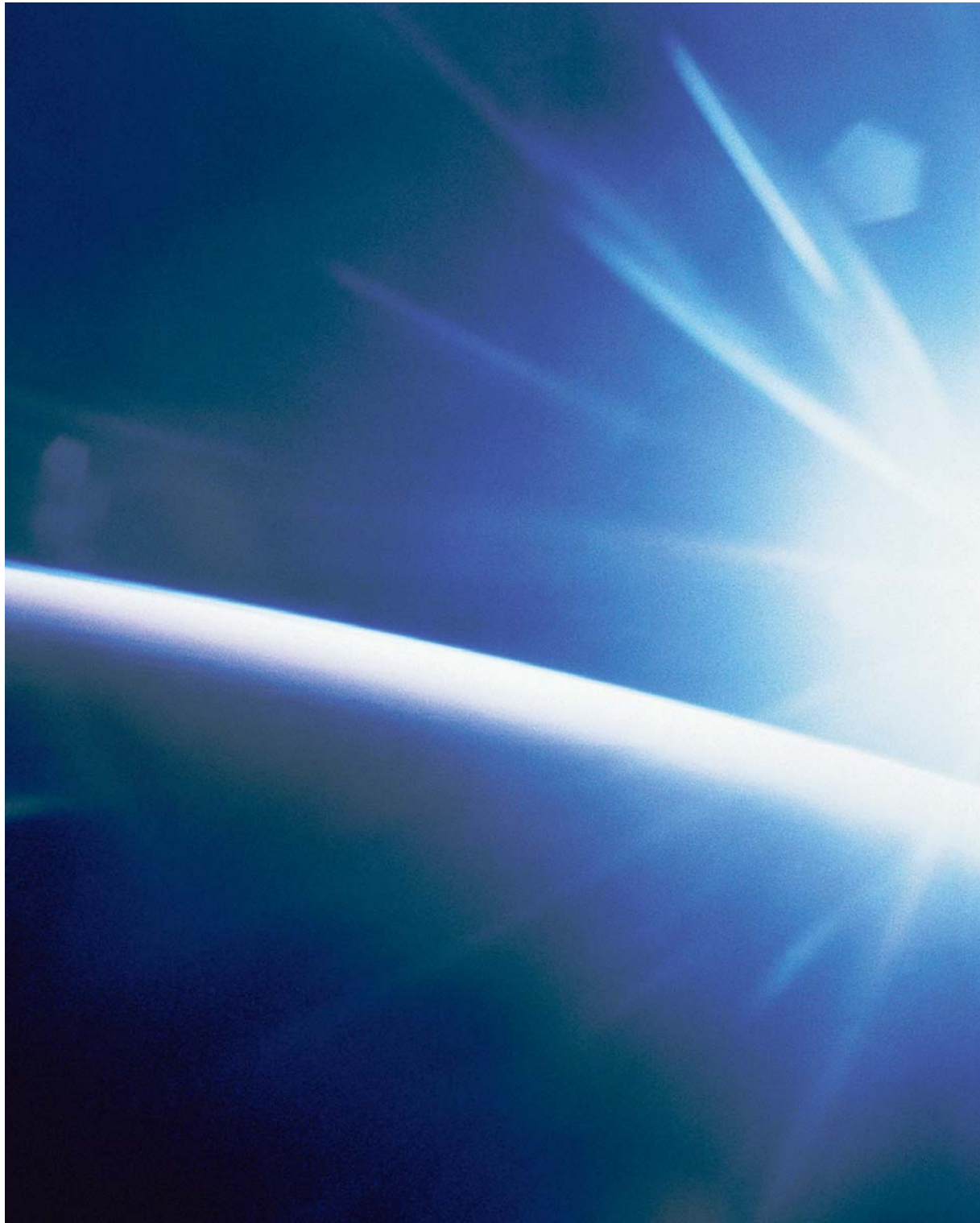




**Shin-Etsu Silicone**

**LIMS** Liquid Injection Molding System



# A molding system for the modern age.

Liquid Injection Molding System

# LIMS

**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.

## 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

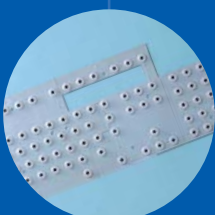
The system uses liquid materials, so molding can be done at low injection pressures and it is suitable for molding high-precision components. The two liquid components are mixed precisely and contaminants are kept out, resulting in high quality molds and greater efficiency.

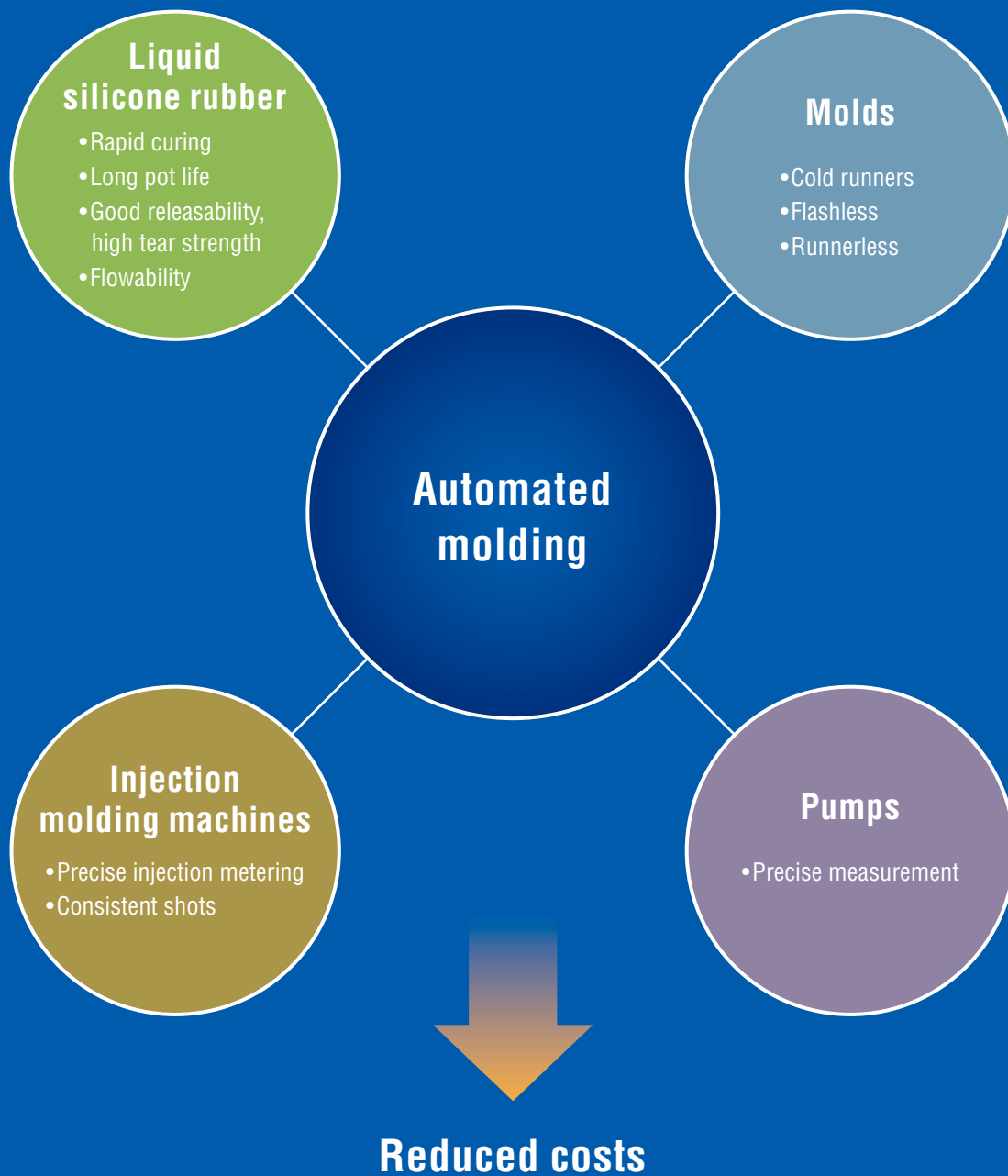
## Automated molding

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.





# Products and Features

Our liquid silicone rubbers for LIMS applications have properties similar to those of ordinary silicone rubbers. These include excellent heat resistance, radiation resistance, corona resistance, and fine performance as an electrical insulator. Our lineup includes general purpose, high strength, transparent and flame retardant grades designed for a range of molding applications. We are also developing new products for other specific applications.

## KEG-2000 Series

These are transparent, high strength silicones that cure rapidly to hardnesses between 40° and 70°. They are suitable for flashless, runnerless molding and can be used in continuous, short-cycle automated molding applications.

## KE-1935 (A/B), KE-1987 (A/B) & KE-1988 (A/B)

Ideal for applications in which high transparency is a must.

## KE-1950 Series

These products cure to become transparent, high strength silicone rubbers with hardnesses between 10° and 70°. They are highly safe and meet the standards of Japan's Food Sanitation Law. Before using, be sure to determine whether these materials comply with comparable laws in your country.

## KE-2014 Series

These oil-bleed products are high strength and have low specific gravities.

## ■ General Properties

| Item \ Grade |                                    |                   | Rapid cure, transparent, high strength |                   |                   |                   | Extra fast cure, transparent, high strength |                   |
|--------------|------------------------------------|-------------------|----------------------------------------|-------------------|-------------------|-------------------|---------------------------------------------|-------------------|
|              |                                    |                   | KEG-2000-40 (A/B)                      | KEG-2000-50 (A/B) | KEG-2000-60 (A/B) | KEG-2000-70 (A/B) | KEG-2001-40 (A/B)                           | KEG-2001-50 (A/B) |
| Pre-cure     | Appearance                         | Liq. A            | Translucent                            | Translucent       | Translucent       | Translucent       | Translucent                                 | Translucent       |
|              |                                    | Liq. B            | Translucent                            | Translucent       | Translucent       | Translucent       | Translucent                                 | Translucent       |
|              | Viscosity*1                        | Pa-s              | 1300                                   | 1500              | 1600              | 1200              | 1300                                        | 1500              |
|              |                                    | Liq. B            | 1300                                   | 1500              | 1600              | 1200              | 1300                                        | 1500              |
| Post-cure*2  | Appearance                         |                   | Transparent                            | Transparent       | Transparent       | Transparent       | Transparent                                 | Transparent       |
|              | Density 23°C                       | g/cm <sup>3</sup> | 1.13                                   | 1.13              | 1.13              | 1.13              | 1.12                                        | 1.13              |
|              | Hardness Durometer A               |                   | 40                                     | 50                | 60                | 70                | 40                                          | 50                |
|              | Tensile strength                   | MPa               | 9.6                                    | 11.1              | 10.5              | 10.2              | 11.0                                        | 11.8              |
|              | Elongation at break                | %                 | 640                                    | 580               | 450               | 350               | 700                                         | 530               |
|              | Tear strength Crescent test pieces | kN/m              | 32                                     | 40                | 40                | 35                | 32                                          | 40                |
|              | Compression set*3 150°C/22h        | %                 | 6                                      | 8                 | 9                 | 7                 | 6                                           | 8                 |
|              | Linear shrinkage                   | %                 | 2.7                                    | 2.6               | 2.6               | 2.6               | 2.7                                         | 2.6               |
|              | Volume resistivity                 | TΩ·m              | 50                                     | 50                | 50                | 50                | 50                                          | 50                |

| Item \ Grade |                                    |                   | Transparent, high strength |                  |                  |                  |                  |                  |
|--------------|------------------------------------|-------------------|----------------------------|------------------|------------------|------------------|------------------|------------------|
|              |                                    |                   | KE-1950-10 (A/B)           | KE-1950-20 (A/B) | KE-1950-30 (A/B) | KE-1950-35 (A/B) | KE-1950-40 (A/B) | KE-1950-50 (A/B) |
| Pre-cure     | Appearance                         | Liq. A            | Translucent                | Translucent      | Translucent      | Translucent      | Translucent      | Translucent      |
|              |                                    | Liq. B            | Translucent                | Translucent      | Translucent      | Translucent      | Translucent      | Translucent      |
|              | Viscosity*1                        | Pa-s              | 60                         | 150              | 250              | 500              | 480              | 680              |
|              |                                    | Liq. B            | 60                         | 150              | 250              | 500              | 480              | 680              |
| Post-cure*4  | Appearance                         |                   | Transparent                | Transparent      | Transparent      | Transparent      | Transparent      | Transparent      |
|              | Density 23°C                       | g/cm <sup>3</sup> | 1.08                       | 1.10             | 1.10             | 1.12             | 1.12             | 1.13             |
|              | Hardness Durometer A               |                   | 13                         | 20               | 32               | 36               | 42               | 52               |
|              | Tensile strength                   | MPa               | 3.9                        | 6.4              | 8.8              | 9.8              | 9.8              | 9.3              |
|              | Elongation at break                | %                 | 700                        | 900              | 700              | 700              | 650              | 550              |
|              | Tear strength Crescent test pieces | kN/m              | 10                         | 25               | 25               | 30               | 35               | 40               |
|              | Compression set*5 150°C/22h        | %                 | 12                         | 15               | 22               | 36               | 20               | 28               |
|              | Linear shrinkage                   | %                 | 2.3                        | 2.1              | 2.0              | 2.2              | 2.1              | 2.0              |
|              | Volume resistivity                 | TΩ·m              | 10                         | 10               | 10               | 10               | 10               | 10               |

\*1: Rotational viscometer \*2: Sheet curing conditions: press cure at 150°C/5 min, then post cure at 150°C/1 h. \*3: Sheet curing conditions: press cure at 150°C/10 min, then post cure at 200°C/4 h.

\*4: Sheet curing conditions: press cure at 120°C/5 min, then post cure at 150°C/1 h. \*5: Sheet curing conditions: press cure at 120°C/10 min, then post cure at 150°C/1 h.

## Pigments for LIMS Materials

The following pigments should be used to color LIMS materials.

Our lineup includes pigments designed for oil-bleed products.

■ For oil-bleed products

■ For coloring

| Grade        | Color         | Grade        | Color      |
|--------------|---------------|--------------|------------|
| LIM Color 01 | Black         | LIM Color 02 | Black      |
| LIM Color 03 | Reddish brown | LIM Color 04 | Orange     |
| LIM Color 06 | Brown         | LIM Color 05 | Gray-green |

\* Other color pigments are available besides those listed above. Contact Shin-Etsu for details.

| Grade<br>Item |                                    |        | Transparent, high strength |                  | High transparency |                   |                   |     |
|---------------|------------------------------------|--------|----------------------------|------------------|-------------------|-------------------|-------------------|-----|
|               |                                    |        | KE-1950-60 (A/B)           | KE-1950-70 (A/B) | KE-1935 (A/B)     | KE-1987 (A/B)     | KE-1988 (A/B)     |     |
| Pre-cure      | Appearance                         | Liq. A | Translucent                | Translucent      | Transparent       | Translucent       | Translucent       |     |
|               |                                    | Liq. B | Translucent                | Translucent      | Transparent       | Translucent       | Translucent       |     |
|               | Viscosity*1                        | Pa·s   | Liq. A                     | 730              | 750               | 80                | 700               | 600 |
|               |                                    |        | Liq. B                     | 740              | 750               | 45                | 700               | 450 |
| Post-cure*4   | Appearance                         |        | Transparent                | Transparent      | High transparency | High transparency | High transparency |     |
|               | Density 23°C                       | g/cm³  | 1.14                       | 1.15             | 1.03              | 1.15              | 1.15              |     |
|               | Hardness Durometer A               |        | 60                         | 70               | 55                | 55                | 62                |     |
|               | Tensile strength                   | MPa    | 7.8                        | 7.8              | 5.9               | 8.3               | 7.8               |     |
|               | Elongation at break                | %      | 380                        | 350              | 350               | 430               | 250               |     |
|               | Tear strength Crescent test pieces | kN/m   | 35                         | 40               | 8.0               | 35                | 35                |     |
|               | Compression set*5 150°C/22h        | %      | 22                         | 50               | 30                | 50                | 49                |     |
|               | Linear shrinkage                   | %      | 1.9                        | 2.1              | 3.2               | 2.1               | 2.2               |     |
|               | Volume resistivity                 | TΩ·m   | 10                         | 10               | 10                | 100               | 100               |     |

| Grade<br>Item |                                    |        | Oil bleed applications  |                         |                         |                         |      |
|---------------|------------------------------------|--------|-------------------------|-------------------------|-------------------------|-------------------------|------|
|               |                                    |        | KE-2014-30 (A/B)        | KE-2014-40 (A/B)        | KE-2014-50 (A/B)        | KE-2014-60 (A/B)        |      |
| Pre-cure      | Appearance                         | Liq. A | Milky white translucent | Milky white translucent | Milky white translucent | Milky white translucent |      |
|               |                                    | Liq. B | Milky white translucent | Milky white translucent | Milky white translucent | Milky white translucent |      |
|               | Viscosity*1                        | Pa.s   | Liq. A                  | 900                     | 1400                    | 2000                    | 2400 |
|               |                                    | Liq. B | 800                     | 1400                    | 2000                    | 2400                    |      |
| Post-cure*6   | Appearance                         |        | Translucent             | Translucent             | Translucent             | Translucent             |      |
|               | Density 23°C                       | g/cm³  | 1.12                    | 1.13                    | 1.14                    | 1.14                    |      |
|               | Hardness Durometer A               |        | 30                      | 40                      | 50                      | 60                      |      |
|               | Tensile strength                   | MPa    | 8.4                     | 8.8                     | 10.2                    | 9.7                     |      |
|               | Elongation at break                | %      | 750                     | 600                     | 560                     | 450                     |      |
|               | Tear strength Crescent test pieces | kN/m   | 25                      | 30                      | 31                      | 39                      |      |
|               | Compression set 150°C/70h          | %      | 19                      | 30                      | 24                      | 20                      |      |
|               | Linear shrinkage                   | %      | 2.2                     | 2.1                     | 2.0                     | 2.0                     |      |
|               | Volume resistivity                 | TΩ.m   | 50                      | 50                      | 50                      | 50                      |      |

\*6: Sheet curing conditions: 150°C/10 min (press cure only).

(Not specified values)

# Curing Properties and Molding Properties

## 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<sup>2</sup> to 120 kg/cm<sup>2</sup>.

## 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% (see "General Properties" on pp. 4-5.)

## Pot life

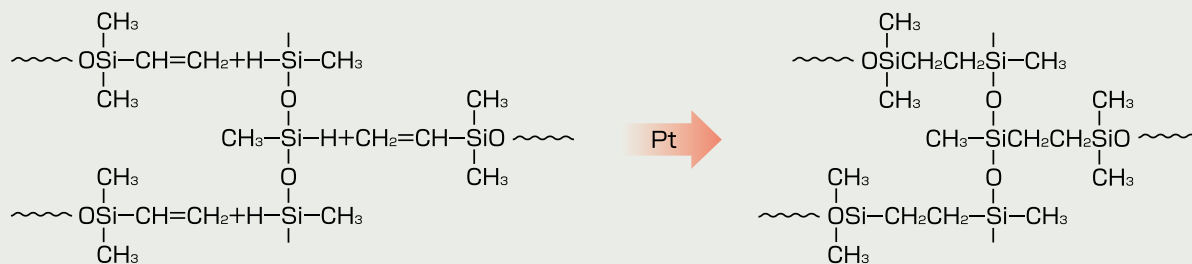
The pot life of a given product after mixing components A and B is dependent on temperature. Ordinary products will retain a suitable viscosity (one that will not cause problems for molding) for 72 hours at room temperature (25°C). To extend the pot life, install a chiller to cool the mixing section.

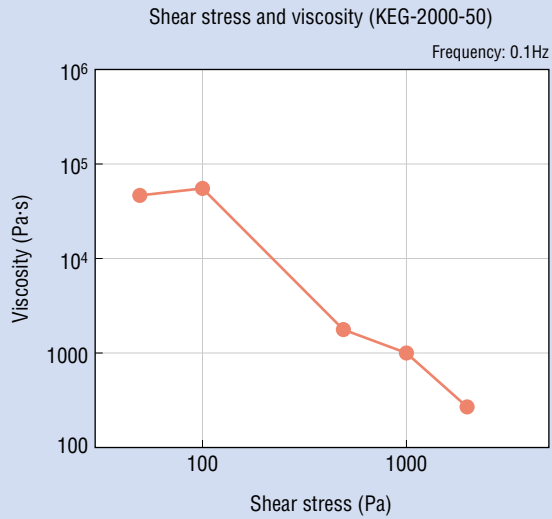
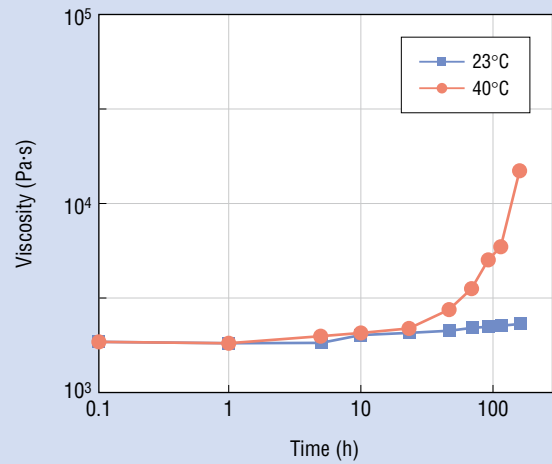
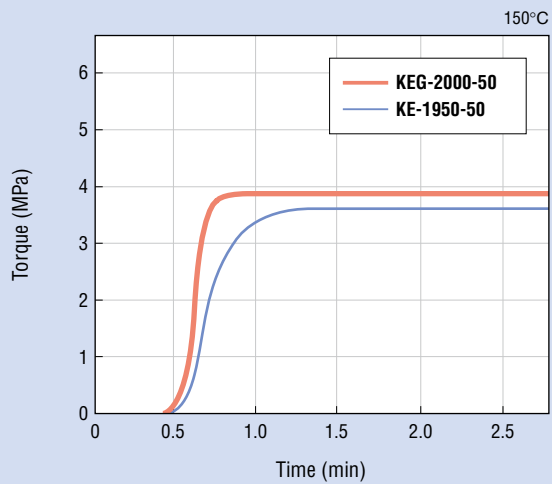
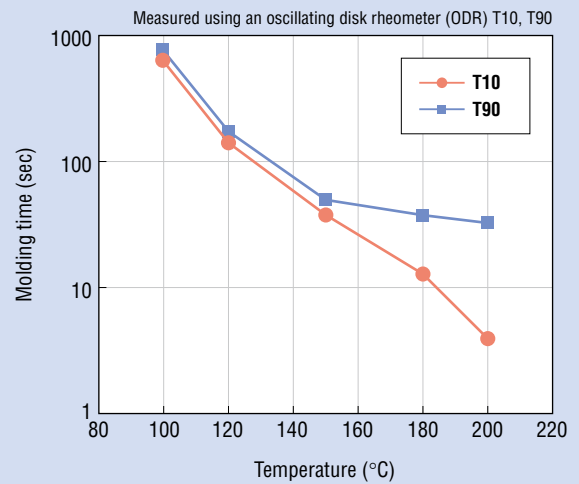


Swimming goggles

## ■ 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.

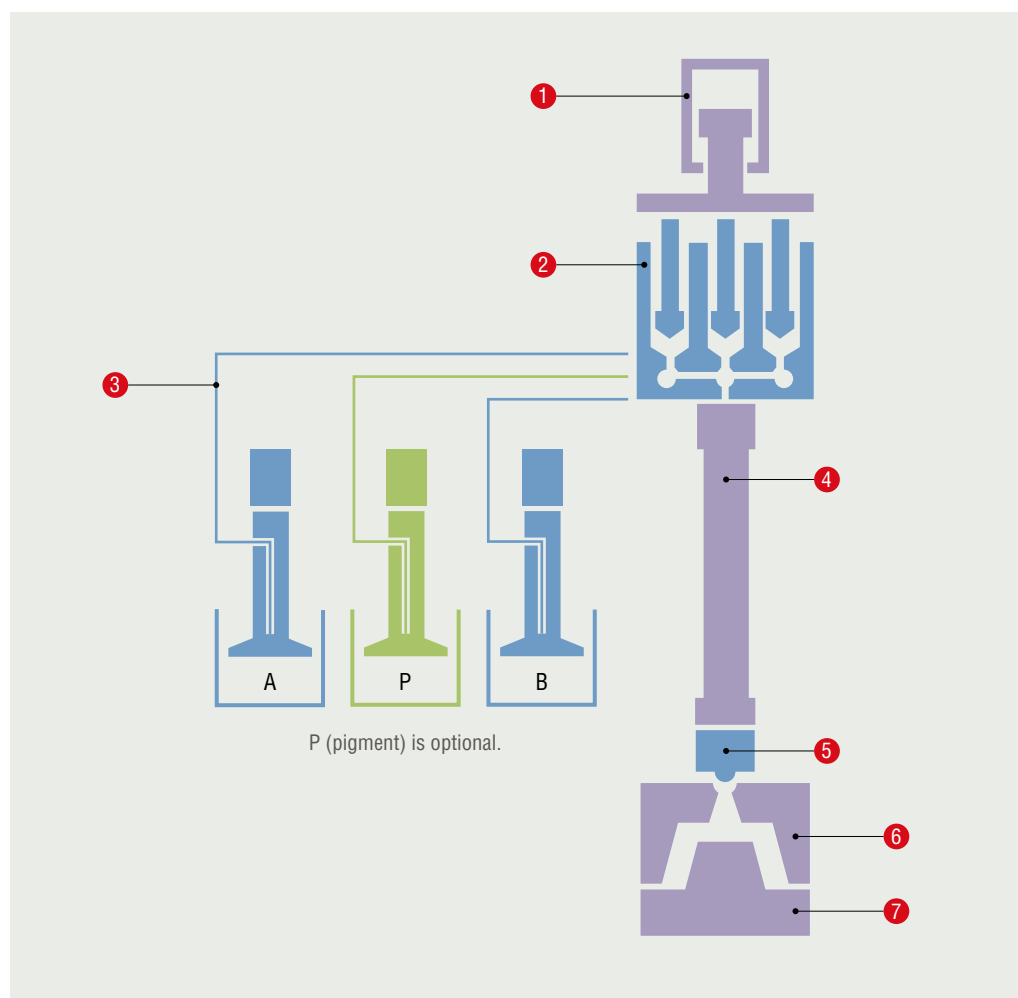


**■ KEG-2000-50 (A/B): flow properties and curing properties****Flow properties****Pot life and viscosity****Curing properties****Molding time and temperature**

## LIMS molding machines

At room temperature, the viscosity of these special liquid silicone rubbers is between 50 Pa·s and 2,000 Pa·s. They are used with molding machines designed for materials in this viscosity range. A basic injection molding system has a metered delivery pump unit and an injection unit equipped with a mixing apparatus, typically a dynamic mixer or static mixer. All these elements are integrated in compact, high precision, specialized LIMS injection molding machines. Talk to a Shin-Etsu representative for more information about molding machines.

### ■ Basic configuration of a LIMS molding machine



#### 1 Injection unit

An advantage of LIMS systems is that molding can be done at low injection pressures. The user sets the pressure and injection rate.

#### 2 Metering unit

A pump pressurizes the liquid components (A & B), which are metered accurately and ejected simultaneously at a constant ratio (1:1).

#### 3 Materials supply unit

The pails (or drums) of liquids A and B are set in place to connect with the pumps.

#### 4 Mixing unit

The two components are mixed thoroughly by a dynamic or static mixer. The mixture is pressurized and injected directly into the mold.

#### 5 Shut-off nozzle

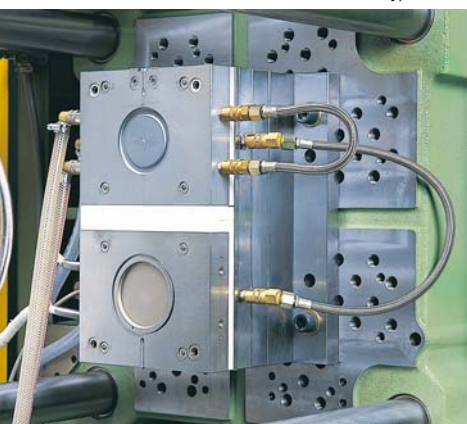
The nozzle features a shut-off mechanism, preventing the molding compound from leaking from the nozzle.

#### 6 Mold clamping unit

The mold is clamped and opened in coordination with the operation of the supply unit, metering pump and injection unit.

#### 7 Mold

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<br>Surface bubbles<br>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.                                                           |

## ■ 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.

#### Primer No. 4: general properties

| Grade                           | Primer No. 4              |
|---------------------------------|---------------------------|
| Appearance                      | Pale yellow, transparent  |
| Viscosity                       | 0.2-1.0mm <sup>2</sup> /s |
| Specific gravity                | 0.77-0.78                 |
| Nonvolatile content             | 6-8%                      |
| Solvent                         | Aliphatic hydrocarbones   |
| Usable time (after application) | 24h                       |
| Drying conditions               | Air dry15min              |

UN Classification: Flammable Liquids  
UN No: 1133

## ■ For plastics

### Primer 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 type, 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.

#### Primer X-33-156-20: general properties

| Grade                           | Primer X-33-156-20        |
|---------------------------------|---------------------------|
| Appearance                      | Pale yellow               |
| Viscosity                       | 0.2-1.0mm <sup>2</sup> /s |
| Specific gravity                | 0.70-0.72                 |
| Nonvolatile content             | 3-5%                      |
| Usable time (after application) | 24h                       |

UN Classification: Flammable Liquids  
UN No: 1133

## Handling Precautions

### ■ Preserving quality

1. 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

2. Keep out of rain and away from excessive humidity. Store in a cool, dark place.

### ■ Safety and hygiene

1. 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.
2. Avoid prolonged and repeated contact with the skin. Especially about primer, avoid direct contact to the skin. If contact occurs, wipe off with a dry cloth and then wash thoroughly with soap and water.
3. In case of eye contact, immediately flush thoroughly with water and seek medical attention if necessary.
4. Primers contain organic solvents. Always use in a ventilated area and wear protective gear (goggles, gloves, etc.). If using these products in a poorly-ventilated area, wear a respirator mask designed to filter organic gases.
5. Mixing Liquid B with alkaline substances produces flammable hydrogen gas, so handle with caution.
6. The primers mentioned herein may be classified as hazardous materials under federal or state fire prevention laws, and must be stored and handled accordingly. Contact Shin-Etsu for details.
7. Please read the Material Safety Data Sheet (MSDS) before use. MSDS can be obtained from our Sales Department.

### ■ Packaging / Hazardous materials classification

| Grade             | Packaging |      |            |       | UN Classification | UN No. |
|-------------------|-----------|------|------------|-------|-------------------|--------|
|                   | 18 ℓ can  |      | 180 ℓ drum |       |                   |        |
|                   | 18kg      | 20kg | 180kg      | 200kg |                   |        |
| KEG-2000-40 (A/B) |           | ●    |            | ●     | N/A               | N/A    |
| KEG-2000-50 (A/B) |           | ●    |            | ●     | N/A               | N/A    |
| KEG-2000-60 (A/B) |           | ●    |            | ●     | N/A               | N/A    |
| KEG-2000-70 (A/B) |           | ●    |            | ●     | N/A               | N/A    |
| KEG-2001-40 (A/B) |           | ●    |            | ●     | N/A               | N/A    |
| KEG-2001-50 (A/B) |           | ●    |            | ●     | N/A               | N/A    |
| KE-1950-10 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |
| KE-1950-20 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |
| KE-1950-30 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |
| KE-1950-35 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |
| KE-1950-40 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |
| KE-1950-50 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |
| KE-1950-60 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |
| KE-1950-70 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |
| KE-1935 (A/B)     | ●         |      | ●          |       | N/A               | N/A    |
| KE-1987 (A/B)     | ●         |      |            | ●     | N/A               | N/A    |
| KE-1988 (A/B)     | ●         |      |            | ●     | N/A               | N/A    |
| KE-2014-30 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |
| KE-2014-40 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |
| KE-2014-50 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |
| KE-2014-60 (A/B)  |           | ●    |            | ●     | N/A               | N/A    |

N/A: Not Applicable

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