Shin-Etsu Silicone

LIMS®

Liquid Injection Molding System

A molding system for the modern age.

LIMS

Liquid Injection Molding System

With LIMS, users can achieve significant cost reductions thanks to reduced molding time, improved yield and greater production efficiency.

LIMS (Liquid Injection Molding System) is a new type of molding system. Fine liquid silicone rubber is metered precisely and consistently by special molding equipment. After loading the two liquid components (A & B) into the molding machine, all steps proceed automatically, from mixing to molding. The molding process is simpler and takes less time, making it easy to produce high quality molded products. And the many fine properties of liquid silicone rubbers make this system ideal for electronic, automotive and food product applications, to name but a few. LIMS is highly economical, because it helps improve productivity and reduce labor costs. In addition, there is Self-adhesive Liquid Silicone which bonds well to a variety of metals or thermo plastics without primers. The short cycle times required for molding this Silicone, coupled with the ease with which the molding processes may be automated, leads to improved quality and productivity.

Excellent material properties

These silicones have excellent heat resistance, high strength and flame retardancy. Some are electrical insulators, while others are conductors. Our transparent products can be used as is, or can be colored easily. Our silicone materials are ideal for a wide range of applications.

Reduced molding time

Addition-cure liquid silicone is used, so cure time is short.
The molding process takes less time.

Improved productivity

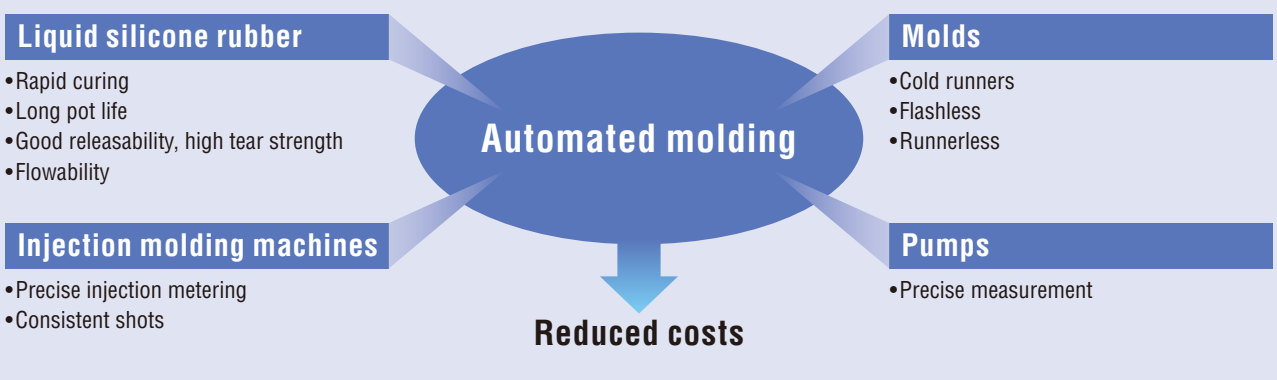
The system uses liquid materials, so molding can be done at low injection pressures and it is suitable for molding high-precision components.
The two liquid components are mixed precisely and contaminants are kept out, resulting in high quality molds and greater efficiency.

Automated molding

Can be used for flashless, runnerless molding. After curing, molded items eject easily, so the molding process can be automated.
Continuous automated molding with short cycle times is also possible.

More eco-friendly molding

No by-products are produced in the curing reaction. Flashless, runnerless molding eliminates the need for disposal of waste material, so the manufacturing process is gentler to the environment.



Overview

Series	Feature	Hardness Durometer A	Note (Regulatory)
KE-1950 Series	For General Purpose, Low Viscosity	10 to 70	FDA, BfR: 30 to 70★
KEG-2000 Series	For General Purpose, Fast Curing	20 to 80	FDA, BfR: 30 to 80★ USP Class VI: 40 to 75★ ISO 10993: 20 to 80★ UL94HB listed: 20 to 75★
KEG-2001 Series	Very Fast Curing	40 to 70	FDA, BfR: 40 to 70★ USP Class VI: 40 to 70★ ISO 10993: 50 to 70★
KEG-2002 Series	Low Viscosity	50, 60	FDA, BfR: 50, 60★
KEG-2003H Series	Non Post Cure, Reduced Low-Molecular-Weight (LMW) Siloxane	30 to 70	FDA, BfR: 30 to 70★ USP Class VI: 30 to 70★ ISO 10993: 30 to 70★
KE-2017	Non Post Cure, Oil Bleeding, Reduced Low-Molecular-Weight (LMW) Siloxane	20	Especially for Automotive
KEG-2017 Series		30 to 50	
KE-2019 Series	Non Post Cure Reduced Low-Molecular-Weight (LMW) Siloxane Low Compression Set	40 to 60	Especially for Automotive
KE-2090 Series	Self-adhesive For General Purpose	10 to 70	USP Class VI: 30 to 70★ ISO 10993: 20, 40★
KE-2098 Series	Self-adhesive For PA resins and Metals	40 to 60	Universal for Plastic and Metal
KE-1935	High Transparency	55	For LED, Lens, etc
KE-2062 Series		30 to 80	

★ Hardness (Durmeter A)

Product	Appearance	Hardness Durometer A	Density g/cm³	Viscosity (A/B) Pa·s	
KE-1950 Series*1 (For General Purpose, Low Viscosity)					
KE-1950-10-A/B	Translucent	13	1.08	60/60	
KE-1950-20-A/B	Translucent	20	1.10	160/160	
KE-1950-30-A/B	Translucent	31	1.10	250/250	
KE-1950-35-A/B	Translucent	36	1.13	560/500	
KE-1950-40-A/B	Translucent	39	1.12	530/530	
KE-1950-50-A/B	Translucent	49	1.13	680/630	
KE-1950-60-A/B	Translucent	57	1.14	730/690	
KE-1950-70-A/B	Translucent	68	1.13	680/650	
KEG-2000 Series*2 (For General Purpose, Fast Curing)					
KEG-2000-20-A/B	Translucent	23	1.08	700/700	
KEG-2000-30-A/B	Translucent	32	1.12	1,200/1,200	
KEG-2000-40-A/B	Translucent	43	1.12	1,300/1,300	
KEG-2000-50-A/B	Translucent	51	1.14	1,400/1,400	
KEG-2000-60-A/B	Translucent	60	1.14	1,600/1,600	
KEG-2000-70-A/B	Translucent	70	1.14	1,400/1,400	
KEG-2000-75-A/B	Translucent	77	1.15	1,400/1,400	
KEG-2000-80-A/B	Translucent	81	1.13	1,120/1,080	
KEG-2001 Series (Very Fast Curing)					
KEG-2001-40-A/B	Translucent	42	1.12	1,000/1,000	
KEG-2001-50-A/B	Translucent	52	1.13	1,000/1,000	
KEG-2001-60-A/B	Translucent	60	1.13	1,320/1,280	
KEG-2001-70-A/B	Translucent	70	1.14	1,200/1,200	
KEG-2002 Series (Low Viscosity)					
KEG-2002-50-A/B	Translucent	51	1.13	700/700	
KEG-2002-60-A/B	Translucent	59	1.13	500/500	
KEG-2003H Series*3 (Non Post Cure, Reduced LMW Siloxane)					
KEG-2003H-30-A/B	Translucent	31	1.13	740/690	
KEG-2003H-40-A/B	Translucent	41	1.13	900/960	
KEG-2003H-50-A/B	Translucent	51	1.13	1,030/1,000	
KEG-2003H-60-A/B	Translucent	60	1.13	750/700	
KEG-2003H-70-A/B	Translucent	69	1.14	1,040/1,010	

Curing condition: 150°C × 5 min + 200°C × 4 h Standard: JIS K 6249

*1 Curing condition: 120°C × 5 min + 150°C × 1 h
*2 Curing condition: 120°C × 10 min + 200°C × 4 h
*3 Curing condition (Non post cure): 150°C × 5 min
*4 Curing speed at 150°C
*5 Curing condition: 150°C × 15 min + 150°C × 1 h Testing condition: 150°C × 22 h
*6 Curing condition: 150°C × 15 min + 200°C × 4 h Testing condition: 175°C × 22 h

	Curing Speed at 130°C (MDR) sec		Linear Shrinkage %	Tensile Strength		Elongation at break %	Tear Strength		Compression Set %
	T10	T90		MPa	psi		kN/m	ppi	
	47*4	99*4	2.3	4.3	620	750	10	58	12*5
	47*4	98*4	2.3	7.3	1,060	970	24	139	15*5
	35*4	44*4	2.3	8.2	1,190	710	22	128	22*5
	29*4	38*4	2.2	9.5	1,380	730	28	162	36*5
	28*4	42*4	2.2	9.3	1,350	670	31	180	20*5
	33*4	55*4	2.2	8.9	1,290	560	37	215	28*5
	30*4	53*4	2.2	8.0	1,160	420	39	226	22*5
	28*4	45*4	2.2	9.5	1,380	470	39	226	34*5
	26	42	2.4	6.2	900	880	15	87	28*6
	31	53	2.3	9.2	1,330	830	28	162	14*6
	25	45	2.3	9.9	1,440	630	34	197	17*6
	31	64	2.2	12.7	1,840	670	38	220	11*6
	35	76	2.1	11.5	1,670	550	48	220	20*6
	29	61	2.1	10.8	1,570	470	34	197	18*6
	31	66	2.1	8.6	1,250	220	5.5	32	25*6
	27*4	40*4	2.2	8.0	1,160	200	5	29	—
	22	38	2.3	11.0	1,600	630	33	191	—
	18	35	2.2	11.8	1,710	530	40	232	—
	21	39	2.2	9.2	1,330	550	44	255	—
	22*4	40*4	2.1	9.5	1,380	420	40	232	—
	27	41	2.5	10.0	1,450	520	35	203	—
	27	40	2.5	9.5	1,380	460	43	249	—
	23	44	2.4	9.3	1,348	900	30	174	—
	23	45	2.4	9.1	1,320	830	36	209	—
	21	41	2.4	10.6	1,537	790	40	232	—
	22	43	2.4	9.9	1,436	660	46	267	—
	30	61	2.4	9.1	1,320	490	46	267	—

(Not specified values)

Product	Appearance	Hardness Durometer A	Density g/cm³	Viscosity (A/B) Pa·s	
KE-2017 (Non Post Cure, Oil Bleeding, Reduced LMW Siloxane)					
KE-2017-20-A/B	Translucent	21	1.09	500/380	
KEG-2017 Series*1 (Non Post Cure, Oil Bleeding, Reduced LMW Siloxane)					
KEG-2017-30-A/B	Translucent	33	1.13	1,840/1,450	
KEG-2017-40-A/B	Translucent	42	1.13	1,800/1,700	
KEG-2017-50-A/B	Translucent	52	1.13	1,700/1,500	
KE-2019 Series*1 (Non Post Cure, Reduced LMW Siloxane, Low Compression Set)					
KE-2019-40-A/B	Translucent	42	1.11	320/300	
KE-2019-50-A/B	Translucent	52	1.13	840/710	
KE-2019-60-A/B	Translucent	62	1.14	720/810	
KE-2090 Series*2 (Self-adhesive, for General Purpose)					
KE-2090-10-A/B	Translucent	9	1.06	90/85	
KE-2090-20-A/B	Translucent	21	1.07	250/250	
KE-2090-30-A/B	Translucent	30	1.11	400/700	
KE-2090-40-A/B	Translucent	40	1.11	300/700	
KE-2090-50-A/B	Translucent	52	1.12	300/700	
KE-2090-60-A/B	Translucent	59	1.12	400/700	
KE-2090-70-A/B	Translucent	69	1.13	500/600	
KE-2098 Series*2 (Self-adhesive, for PA resins and Metals)					
KE-2098-40-A/B	Translucent	40	1.14	1,040/1,150	
KE-2098-50-A/B	Translucent	49	1.14	1,100/1,210	
KE-2098-60-A/B	Translucent	59	1.14	940/975	
KE-1935 (High Transparency)					
KE-1935-A/B*3	Transparent	55	1.03	88/41	
KE-2062 Series (High Transparency)					
KE-2062-30-A/B*4	Transparent	30	1.02	160/80	
KE-2062-40-A/B*4	Transparent	40	1.03	166/90	
KE-2062-50-A/B*4	Transparent	50	1.03	155/85	
KE-2062-60-A/B*4	Transparent	59	1.04	159/69	
KE-2062-70-A/B*4	Transparent	69	1.05	195/85	
KE-2062-80-A/B*4	Transparent	78	1.07	187/75	

Standard: JIS K 6249

*1 Curing condition (Non post cure): 150°C × 15 min
*2 Curing condition (Non post cure): 120°C × 10 min
*3 Curing condition: 120°C × 5 min + 150°C × 1 h
*4 Curing condition: 120°C × 10 min + 150°C × 1 h
*5 Curing speed at 150°C (ODR)
*6 Curing speed at 120°C (ODR)

	Curing Speed at 130°C (MDR) sec		Linear Shrinkage %	Tensile Strength		Elongation at break %	Tear Strength		Compression Set 150°C × 70 h %
	T10	T90		MPa	psi		kN/m	ppi	
	31	83	2.6	7.9	1,150	860	10	58	14
	41	77	2.5	9.9	1,440	740	20	116	16
	36	76	2.5	10.2	1,480	650	33	191	18
	32	75	2.5	9.4	1,360	490	38	220	18
	30	73	2.4	9.8	1,420	655	35	203	12
	27	69	2.3	9.3	1,350	538	44	255	16
	38	65	2.3	9.8	1,420	470	47	273	42
	26*5	50*5	2.4	3.4	490	870	11	64	—
	22*5	68*5	2.6	7.3	160	970	18	104	—
	62*6	80*6	2.0	9.5	1,380	800	20	116	—
	85*6	105*6	2.0	9.0	1,310	650	30	174	—
	70*6	100*6	2.0	8.3	1,200	450	29	168	—
	94*6	154*6	2.0	7.5	1,090	320	30	174	—
	72*6	110*6	2.0	7.8	1,130	250	8	46	—
	25	54	—	9.7	—	650	33	—	—
	25	46	—	9.6	—	600	47	—	—
	23	48	—	8.4	—	410	39	—	—
	41	96	—	5.3	769	400	8	46	—
	25	75	2.3	3.5	—	270	4.5	—	—
	28	66	2.3	6.5	—	210	3	—	—
	30	88	2.3	7.0	—	160	5	—	—
	32	87	2.3	9.0	—	130	5	—	—
	32	80	2.3	9.6	—	120	6	—	—
	34	83	2.3	11.0	—	71	6	—	—

(Not specified values)

Cure temperature

The standard temperature range for curing is between 130°C and 200°C, although the ideal temperature varies depending on the thickness and shape of the molded item. Generally speaking, molding can be done at temperatures from 90°C to 210°C.

Injection pressure

Best results are achieved at cure temperatures from 130°C to 200°C and pressures from 40 kg/cm^2 to 120 kg/cm^2.

Cure time

At 150°C, cure time is under 10 seconds per 1-mm of thickness. This enables molding with very short cycle times.

Linear shrinkage

At temperatures between 100°C and 150°C, linear shrinkage is about 2%-3%.

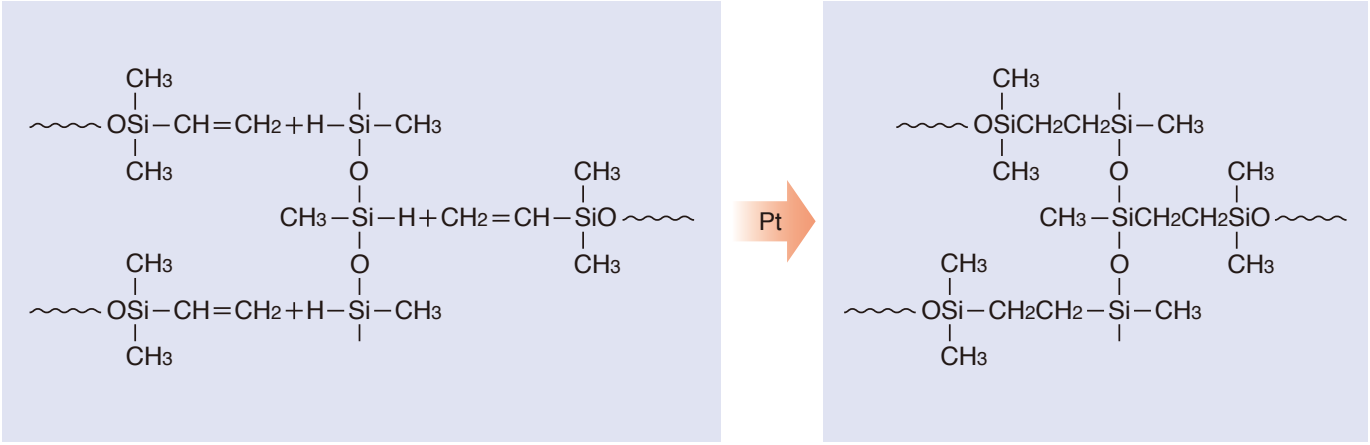
Pot life

The pot life of a given product after mixing components A and B is dependent on temperature. Ordinary products will retain a suitable viscosity (one that will not cause problems for molding) for 72 hours at room temperature (25°C). To extend the pot life, install a chiller to cool the mixing section.

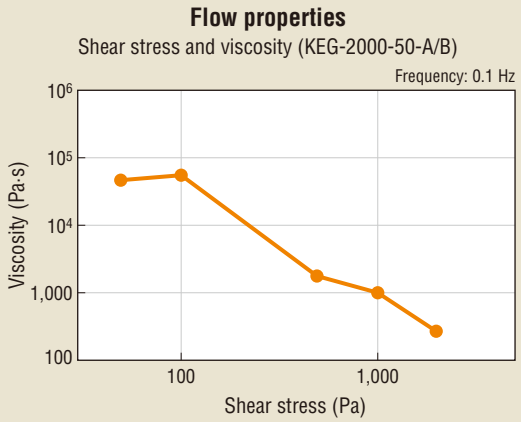


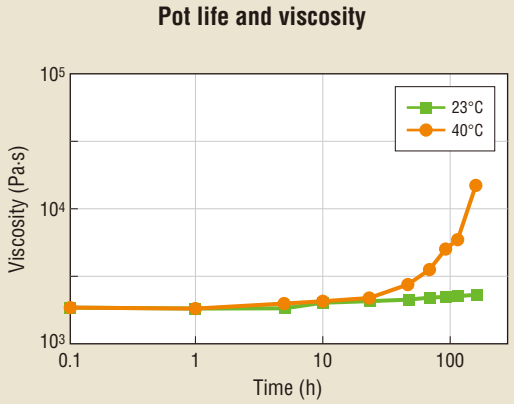

Curing mechanism

LIMS liquid silicone rubbers normally cure by addition reaction as shown below.
Heating accelerates the reaction, and cure time decreases as the temperature increases.



Flow properties and pot life of KEG-2000-50-A/B





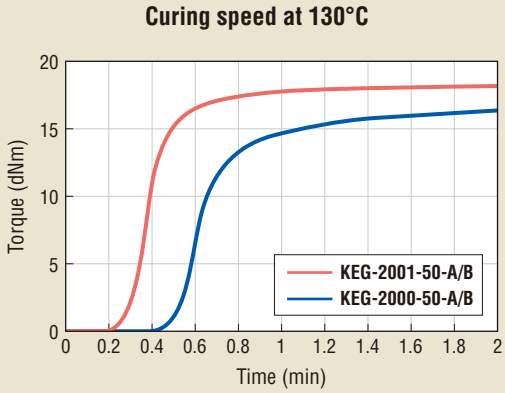
Curing profile of KEG-2000-50-A/B and KEG-2001-50-A/B by means of MDR (Moving Die Rheometer)

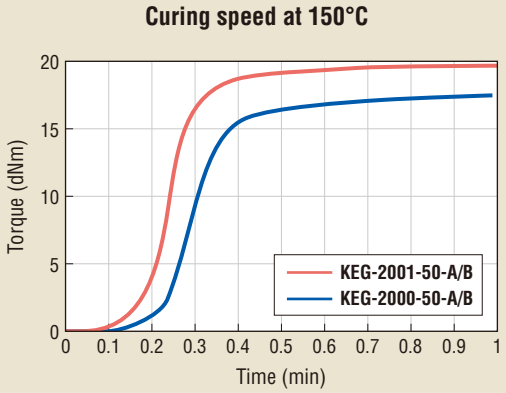
KEG-2001-50-A/B is the fast curing version of KEG-2000-50-A/B.

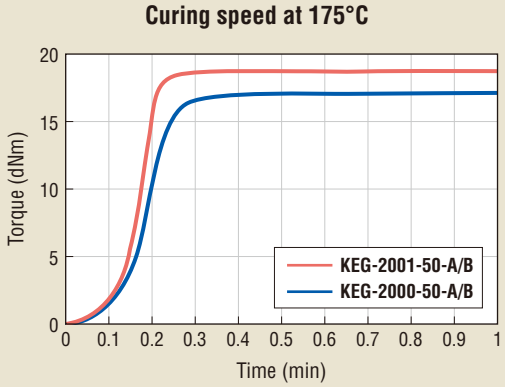
(Unit: sec)

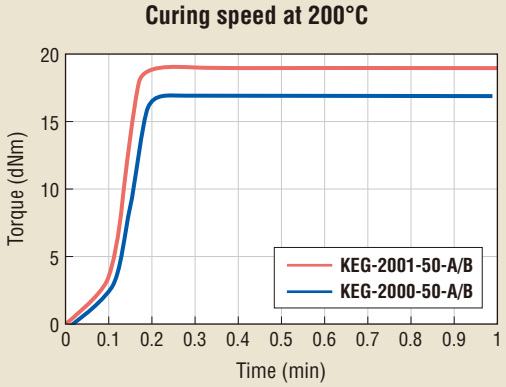
Curing speed / Temperature	KEG-2000-50-A/B			KEG-2001-50-A/B		
	T10	T50	T90	T10	T50	T90
110°C	151	167	227	58	70	141
130°C	31	38	64	18	23	35
150°C	13	18	25	10	14	20
175°C	8	11	15	7	10	13
200°C	5	9	11	5	8	10

T10: How long it takes time until the cured torque has achieved to 10% of maximum torque. T50: Up to 50% of maximum torque. T90: Up to 90% of maximum torque.







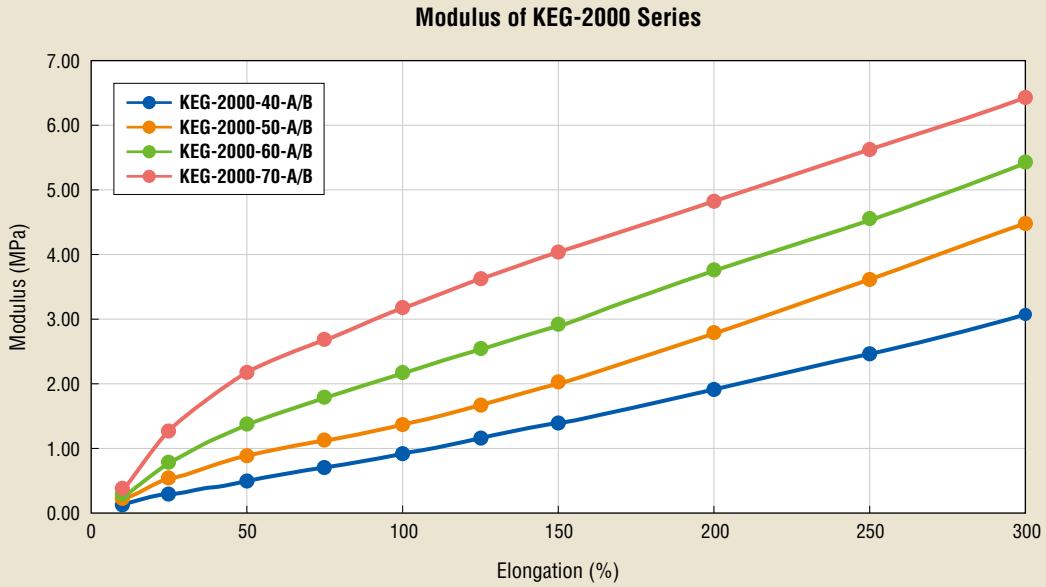


Modulus of KEG-2000 Series

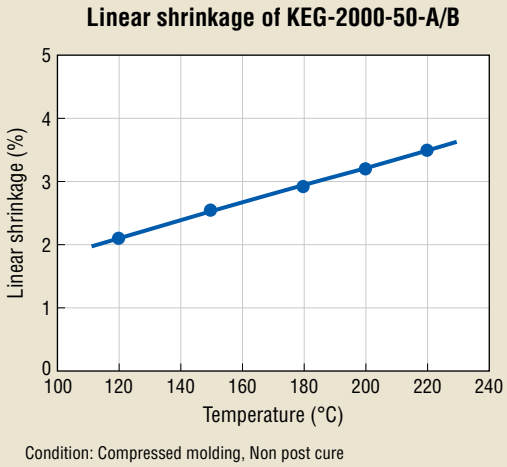
(Unit: MPa)

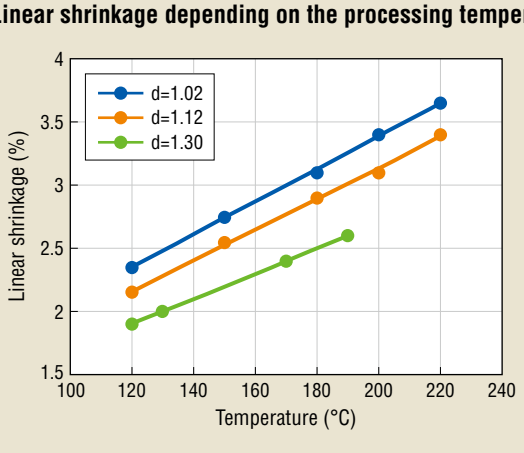
	KEG-2000-40-A/B	KEG-2000-50-A/B	KEG-2000-60-A/B	KEG-2000-70-A/B
10%	0.15	0.22	0.23	0.35
25%	0.28	0.53	0.76	1.24
50%	0.49	0.85	1.36	2.14
75%	0.68	1.10	1.77	2.68
100%	0.90	1.36	2.14	3.15
125%	1.14	1.66	2.52	3.59
150%	1.37	2.00	2.92	4.01
200%	1.89	2.76	3.73	4.83
250%	2.45	3.60	4.55	5.62
300%	3.05	4.48	5.40	6.42

Curing condition: 120°C × 10 min + 150°C × 1 h



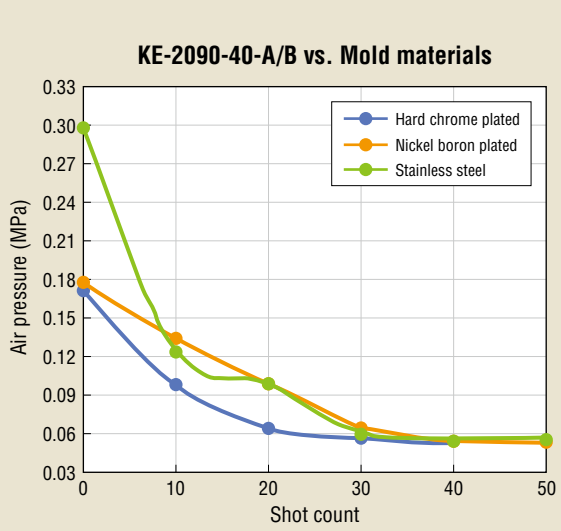
Linear Shrinkage of KEG-2000 Series

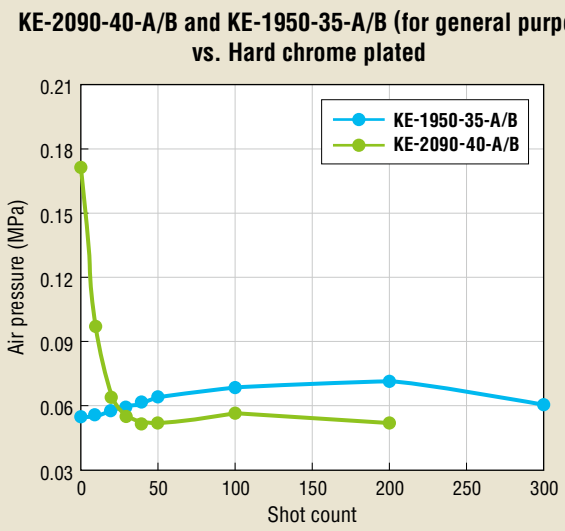




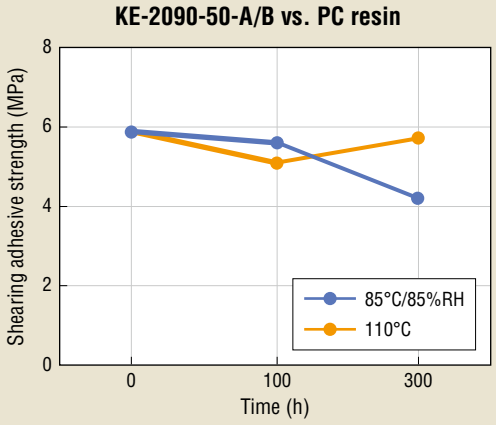
Condition: Compressed molding, Non post cure

Differences in demolding force of KE-2090-40-A/B (Air pressure when ejecting piece from mold)

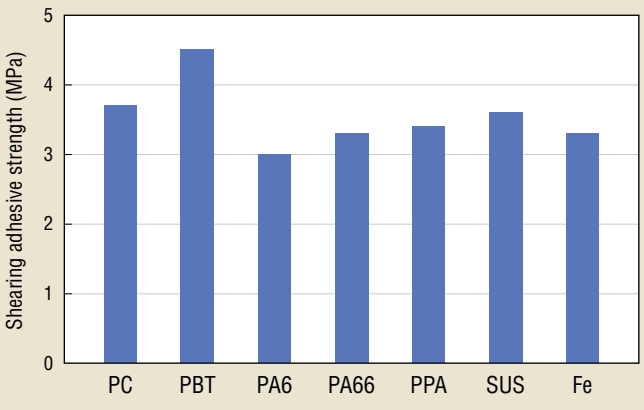




Differences in adhesive durability by temperature and humidity of KE-2090-50-A/B



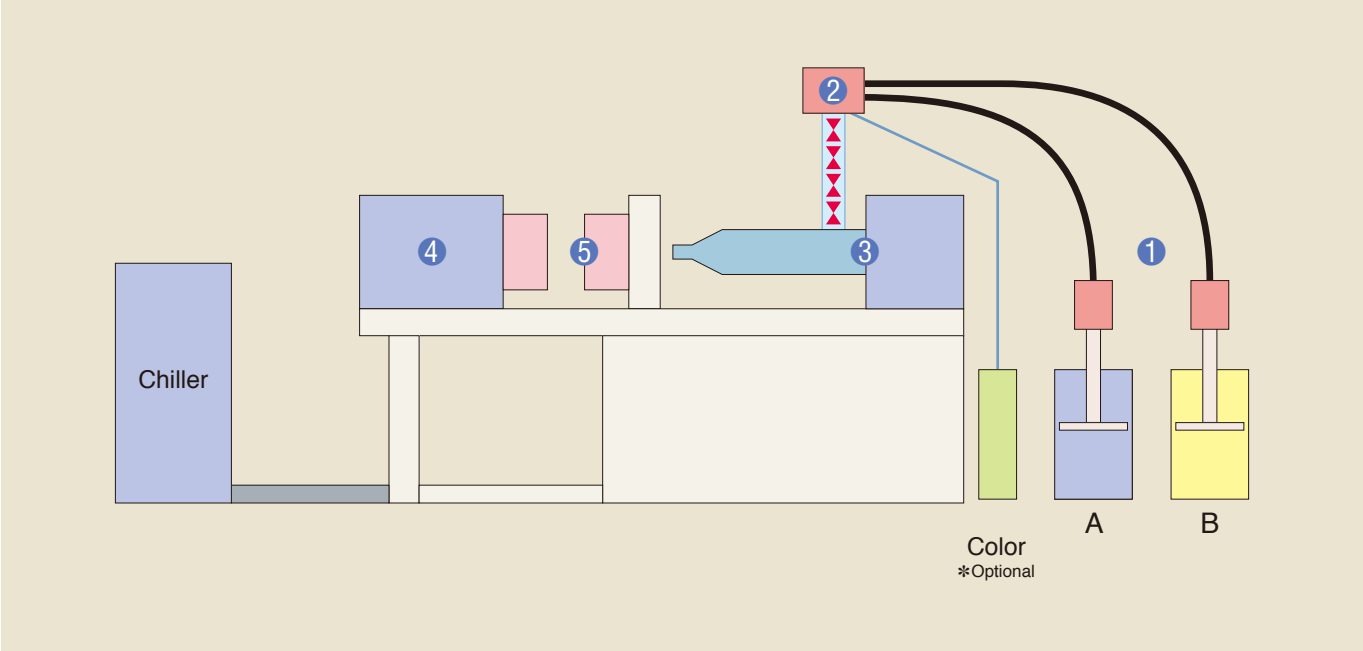
Shearing adhesive strength on various materials of KE-2098-40-A/B



LIMS molding machines

LIMS materials consist of two viscous fluid components, with viscosities between 50 and 2,000 Pa·s at room temperature.
Two components ("A" and "B") are mixed in a 100:100 ratio and the mixture quickly vulcanizes in a high temperature heated tool.
LIMS molding requires an injection unit which can be cooled by water and a dosage system which feeds and mixes the material.
Please contact a Shin-Etsu representative for more information about molding machines.

Basic configuration of a LIMS molding machine



❶ Material supply unit
This should pump both components in a 100:100 ratio into the mixing unit.

❷ Mixing unit
Mixes two components homogeneously.
A static mixer is often utilized in order to avoid air entrainment.
✻ Pigment line is joined here if coloring is necessary.

❸ Injection unit
LIMS material is highly flowable, therefore LIMS molding can be done at low injection pressure.
The user sets the injection speed/pressure according to the volume or shape of the product.
This unit is water-cooled in order to retard reaction progress.

❹ Molding machine
This controlls clamping, opening, ejection, etc.
The operation is basically same as one for thermoplastics.

❺ Mold
For LIMS molding, cold-runner system is becoming popular to minimize sprue and runner scrap that cannot be reused.

A typical mold

Points to consider when putting together a system

- The most important consideration when putting together a system is the material to be used for the seals. For example, for sliding and rotating parts, use nitrided steel or ceramic, avoid metal-on-metal contact, and use 1-3 Teflon-based gaskets.
- Be careful to prevent leakage, because the liquid molding compound can easily seep into gaps.
- The inorganic fillers contained in the molding compounds can cause increased wear on the mechanical components (mixing unit, mold). This should be considered when selecting materials for the components.
- In designing the mechanisms "downstream" of the mixing unit (shut-off nozzle, mold clamping unit, mold, etc.), take care to avoid configurations that create spots where the molding compound can collect.
- The molding compounds are compressible fluids, so be sure to adjust the timing so that the liquids flow into the mixing system simultaneously.
- Be sure the mold configuration permits air bleeding.

✻ For more information, please talk to a Shin-Etsu representative.

Molding defects: causes and remedies

Problem	Cause	Remedy
Blistering	Insufficient cure	Increase curing time, increase temperature.
	Insufficient molding pressure	Increase pressure.
	Air bubbles	Thoroughly remove air from pails. Adjust injection rate.
	Uneven heating	Adjust heating unit.
Voids Surface bubbles Uneven color	Insufficient cure	Increase curing time.
	Insufficient air removal	Thoroughly remove air from pail.
	Trapped air	Prevent introduction of air during injection.
	Mold temperature too high	Reduce mold temperature. Be aware of temperature distribution throughout mold.
	Uneven mixing	Adjust injection rate. Check mixing unit.
Weld marks	Improper mix ratio and uneven mixing	Adjust mix ratio. Adjust injection rate.
	Improper molding pressure	Increase pressure. Reduce temperature.
	Injection time too long	Reduce injection time.
	Insufficient air-bleed at the fused sections	Make an air bleed.
	Unbalanced gates	Balance the gates.
Poor gloss	Insufficient cure	Increase curing time. Raise mold temperature.
	Roughness of the mold surface	Polish and use hard chrome plating. Use weaker release agent.
Poor mold release	Improper curing conditions	Increase curing time.
	Poor mold surface	Repair mold.
	Uneven surface temperature distribution	Consider changing heating method.
Nozzle leaks	Worn or damaged nozzle	Inspect shut-off nozzle.
Poor cure	Curing inhibition	Eliminate curing inhibitors.
	Mix ratio	Check mixing system.

Coloring agents

As silicone rubber materials have good transparency, materials can be easily pigmented and bright-colored articles can be produced.


LIMS-COLOR-02


LIMS-COLOR-04


K-COLOR-BL-70


X-93-652

X-93-633

✻ Color tones of actual products might be different. Shin-Etsu recommends to test small area in advance.

✻ About other colers, please see the catalog "Color guide of Shin-Etsu Silicone HCR and LIMS".

Primers

• General-purpose primer

PRIMER-NO.4

This is a general-purpose, quick-drying primer. Easy to use due to its low viscosity.

Instructions for use

· Apply by dipping, spray on, or apply by brush, etc.
· Allow primer to dry for 15 minutes at room temperature.
· As a general rule, mold should be used within 24 hours after primer application.

General properties

Grade		PRIMER-NO.4
Appearance		Colorless transparent
Viscosity	mm^2/s	0.2-1.0
Specific gravity		0.77-0.78
Active ingredient	%	20
Solvent		n-Heptane
Usable time (after application)	h	24
Drying conditions Air dry	min	15

UN Classification: Flammable Liquids, UN No: 1133 (Not specified values)

• For plastics

X-33-156-20

This primer is designed for plastic molds. It can be air-dried or baked on.

Instructions for use

· Apply by dipping, spray on, or apply by brush, etc.
· When using an air-dry method, allow primer to dry for 30 minutes at room temperature. If the situation permits, after air drying, bake on at 80-120°C for 10-20 minutes to ensure more consistent adhesion.
· As a general rule, mold should be used within 24 hours after primer application.
· After use, seal container tightly and store in a cool, dark place.
· Contains n-heptane (solvent). Handle with caution.

General properties

Grade		X-33-156-20
Appearance		Pale yellow
Viscosity	mm^2/s	0.2-1.0
Specific gravity		0.70-0.72
Active ingredient	%	3-5
Usable time (after application)	h	24

UN Classification: Flammable Liquids, UN No: 1133 (Not specified values)

Handling Precautions

■ Handling precautions

1. Seal container tightly and store in a cool, dark place (25°C or below, out of direct sunlight) with good ventilation. Keep away from heat and flame because the primers used may be classified as flammable hazardous materials.
2. LIMS liquid silicone rubbers may not cure properly if they come in contact with certain substances, including amines, sulfur, organophosphorus compounds and organotin compounds. If there is a possibility of curing inhibition, the user should perform a test to determine whether the product will cure properly.

   Some curing inhibitors
   - Chloroprene and other synthetic rubbers
   - Sulfur compounds
   - Soft PVC
   - Amine-cure epoxies
   - PVC insulating tape
   - Soldering flux that contains rosin
3. Mixing Liquid B with alkaline substances produces flammable hydrogen gas, so handle with caution.

■ Cautions in using self-adhesive liquid silicone

1. Even among the same resin materials, some materials are not suited to addition reactions of silicone rubbers or cannot sufficiently exert adhesion depending on their method of polymerization, degree of refining and types of additive and resin. When designing, check the resin to be used in advance.
2. In the situations where the resin surface is dirty, clean the surface with a solvent or similar.
3. As for polyamide resin, it is recommended to dry the resin before molding since it has high water absorption properties. Moreover, attention must be paid to the molding procedure and conditions in the situations where heat treatment and humidity conditioning are performed to acquire dimensional stability.
4. The release properties may vary depending on the mold material and condition of the surface (plating), so be sure to test prior to use.

■ Safety and hygiene

1. When handling the products, take care to avoid contact with the skin and mucous membranes by wearing protective glasses and protective gloves. In case of skin contact, immediately wipe off with dry cloth and then flush thoroughly with running water. In case of accidental eye contact, flush immediately with plenty of clean water for at least 15 minutes and then seek medical attention. Contact lens wearers must take special care. If the products get into the eye, the contact lens may become stuck to the eye.
2. In the small place with poor ventilation, please wear a protective mask. And it is recommended to install a local exhaust ventilation system. If you become uncomfortable with inspiring the vapors, move to an area with fresh air immediately.
3. Keep out of the reach of children.
4. Please read the Safety Data Sheets (SDS) before use. SDS can be obtained from our sales department.
5. If these LIMS materials are to be used to manufacture items that will be used in contact with food, be sure to determine whether the materials meet relevant food sanitation laws.

Packaging

All products are supplied in 20 L pails (Net Wt. 20 kg*) or 200 L drums (Net Wt. 200 kg).

* KE-1950-10-A/B and KE-1950-20-A/B are supplied in 20 L pails (Net Wt. 18 kg).

Hazardous Materials Classification

All products are NOT classified as UN Hazardous Materials.

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

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