shape, then the force required to pull them apart is measured.
Adhesion area: 500 mm² (25 mm × 20 mm)
Pulling speed: 5 mm/min

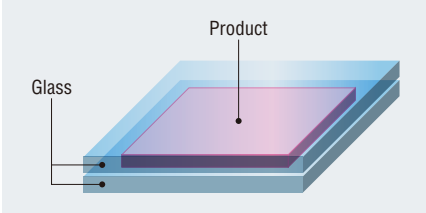
■ Heat resistance test result of KER-4551

Parameter \ Conditions		Initial	95°C × 1,000 h	85°C/85%RH × 1,000 h	40°C⇔85°C/h × 1,000 cycles
Yellow index*		-0.20	0.21	0.24	0.31
Light transmissivity 400 nm, t=310 µm %		> 99	> 99	> 99	> 99
Color	L*	103.0	102.6	102.6	102.6
	a*	-0.00	-0.06	-0.07	-0.01
	b*	-0.11	0.14	0.16	0.18
Hardness Penetration		32	30	32	29
Cross adhesion strength (glass/glass) t=230 µm MPa		0.42	0.41	0.42	0.39

* YI ASTM E313

(Not specified values)

■ Method for measuring color shade



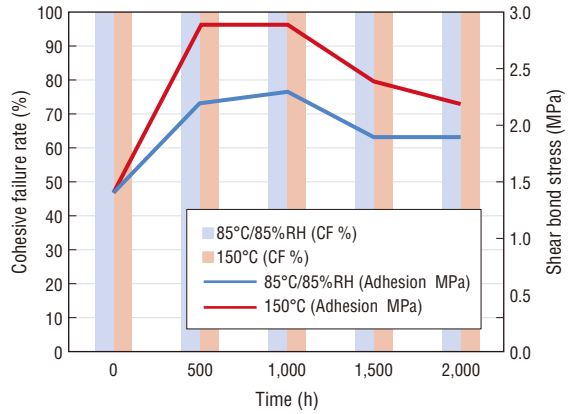
Test method: measured using two glass plates as blanks
Coating thickness: 310 µm
Measuring instrument: CM-5,
a Konica Minolta spectrophotometer

■ General properties

Parameter \ Product name		KER-4410	KER-4510	KER-4690-A/B	KER-4691-A/B
Brief description		Adhesive, room temperature cure	Adhesive, low temperature cure	Non-adhesive, high definition transfer	Non-adhesive, high definition transfer
Reaction mechanism		Addition	Addition	Addition	Addition
Appearance		Colorless slightly cloudy	Colorless transparent	Colorless transparent	Colorless transparent
Viscosity mPa·s		59,000	49,000	3,000	80,000
Recommended curing conditions	UV light source	UV-LED (365 nm)			
	Illuminance mW/cm²	100	100	100	100
	Irradiation time s	30	30	30	30
	Estimated light intensity mJ/cm²	3,000	3,000	3,000	3,000
Curing conditions after UV irradiation		80°C × 1 h or 23°C × 24 h	60°C × 1 h	23°C × 24 h	23°C × 24 h
Density at 23°C g/cm³		1.06	1.04	1.03	1.09
Hardness Durometer A		15	50	56	42
Tensile strength MPa		2.3	6.6	7.9	6.2
Elongation at break %		350	530	110	420
Tensile lap-shear strength MPa		1.6 (AL/AL) 1.7 (PBT/PBT) 1.4 (PPS/PPS)	2.2 (GL/GL)	NA	NA
Light transmissivity 400 nm, t=2.0 mm %		NA	87	90	NA
Cure shrinkage %		—	—	> 0.1	> 0.1
Atmospheric air cure		Possible	Possible	Possible	Possible
Refrigeration storage		Necessary	Necessary	Unnecessary	Unnecessary

(Not specified values)

■ KER-4410 lap-shear durability test data (substrate PPS/PPS)



■ Hardness change by UV light source of KER-4410

Light source \ Estimated light intensity mJ/cm² \ Elapsed time after UV irradiation		15 min	1 h	2 h	3 h	5 h	7 h	24 h
LED-UV (365 nm)	3,000	Liquid	Gel	0	1	5	7	11
	8,000			1	3	6	7	12
	12,000			1	3	6	7	12
Metal halide lamp	3,000	Liquid	Gel	0	2	6	7	12
	8,000			0	0	3	6	12
	12,000			0	0	2	6	12

(Not specified values)

■ Comparative shrinkage data for heat addition curing type (KE-106) and UV addition curing type (KER-4690-A/B)

Test method:
1. The KE-106 (heat curing type) and KER-4690-A/B are poured into a mold 100 mm long, 100 mm wide, and 2 mm thick, respectively, and cured.
   Curing condition: KE-106 150°C x 30 min, KER-4690-A/B 200 mJ per cm² UV-LED (365 nm)
2. The length after curing is measured, and the shrinkage rate is determined from the difference before curing.

Test piece left: KE-106 right: KER-4690-A/B

■ KER-4690-A/B results of heat resistance experiments

Parameter \ Product name		KE-106		KER-4690-A/B	
		Before curing	After curing	Before curing	After curing
The length of the four sides mm	Up	99.0	96.4	99.1	99.1
	Down	99.5	97.0	99.3	99.2
	Left	99.5	97.0	99.8	99.7
	Right	100	97.2	100.8	100.8
	Average	99.5	96.9	99.8	99.7
Shrinkage percentage %		2.6		0.05	
Coefficient of linear contraction %		2.6		0.1	

(Not specified values)

■ General properties

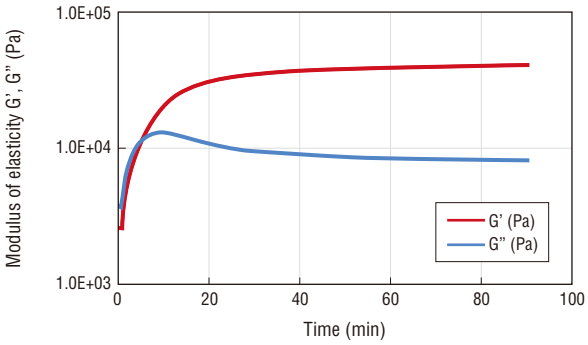
Parameter \ Product name		KER-4951	KER-4952-A/B	GUV-300	GUV-500	SCR-4016-A/B
Brief description		Gel	Gel	Thermal interface material	Thermal interface material	High hardness, Gas barrier
Reaction mechanism		Addition	Addition	Addition	Addition	Addition
Appearance		Colorless transparent	Colorless transparent	White	White	Colorless transparent
Viscosity mPa·s		600	900/600	154,000	311,000	260
Refractive index		1.42	1.42	NA	NA	1.52
Mix ratio		NA	A:B = 100:100	NA	NA	A:B = 100:100
Recommended curing conditions	UV light source	UV-LED (365 nm)				
	Illuminance mW/cm²	100	100	100	100	100
	Irradiation time s	50	20	60	60	30
	Estimated light intensity mJ/cm²	5,000	2,000	6,000	6,000	3,000
Curing conditions after UV irradiation		23°C x 24 h	23°C x 24 h	25°C x 1 h	25°C x 1 h	80°C x 1 h
Density at 23°C g/cm³		0.97	0.99	2.98	3.23	—
Hardness	Shore D	NA	NA	NA	NA	68
	Durometer A	NA	NA	NA	NA	NA
	Penetration	60	60	NA	NA	NA
Modulus of elasticity G' 0.2 mm Pa		NA	NA	38,730	30,360	NA
Tensile strength MPa		NA	NA	NA	NA	NA
Elongation at break %		NA	NA	NA	NA	NA
Tensile lap-shear strength (Al/Al) t=2.0 mm MPa		NA	NA	NA	NA	11.0
Light transmissivity 400 nm, t=2.0 µm %		99	99	NA	NA	89.7
Thermal conductivity W/m·k		NA	NA	3.1	5.1	NA
Atmospheric air cure		Possible	Possible	Possible	Possible	Possible
Refrigeration storage		Necessary	Unnecessary	Necessary	Necessary	Unnecessary

(Not specified values)

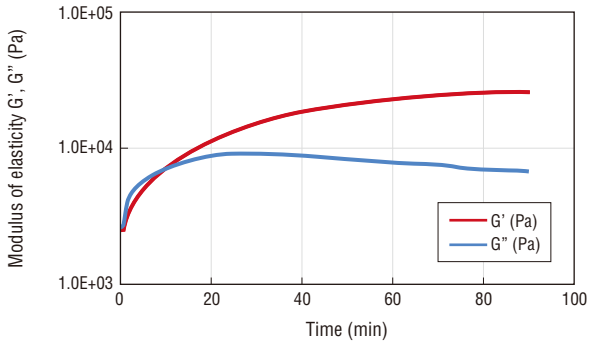
■ UV curability (thickness dependence) of GUV-300

100 mW/cm²@1 min irradiation → leave under 25°C

Thickness: 0.2 mm

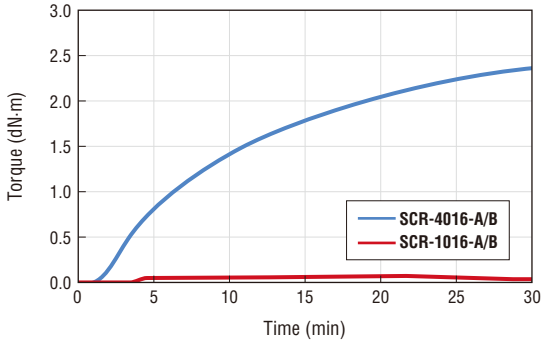


Thickness: 0.4 mm



■ SCR-4016-A/B curability data

Curability (100°C x 30 min)



✻ Only SCR-4016-A/B is irradiated with UV-light (365 nm UV LEDs: 3,000 mJ/cm²)

■ SCR-4016-A/B sulfurization test data

Before test

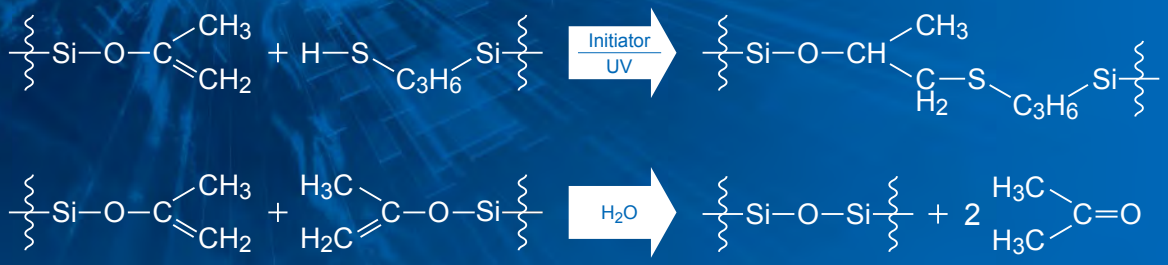
After test

No change

Test conditions: 70°C x 72 h in a sulfur atmosphere

Combination of Radical and Condensation Type Silicone

- The portions not irradiated with UV rays are also curable by reaction with moisture in the air while producing by-products (outgas).
- Depending on the type of reaction by-product, it is classified into a type such as dealcoholization type, deacetone type.



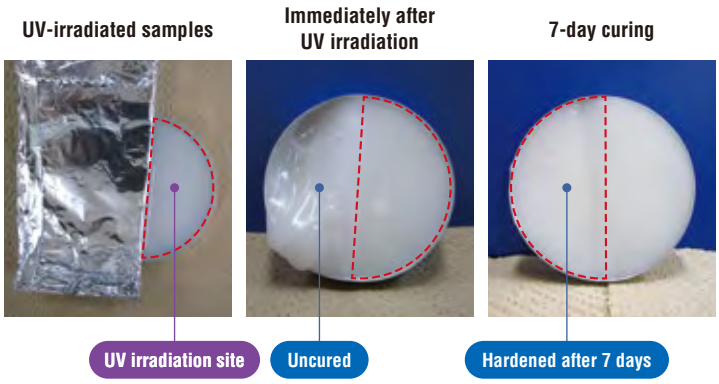
Shaded section Cure Type

■ Shaded section cure test

Point

Curability can be ensured even in areas not irradiated with UV rays.

One side of a sample placed in an aluminum petri dish with a depth of 10 mm was covered with aluminum foil, and UV irradiation was performed. Removed the aluminum foil, placed the aluminum petri dish in a container, and cured at 23±2°C/50±5% RH for 0, 1, 3, 5, or 7 days to check the hardness. The container was covered with aluminum foil so that no light would impinge on the container.



■ Curability test data

Parameter \ Product name	KE-3431									
Curing period	0 day		1 day		3 days		5 days		7 days	
UV irradiation	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Hardness*	A26	—	A40	C8	A45	A19	A50	A30	A51	A34

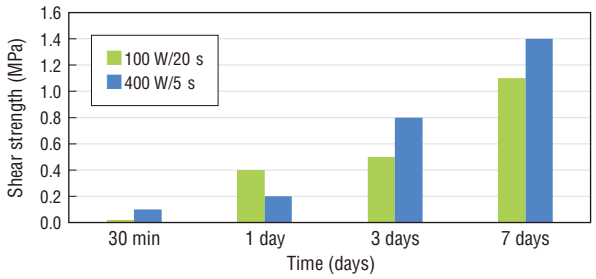
* Hardness: A = Durometer A C = Asker C

(Not specified values)

■ Changes in UV irradiation intensity and adhesion strength of KE-3432

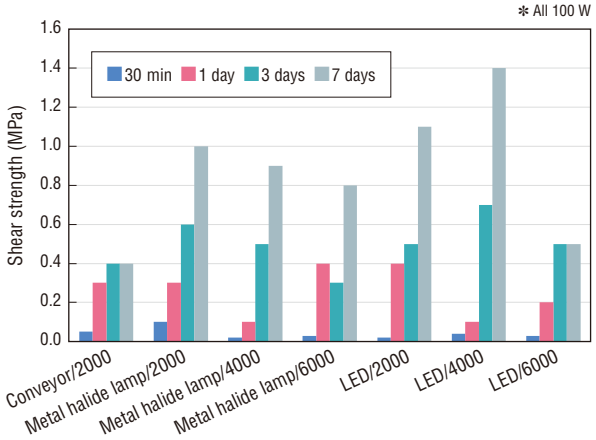
Product name	KE-3432	
UV irradiation intensity/ time	Storage period	Tensile lap-shear strength MPa
100 W/20 s	30 min	0.02
	1 day	0.4
	3 days	0.5
	7 days	1.1
400 W/5 s	30 min	0.1
	1 day	0.2
	3 days	0.8
	7 days	1.4

(Not specified values)



■ Change in adhesion strength of KE-3432 due to changes in UV irradiation equipment and cumulative amount of light

* All 100 W



■ General properties

Parameter \ Product name		KE-4835	KE-3431	KE-3432
Brief description		Adhesion/fixing	Adhesion/fixing	Adhesion/fixing
Reaction mechanism		Combination of radical and condensation	Combination of radical and condensation	Combination of radical and condensation
Appearance		Creamy white translucent	Creamy white translucent	Creamy white translucent
By-product gas		Alcohol	Acetone	Acetone
Viscosity	mPa·s	6,000	30,000	10,000
Recommended curing conditions	UV light source	Metal halide lamp		
	Illuminance* mW/cm²	100	100	100
	Irradiation time s	20	20	20
	Estimated light intensity mJ/cm²	2,000	2,000	2,000
Curing conditions after UV irradiation		23°C/50%RH x 3 days	23°C/50%RH x 7 days	
Density at 23°C	g/cm³	1.01	1.08	1.06
Hardness Durometer A		27	54	52
Tensile strength	MPa	1.1	2.7	2.6
Elongation at break	%	105	80	75
Tensile lap-shear strength (glass/glass) t=2.0 mm	MPa	0.3	1.3	1.4
LED-UV (365 nm) applicability		Applicable	Applicable	Applicable
Atmospheric air cure		Possible	Possible	Possible
Refrigeration storage		Unnecessary	Necessary	Necessary

* Illuminance at 365 nm

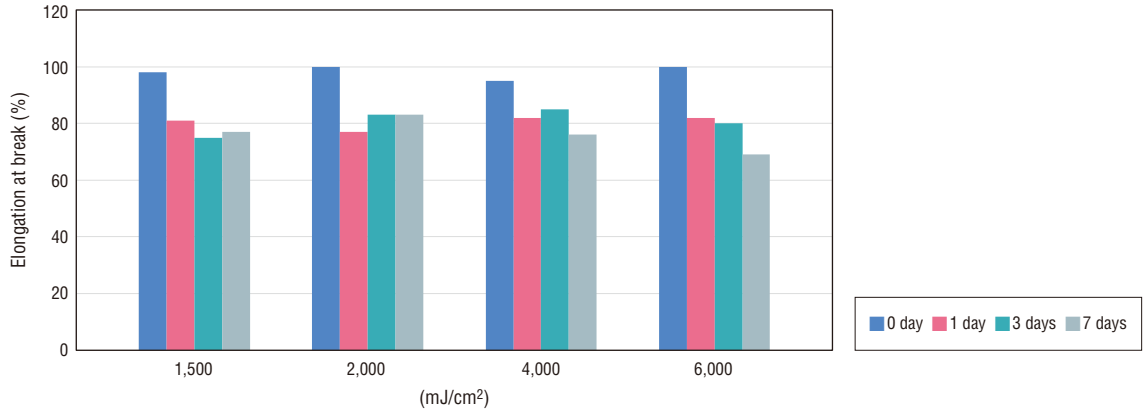
(Not specified values)

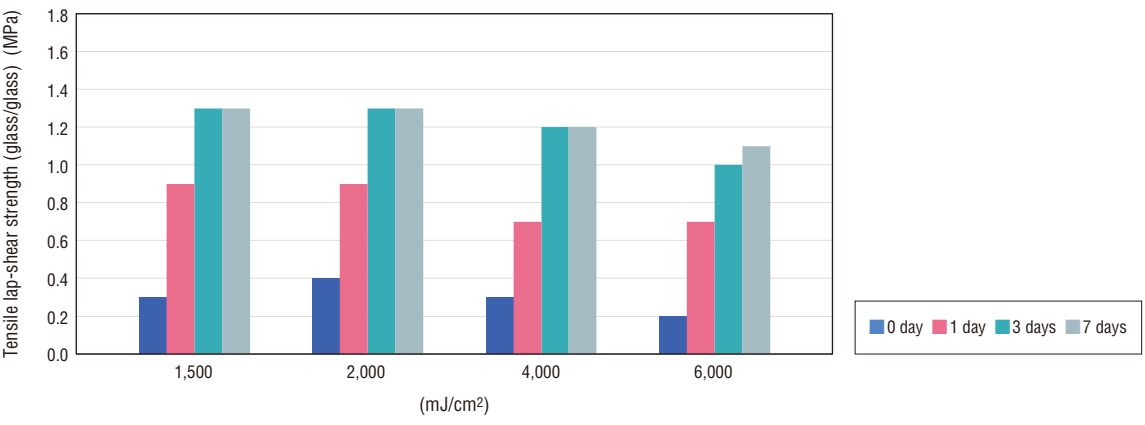
■ Curing period and cure shrinkage

Parameter \ Product name	KE-3431			KE-3432		
Curing period	1 day	3 days	7 days	1 day	3 days	7 days
Cure shrinkage %	1.8	2.2	2.3	1.2	1.7	1.9

(Not specified values)

■ Cure properties of KE-3431 according to UV irradiation conditions (23°C/50% RH)





Packaging Options / Product Index

Radical Polymerization Type
UV Addition Type
Combination of Radical and Condensation Type

Product name	Packaging	RoHS*	Page
FE-90-UV	50 g, 100 g (brown glass bottle) / 1 kg (black bottle)	○	P7
GUV-300	500 g (round can) / 900 g (cartridge) / 1 kg (round can)	○	P15
GUV-500	500 g (round can) / 900 g (cartridge) / 1 kg (round can)	○	P15
KE-3431	330 mL (cartridge)	○	P17
KE-3432	100 g (tube)	○	P17
KE-4835	330 mL (cartridge)	○	P17
KER-4000-UV	100 g (brown glass bottle)	○	P7
KER-4301-UV	30 g (brown syringe) / 50 g, 100 g (brown glass bottle)	○	P8
KER-4302-UV	30 g (brown syringe) / 50 g, 100 g (brown glass bottle)	○	P8
KER-4303-UV	30 g (brown syringe) / 50 g, 100 g (brown glass bottle)	○	P8
KER-4304-UV	30 g (brown syringe) / 50 g, 100 g (brown glass bottle)	○	P8
KER-4320-UV	30 g (brown syringe) / 50 g, 100 g (brown glass bottle)	○	P8
KER-4410	30 g (brown syringe) / 50 g, 100 g (brown glass bottle) / 1 kg (black plastic bottle)	○	P14
KER-4510	30 g (brown syringe) / 50 g, 100 g (brown glass bottle) / 1 kg (black plastic bottle)	○	P14
KER-4530	30 g (brown syringe) / 50 g, 100 g (brown glass bottle) / 1 kg (black plastic bottle)	○	P13
KER-4531	30 g (brown syringe) / 50 g, 100 g (brown glass bottle) / 1 kg (black plastic bottle)	○	P13
KER-4532	30 g (brown syringe) / 50 g, 100 g (brown glass bottle) / 1 kg (black plastic bottle)	○	P13
KER-4551	30 g (brown syringe) / 50 g, 100 g (brown glass bottle) / 1 kg (black plastic bottle)	○	P13
KER-4580	30 g (brown syringe) / 50 g, 100 g (brown glass bottle) / 1 kg (black plastic bottle)	○	P13
KER-4690-A/B	50 g (brown glass bottle) / 500 g (brown plastic bottle)	○	P14
KER-4691-A/B	50 g (brown glass bottle) / 1 kg (black plastic bottle)	○	P14
KER-4700-UV	50 g, 100 g (brown glass bottle)	○	P7
KER-4700BK-UV	50 g, 100 g (brown glass bottle)	○	P7
KER-4800-UV	50 g, 100 g (brown glass bottle)	○	P7
KER-4910-UV	50 g, 100 g (brown glass bottle) / 1 kg (square can)	○	P7
KER-4951	100g (brown glass bottle) / 1 kg (black plastic bottle)	○	P15
KER-4952-A/B	100g (brown glass bottle) / 1 kg (black plastic bottle)	○	P15
KUV-3433-UV	100 g (brown glass bottle) / 1 kg (square can)	○	P7
STP-102-UV	100 g (brown glass bottle)	○	P10
STP-103-UV	100 g (brown glass bottle)	○	P10
STP-104-UV	100 g (brown glass bottle)	○	P10
STP-106T-UV	100 g (brown glass bottle)	○	P10
SCR-4016-A/B	100 g (brown glass bottle) / 1 kg (black plastic bottle)	○	P15
SMP-7004	30 g (brown syringe) / 100 g, 0.8 kg (brown glass bottle)	○	P11
SMP-7004-3S	30 g (brown syringe) / 100 g, 0.8 kg (brown glass bottle)	○	P11
SMP-7014	30 g (brown syringe) / 100 g (brown glass bottle) / 0.8 kg (brown bottle)	○	P11
SMP-7014-3S	30 g (brown syringe) / 100 g (brown glass bottle) / 0.8 kg (brown bottle)	○	P11
SMP-7015	30 g (brown syringe) / 100 g (brown glass bottle)	○	P11
SMP-7015-3S	30 g (brown syringe) / 100 g (brown glass bottle)	○	P11

* ○: This indicates that none of the six RoHS-prohibited substances (Cd, Cr6+, Hg, Pb, PBB, PBDE) are used intentionally as ingredients.

Handling precautions

1. The cure properties, physical properties, and adhesiveness of UV-cure products may vary depending on the wavelength and intensity of the light source, the irradiation angle, and the thickness of the material. In particular, increasing the intensity and shortening the irradiation time can have significant effects on the material's physical properties, even if the cumulative light dose is the same. Be sure to experiment and determine which curing conditions will work best.
2. The UV dose required to cure the material completely will vary depending on the amount applied and the application area.
3. Products that cure via radical polymerization should be cured under nitrogen atmosphere. Sections exposed to air may not cure. These products are extremely sensitive to light, and should thus be handled in a "yellow room" environment.
4. Addition-cure liquid silicone rubber products may not cure properly if they are contaminated with or come in contact with certain cure-inhibiting substances (e.g. sulfur, phosphorus, nitrogen compounds, water, organometallic salts).
5. Condensation-cure products cure by reacting with moisture in the air, and thus curing speed may vary depending on conditions (e.g. temperature and humidity) in the area where they are used.
6. Condensation-cure liquid silicone rubber products should not be used in places where completely airtight conditions will be created.
7. Use of these products in hot or humid conditions may cause improper curing or poor adhesion.
8. Products may yellow over time, but their other characteristics will not be affected.

Precautions when using

1. Wear protective glasses and protective gloves when using these products, and be sure the work area is well ventilated.
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 measure, 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.

Safety and hygiene

1. Be sure there is adequate ventilation when using condensation-cure liquid silicone rubber products. As condensation-cure liquid silicone rubber products cure, alcohol-cure products release methanol and acetone-cure products release acetone. If you experience unpleasant symptoms when using these products, move to an area with fresh air.
2. Uncured liquid silicone rubber products 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 liquid silicone rubber: if uncured liquid silicone 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. Keep out of reach of children.
5. Be sure to read the Safety Data Sheets (SDS) for these products before use. SDS are available from the Shin-Etsu Sales Department.

Precautions related to storage

1. Avoid exposure to direct sunlight and store at room temperature (1°C–30°C). Certain products must be kept at lower temperatures. Details can be found on the product label, etc.
2. Once products have been opened, the entire contents should be used at one time whenever possible. If some remains, be sure to seal the container completely.

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The Development and Manufacture of Shin-Etsu Silicones are based on the following registered international quality and environmental management standards.

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)

https://www.shinetsusilicone-global.com/

This is an edited version of the product data released on Sep. 2020.