Take your products to the next level

In our quest to serve the complex needs of users in diverse industries, Shin-Etsu Silicone has developed in excess of 5,000 different products. We brought our technical expertise to bear in the field of coating agents and paints to develop a wide array of products. Our Silicone based Resins, Resin Hybridization Agents, Surface Modifiers for Coating, and Surface Modifiers for Pigments & Fillers are used extensively to make your products meet the demanding needs of your customers.

Features of Silicones .................................. 3
Product Map - 4 Types of Silicone Usage ..... 4-5
Silicone based Resins .......................... 6-11
  Silicone Resins ................................. 6-9
  Silicone Oligomers ......................... 10-11
Resin Hybridization Agents .................. 12-21
  Acrylic Resins ............................... 12-15
  Polyester & Alkyd Resins ......... 16-17
Epoxy Resins .................................. 18-19
Urethane Resins ................................. 20-21
Surface Modifiers for Coating ............. 22-29
  Silicone Powders ............................ 22-23
  KP Series ....................................... 24-27
Other Highly Functional Products ........ 28-29
Surface Modifiers for Pigments & Fillers 30-31
  Alkoxy Silanes & Silane Coupling Agents 30
  Spherical Silica Fine Particles .......... 31

*For information on handling precautions and packaging, see the catalog for the relevant product. Please read the Safety Data Sheet (SDS) before use. SDS can be obtained from our Sales Departments.
Silicones are a type of hybrid material which has properties of both organic and inorganic materials.

**Structures of Silicones**

All silicone products are composed of the four basic units shown at right. How they are combined will determine the category in which the product falls.

- **Features of materials with siloxane bonds**
  - High bonding energy (106 kcal/mol): Resists breakdown from heat and light. Around 25% higher bonding energy than C-C bonds.

- **Features of materials with siloxane chain**
  - Helical molecule & low intermolecular force: Excellent water repellency, defoaming, and release properties (interfacial characteristics); gas permeable. Physical properties are not strongly temperature dependent.

**Structure of Resin**

- Three-dimensional network structure composed primarily of T Units.
- Owing to their dense structures, silicone resins outperform other silicones in weatherability and heat resistance.
  - Used for resin modification and to make heat- and weather-resistant paints.
  - Constituent Units: D Units, T Units, (Q Units)

**Structure of Fluid**

- Dimethyl polysiloxane composed primarily of D Units.
- Low surface tension, with excellent water repellency and release properties.
  - Used for resin modification and to make release agents, defoamers, etc.
  - Constituent Units: D Units, T Units

**Features of Silicones**

- Each molecule contains two functional groups with different reactivity.
- Constituent Units: M Units, D Units, T Units, Q Units

**Characteristics imparted by organic groups**

- **Primary Organic Groups**
  - Methyl groups: hydrophobicity
  - Phenyl groups: compatibility with resins, heat resistance
  - Polyether groups: hydrophilicity
  - Alkoxy groups: adhesiveness, moisture-cure properties
  - Amino groups: reactive with epoxies and other resins
  - (Meth)acryl groups: radical polymerization

**Structure of Silane**

- Each molecule contains two functional groups with different reactivity.
- Constituent Units: M Units, D Units, T Units, Q Units
Product Map – 4 Types of Silicone Usage –

Silicone based Resins

Silicone Resins

Structure: Resin having a high molecular weight and 3D siloxane network structure.
Features: With excellent film-forming abilities, coatings can range from very hard to flexible.

Silicone Oligomers (Type A)

Structure: Resin having a relatively low molecular weight and 3D siloxane network structure. Molecules contain alkoxy groups and non-reactive functional groups.
Features: Can be used as coating materials, or to modify organic resins.

Resin Hybridization Agents

Silicone Oligomers (Type AR)

Structure: Resin having relatively a low molecular weight and 3D siloxane network structure. Molecules contain alkoxy groups and reactive functional groups.
Features: Can be used as an organic resin modifier or reactive diluents.

Silicone Resins

Structure: Resin having a high molecular weight and 3D siloxane network structure.
Features: With excellent film-forming abilities, coatings can range from very hard to flexible.

Modified Silicone Fluids

Structure: 2D siloxane main chain with reactive or non-reactive functional groups in the side chains and on the ends.
Features: Silicone fluids having reactive functional groups can be used for the modification of organic resins.
Silicone Powders

Structure (3 types): Resin, rubber & resin coated rubber
Features: Available in a variety of particle sizes to meet a range of requirements.

KP Series

Features: Surface Modifiers designed to use as leveling agents, defoamers, slip agents, and in paints and coatings.

Additives

Surface Modifiers for Pigments & Fillers

Silane Coupling Agents

Structure: Monomers whose molecules contain alkoxy groups and reactive functional groups.
Features: While alkoxy groups improve adhesion to inorganic materials, reactive functional groups improve adhesion to organic materials.

Spherical Silica Fine Particles

Structure: Very small particle size with narrow particle size distribution. Particle surfaces are treated to give them extra water repellency.
Features: Monodisperse, less aggregation. Highly adhesive to various powders. Improves flowability.

Alkoxy Silanes

Structure: Monomers whose molecules contain alkoxy groups.
Features: Alkoxy groups act to improve adhesion to inorganic materials and modify the surface energy of the substrate.

Product Map
Silicone resins are composed primarily of T Units and have a 3D structure. Silicone resins form coatings with excellent heat resistance and weatherability. Unmodified silicones include methyl and methyl phenyl resins, while the organic resin-modified types include epoxy-modified, polyester-modified, and alkyd-modified resins.

**Features**
- Heat Resistance
- Weatherability
- Flexibility
- High Hardness
- Anti-corrosion Properties
- Electrical Insulation

**Product List**

<table>
<thead>
<tr>
<th>Product name</th>
<th>Type</th>
<th>Non-volatile content 100°C/3h</th>
<th>Solvent</th>
<th>Cure speed</th>
<th>Hardness</th>
<th>Compatibility with organic resins</th>
<th>Main applications</th>
<th>Cure conditions</th>
<th>Applicable type</th>
<th>Features</th>
<th>TSCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>KR-220L</td>
<td>Methyl</td>
<td>100</td>
<td>None</td>
<td>Rapid</td>
<td>High</td>
<td>Low</td>
<td>Heat resistant and flame retardant binders</td>
<td>Baking</td>
<td>Powder, solvent</td>
<td>White flake, excellent heat resistance and flame retardance, very little smoking upon heating</td>
<td>Listed</td>
</tr>
<tr>
<td>KR-220LP</td>
<td>Methyl</td>
<td>100</td>
<td>None</td>
<td>Rapid</td>
<td>High</td>
<td>Low</td>
<td>Heat resistant and flame retardant binders</td>
<td>Baking</td>
<td>Powder, solvent</td>
<td>Powder type of KR-220L</td>
<td>Listed</td>
</tr>
<tr>
<td>KR-242A</td>
<td>Methyl</td>
<td>50</td>
<td>Toluene, isopropyl alcohol</td>
<td>Rapid</td>
<td>High</td>
<td>Low</td>
<td>Heat resistant and flame retardant binders</td>
<td>Baking</td>
<td>Solvent</td>
<td>Excellent heat resistance and flame retardance</td>
<td>Listed</td>
</tr>
<tr>
<td>KR-251</td>
<td>Poly</td>
<td>20</td>
<td>Toluene</td>
<td>Rapid</td>
<td>Medium</td>
<td>Low</td>
<td>Water proofing and insulating coatings</td>
<td>Baking, room temperature</td>
<td>Solvent</td>
<td>Thin hard coating</td>
<td>Listed</td>
</tr>
<tr>
<td>KR-255</td>
<td>Methyl / Phenyl</td>
<td>50</td>
<td>Toluene, xylene</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Water proofing and insulating coatings</td>
<td>Baking, room temperature</td>
<td>Solvent</td>
<td>Glossy hard coating</td>
<td>Listed</td>
</tr>
<tr>
<td>KR-282</td>
<td>Methyl</td>
<td>50</td>
<td>Xylene</td>
<td>Slow</td>
<td>Low</td>
<td>Medium</td>
<td>Heat resistant paints</td>
<td>Baking</td>
<td>Solvent</td>
<td>Excellent flexibility and anti-cracking properties</td>
<td>Listed</td>
</tr>
<tr>
<td>KR-300</td>
<td>Methyl</td>
<td>50</td>
<td>Xylene</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Heat resistant paints</td>
<td>Baking</td>
<td>Solvent</td>
<td>Excellent heat resistance</td>
<td>Listed</td>
</tr>
<tr>
<td>KR-311</td>
<td>Methyl</td>
<td>60</td>
<td>Xylene</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td>Heat resistant paints</td>
<td>Baking</td>
<td>Solvent</td>
<td>Excellent heat resistance and compatibility with organic resins</td>
<td>Listed</td>
</tr>
<tr>
<td>ES-1001N</td>
<td>Epoxy modified resin</td>
<td>45</td>
<td>Xylene, diacetone alcohol, n-butanol</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Heat resistant paints</td>
<td>Baking</td>
<td>Solvent</td>
<td>Excellent anti-corrosion property, heat resistance and weatherability</td>
<td>Listed</td>
</tr>
<tr>
<td>ES-1002T</td>
<td>Epoxy modified resin</td>
<td>60</td>
<td>Toluene</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Heat resistant paints</td>
<td>Baking, room temperature</td>
<td>Solvent</td>
<td>Excellent anti-corrosion property and chemical resistance</td>
<td>Listed</td>
</tr>
<tr>
<td>ES-1023</td>
<td>Epoxy modified resin</td>
<td>45</td>
<td>Xylene, diacetone alcohol</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Heat resistant paints</td>
<td>Baking</td>
<td>Solvent</td>
<td>Excellent anti-corrosion properties</td>
<td>Listed</td>
</tr>
<tr>
<td>KR-5206</td>
<td>Alkyd modified resin</td>
<td>50</td>
<td>Xylene</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Heat resistant paints</td>
<td>Room temperature</td>
<td>Solvent</td>
<td>Excellent flexibility and adhesion</td>
<td>Listed</td>
</tr>
<tr>
<td>KR-5230</td>
<td>Alkyd modified resin</td>
<td>60</td>
<td>PGMAC*2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Heat resistant paints</td>
<td>Baking</td>
<td>Solvent</td>
<td>Excellent flexural resistance, heat resistance and weatherability</td>
<td>Listed</td>
</tr>
<tr>
<td>KR-5234</td>
<td>Alkyd modified resin</td>
<td>60</td>
<td>PGMAC<em>2, MMBAC</em>3, isobutyl alcohol</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Heat resistant paints</td>
<td>Baking</td>
<td>Solvent</td>
<td>Retains glossy appearance under high temperature</td>
<td>Listed</td>
</tr>
<tr>
<td>KR-5235</td>
<td>Alkyd modified resin</td>
<td>60</td>
<td>PGMAC<em>2, MMBAC</em>3, isobutyl alcohol</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Heat resistant paints</td>
<td>Baking</td>
<td>Solvent</td>
<td>Excellent releasability and non-stick properties</td>
<td>Listed</td>
</tr>
</tbody>
</table>

**Products Types and Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Type</th>
<th>Methyl type</th>
<th>Methyl / Phenyl type</th>
<th>Epoxy modified resin</th>
<th>Alkyd modified resin</th>
<th>Polyester modified resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat resistance</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Hardness</td>
<td>++</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Weatherability</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Flexibility</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Anti-corrosion property</td>
<td>±</td>
<td>±</td>
<td>±</td>
<td>±</td>
<td>±</td>
<td></td>
</tr>
</tbody>
</table>

* *++:* Excellent |
* *+:* Good |
* *±:* Satisfactory |
* *-:* Poor

---

*1: Active ingredient
*2: PGMAC : Propylene glycol monomethylether acetate
*3: MMBAC : 3-Methyl-3-methoxybutyl acetate
*4: ES-1002T must be used with KP-390 (cross-linker).
Methyl silicone resin that contains no phenyl groups.

T Units / D Units Ratio and phenyl content are key factors determining hardness, cure speed and compatibility with organic resins, but not all products fit this pattern.

Map of Structures and Features

KR-282 → KR-311
High hardness
Room temperature drying
Even higher hardness
KR-255 → KR-300

Methyl Type

KR-220L → KR-242A
Solution
Ultra-high molecular weight

KR-220LP → KR-251
Powder

Epoxy Type

Improved adhesion & thermal shock resistance
Room temperature drying
Imparts Non-stick property
Improved cure speed

Polyester Type

KR-212
KR-211
KR-300
KR-311
KR-255
KR-220L
KR-220LP
KR-251
KR-242A
KR-282

Product Type

Methyl / Phenyl Type

**1 Methyl silicone resin that contains no phenyl groups.

**2 T Units / D Units Ratio and phenyl content are key factors determining hardness, cure speed and compatibility with organic resins, but not all products fit this pattern.
Silicone resins are used in a wide range of applications. Taking advantage of 3D molecular structures, silicone resins exhibit excellent heat resistance, weatherability, and electrical insulation.

**Features of Silicone Resins**

- **Before Curing**
  - Methyl groups or Phenyl groups

- **After Curing**
  - Forms hard coating with three-dimensional network structure

**Model of Silicone Resins**

**Weight Loss Data in air at High Temperature (Methyl/Phenyl Type)**

**Heat Resistance : Comparison Data with Organic Resins (under 250℃)**

**Weather Resistance : Comparison Data with Organic Resins**

**Sunlight Absorption : Comparison Data with Organic Resins**

*Methyl silicone is not affected by sunlight, because sunlight passes through it.*
Silicone based Resins

Unique Silicone Resins
Technology perfected over several decades created a line of silicone resins with unique performance features.

Solid Silicone Resin KR-220L
Solid silicone resin consisting of 100% active content. Available in flake or powder form. Heat-cured resin, and because it is a liquid at temperatures between 80°–150°C, it can be used without a solvent. Can be used to make binders and powder coatings. And because it dissolves in toluene and isopropyl alcohol, KR-220L offers a great number of possibilities in the ways it can be used.

- **Dry Blend**
  - KR-220L
  - Heating
  - Melt
  - Filler addition
  - Cool
  - *Catalysts may also be added

- **Solution Blend**
  - KR-220L
  - Solvent
  - Dissolve in solvent
  - Add fillers
  - Solvent elimination
  - *Catalysts may also be added

- **Melt Blend**
  - KR-220L
  - Filler addition

Ultra High Molecular Weight Silicone Resin KR-251
KR-251 is a methyl silicone resin with a very high molecular weight. Due to its excellent film-forming ability, KR-251 forms coatings with just a simple drying process. In addition, because it contains D units, KR-251 forms coatings that resists cracking even after heat-curing.

- **Model of Coating Structure**
  - **Common Grade Silicone Resin**
    - Low molecular weight
    - Poor film forming properties when dried
    - Heat cure or Catalyst
    - Easy to crack due to high crosslinking density
  - **KR-251**
    - High molecular weight
    - Forms a high quality film by air drying alone

Highly Durable Heat Resistant Paint Resins ES-1023/KR-311
The combination of the epoxy-modified silicone resin ES-1023 (with its outstanding corrosion resistance and adhesiveness) and the unmodified silicone resin KR-311 (with its high heat resistance), a highly durable and heat resistant coating is formed.

- **Application Examples**
  - **Blending example of base coating**
    - ES-1023 · · · · · · 30wt%
    - Zinc powder · · · · · · 40wt%
    - Talc · · · · · · · · · · · 10wt%
    - Xylene · · · · · · · · · · 20wt%
  - **Blending example of top coating**
    - KR-311 · · · · · · · · · · 40wt%
    - Ceramic black · · · · · 20wt%
    - Talc · · · · · · · · · · · 20wt%
    - Xylene · · · · · · · · · · 20wt%

1. **Applying the base coat**
   - Base coat : ES-1023
   - Substrate : Steel plate
   - Baking : 150°C-180°C×20 to 30 min.
2. **Applying the top coat**
   - Top coat : KR-311
   - Base coat : ES-1023
   - Substrate : Steel plate
   - Baking : 150°C-200°C×20 to 30 min.
Type A silicone oligomers (please refer P.4) are used with a curing agent to produce coatings that cure at ambient temperatures and humidities. In recent years, these oligomers have been widely used for exterior automotive coatings and interior floor coatings.

## 2-Part Room Temperature Moisture Cure Coatings

Type A silicone oligomers (please refer P.4) are used with a curing agent to produce coatings that cure at ambient temperatures and humidities. In recent years, these oligomers have been widely used for exterior automotive coatings and interior floor coatings.

### Product Lineup
With a range of silicone oligomers and curing agents to choose from, the user has a great degree of control over the cure speed, hardness, or flexibility of the cured coating.

With silicone oligomers, the degree of polymerization and ratio of 3D crosslinking (T Units) to 2D crosslinking (D Units) will influence such properties as curing speed and the hardness and/or flexibility of the coating. For example, by combining a methyl silicone oligomer with a lesser proportion of a phenyl oligomer, a coating with enhanced flexibility and glossiness is produced.

### Methyl Type
**Features:** Excellent water repellency, cure speed

### Catalysts Lineup

<table>
<thead>
<tr>
<th>Product name</th>
<th>Type</th>
<th>Adding amount wt%</th>
<th>Features</th>
<th>TSCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-220</td>
<td>Phosphoric acid</td>
<td>5-10</td>
<td>Very high activity</td>
<td>Listed</td>
</tr>
<tr>
<td>X-40-2309A</td>
<td>Phosphoric acid</td>
<td>10-50</td>
<td>High activity, can accelerate curing</td>
<td>Listed</td>
</tr>
<tr>
<td>D-25</td>
<td>Titanium</td>
<td>0.5-3</td>
<td>Higher activity than D-20</td>
<td>Listed</td>
</tr>
<tr>
<td>D-20</td>
<td>Titanium</td>
<td>2-5</td>
<td>Slow reactivity</td>
<td>Listed</td>
</tr>
<tr>
<td>DX-175</td>
<td>Titanium</td>
<td>3-5</td>
<td>Solvent diluted type (Easy to use)</td>
<td>Listed</td>
</tr>
<tr>
<td>DX-9740</td>
<td>Aluminum</td>
<td>0.5-6</td>
<td>Forms high hardness coatings</td>
<td>Listed</td>
</tr>
<tr>
<td>CAT-AC</td>
<td>Aluminum</td>
<td>0.5-10</td>
<td>Solvent diluted type (Easy to use)</td>
<td>Listed</td>
</tr>
</tbody>
</table>

### Blending Examples and Film Properties

<table>
<thead>
<tr>
<th>Product name</th>
<th>Parameter</th>
<th>Catalyst (adding amount) %</th>
<th>Film thickness μm</th>
<th>Tack free 25°C min</th>
<th>Pencil hardness</th>
<th>Flexural resistance / Impact resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>KR-500/ X-40-9250 1</td>
<td>D-20(4)</td>
<td>25</td>
<td>25</td>
<td>5H</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>X-40-9225 1</td>
<td>DX-9740(5)</td>
<td>25</td>
<td>100</td>
<td>5H</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>D-20(3)</td>
<td>DX-9740(5)</td>
<td>30</td>
<td>60</td>
<td>H</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>D-20(2)</td>
<td>DX-9740(5)</td>
<td>50</td>
<td>75</td>
<td>F</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

*Substrate: Polished steel sheet, Cure conditions: 25°C / 70% RH x 7days (Tack-free time varies depending on temperature and humidity)  
*1: KR-500 and X-40-9225 are listed in TSCA. X-40-9250 is not listed in TSCA.

---

*Nanotechnology in Resins: A Comprehensive Guide*
1-Part Room Temperature Moisture Cure Coatings

These coating agents come pre-mixed with a curing agent. These one-component products cure at room temperature with exposure to moisture in the air. KR-400 is designed to produce high hardness coatings. X-40-2327 is fast curing, while KR-401 produces coatings with high flex resistance and impact resistance.

New Products

Our product offerings include coating agents with special features such as enhanced water repellency, antistatic properties and UV shielding abilities.

Fluorine-containing type KR-400F

Features: Fluorine is incorporated for enhanced slip property, water repellency and antifouling properties.

Ultraviolet-shielding type X-40-9309A

Features: The silicone coating resists breakdown from UV rays, and also helps prevent degradation of the underlying substrate.

Antistatic type X-40-2450X

Features: Forms an antistatic layer on surfaces, thus making them less likely to attract dirt and dust.
We have products designed for use with water-based, solvent-based, and UV-cure acrylic resins.

### Resulting Properties
- Better heat resistance
- Higher weatherability
- Improved water repellency
- Increased flexibility
- Enhanced wear resistance
- Better water resistance
- Improved adhesion
- Higher hardness
- Room-temperature curability

### Properties that can be Impacted to Acrylic Resins

<table>
<thead>
<tr>
<th>Heat Resistance</th>
<th>Water Resistance</th>
<th>Weatherability</th>
<th>Flexibility</th>
<th>Adhesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Additive</td>
<td>Silane Coupling Agents</td>
<td>Silicone Oligomers</td>
<td>Silicone Resins</td>
<td>Modified Silicone Fluids</td>
</tr>
</tbody>
</table>

### Product List Water type, Solvent type

<table>
<thead>
<tr>
<th>Product category</th>
<th>Product name</th>
<th>Type</th>
<th>Active ingredient %</th>
<th>Solvent</th>
<th>Applicable type</th>
<th>Recommended adding amount %</th>
<th>Features</th>
<th>TSCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silane coupling agents (Radical reaction type)</td>
<td>KBM-1003</td>
<td>Vinyl</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Methoxy tri-functional</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KBM-503</td>
<td>Methacrylic</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Methoxy tri-functional</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KBE-503</td>
<td>Methacrylic</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Ethoxy di-functional</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KBM-502</td>
<td>Methacrylic</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Methoxy di-functional</td>
<td>Not Listed</td>
</tr>
<tr>
<td></td>
<td>KBE-502</td>
<td>Methacrylic</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Ethoxy di-functional</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Silane coupling agents (Room temperature cure type)</td>
<td>KBM-303</td>
<td>Epoxy</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Alicyclic epoxy</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KBM-403</td>
<td>Epoxy</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Glycidyl</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KBM-603</td>
<td>Amino</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Diamine</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KBE-903</td>
<td>Amino</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Primary amine</td>
<td>Listed</td>
</tr>
<tr>
<td>Silicone oligomers</td>
<td>KC-89S</td>
<td>Methyl</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>10-20</td>
<td>Low DP (degree of polymerization)</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KR-515</td>
<td>Methyl</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>10-20</td>
<td>Medium DP</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KR-500</td>
<td>Methyl</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>10-20</td>
<td>Medium DP</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KR-510</td>
<td>Methyl / Phenyl</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>10-20</td>
<td>Excellent compatibility</td>
<td>Listed</td>
</tr>
<tr>
<td>Silicone resins</td>
<td>KR-211</td>
<td>Methyl / Phenyl</td>
<td>70</td>
<td>Xylene</td>
<td>Solvent</td>
<td>10-50</td>
<td>Excellent compatibility</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KR-212</td>
<td>Methyl / Phenyl</td>
<td>70</td>
<td>Xylene</td>
<td>Solvent</td>
<td>10-50</td>
<td>Excellent flexibility and compatibility</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KR-216</td>
<td>Propyl / Phenyl</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>10-50</td>
<td>Solid type</td>
<td>Listed</td>
</tr>
<tr>
<td>Modified silicone fluids</td>
<td>X-22-174ASX</td>
<td>Single-end Methacrylic</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>0.5-20</td>
<td>Short chain length</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>X-22-174BX</td>
<td>Single-end Methacrylic</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>0.5-20</td>
<td>Medium chain length</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KF-2012</td>
<td>Single-end Methacrylic</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>0.5-20</td>
<td>Long chain length</td>
<td>Listed</td>
</tr>
</tbody>
</table>

### Application Examples
- Construction exterior parts
- Heavy-duty anticorrosion, exterior building (Chemical plant)
- Automotive paint (Car, Train)
- Automotive parts
- Display, electrical equipment

- Exterior construction parts
- Hard coating
- Heavy-duty anticorrosion paint
Process of silicone hybridization Water, Solvent type

Radical Polymerization
- Acrylic Monomer
  - Silane Coupling Agents
    - Radical Reaction Type
  - Single-end Modified Silicone Fluids

Dehydration or Dealcoholization Condensation
- Acrylic Polymer
  - Silicone Oligomers

Dehydration-Condensation
- Acrylic Polymer
  - Silicone Resins

Reactions with Organic Functional Groups
- Acrylic Polymer
  - Silane Coupling Agents
    - Room Temperature Cure Type

Heat Reaction
Silicone Modified Acrylic Resin
- Properties Imparted
  - Weatherability, Adhesion, Room Temperature Cure, Water Resistance
  - Water Repellency, Flexibility
  - Weatherability
  - Heat Resistance, Weatherability
  - Adhesion, Water Resistance

Product Type

Silicone Oligomers
- Higher molecular weight
  - (Improves weatherability)
  - KC-89S
  - KR-515
  - KR-500
  - Imparts phenyl groups
    - (Improves compatibility)
    - KR-510

Silicone Resins
- Higher molecular weight and phenyl groups
  - (Improves flexibility and compatibility)
  - KR-211
  - KR-212
  - KR-216
  - Solidification
    - (Solvent less)

Modified Silicone Fluids
- Short chain type
  - (Excellent radical copolymerizability)
  - Longer chain
    - (Improves water repellency, releasability)
  - X-22-174ASX
  - X-22-174BX
  - KF-2012

Silane Coupling Agents Radical Reaction Type
- Methacrylic Type
  - KBM-503
    - Methoxy / Tri-functional
      - (Standard)
  - KBE-503
  - KBE-502
  - Di-functionalization
    - (Improves storage stability, water repellency, lower VOC content)
Resin Hybridization Agents

Acrylic Resins

Synthesis Examples of Heat Reaction Type

- **Modification via Radical Polymerization using KBM-503**
  - Results in improved adhesion to substrates and improved moisture resistance.
  - **Water Type**
    - MMA**, BMA**, etc.
    - KBM-503
    - Water
    - Polymerization Initiator
    - Surfactant
    - Reaction
    - Silicone Modified Acrylic Emulsion
      - Non-volatile content: about 50%

- **Solvent Type**
  - MMA**, BMA**, etc.
  - KBM-503
  - Solvent
  - Polymerization Initiator
  - Reaction
  - Silicone Modified Acrylic Emulsion
    - Non-volatile content: about 50%

*1 MMA = Methyl methacrylate  
*2 BMA = Butyl methacrylate

- **Modification via Dehydration-condensation or Dealkoholization-condensation using KR-500.**
  - Results in improved adhesion to substrates and enhanced weatherability.
  - **Model of Resin Modification**
    - MMA etc.
    - KR-500
    - KBM-503
    - Water
    - Polymerization Initiator
    - Surfactant
    - Stirring (Emulsifying)
    - Copolymerization (Heating)
    - Cooling
    - pH Adjustment (pH around 8)
    - Silicone Modified Acrylic Emulsion
      - Non-volatile content: about 30-50%

- **Modification via Radical Polymerization using KF-2012.**
  - Silicone chains are grafted onto the acrylic resin, thereby improving the surface characteristics and water repellency.

*3 MMA = Methyl methacrylate  
*4 BMA = Butyl methacrylate

- **Model of Resin Modification**
  - MMA etc.
  - KF-2012
  - Solvent
  - Polymerization Initiator
  - Reaction
  - Silicone Modified Acrylic Emulsion
    - Non-volatile content: about 50%
**Product List UV type**

<table>
<thead>
<tr>
<th>Product category</th>
<th>Product name</th>
<th>Type</th>
<th>Active ingredient %</th>
<th>Solvent</th>
<th>Applicable type</th>
<th>Recommended adding amount %</th>
<th>Features</th>
<th>TSCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silane coupling agents</td>
<td>KBM-5103</td>
<td>Acrylic</td>
<td>100</td>
<td>None</td>
<td>UV</td>
<td>1-50</td>
<td>Standard product</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>X-12-1048</td>
<td>Acrylic</td>
<td>100</td>
<td>None</td>
<td>UV</td>
<td>1-50</td>
<td>Acrylic group / Si ratio = 1</td>
<td>Not Listed</td>
</tr>
<tr>
<td></td>
<td>X-12-1050</td>
<td>Acrylic</td>
<td>100</td>
<td>None</td>
<td>UV</td>
<td>1-50</td>
<td>Polymer type, Acrylic group / Si ratio = 5</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Silicone oligomers</td>
<td>KR-513</td>
<td>Acrylic / Methyl</td>
<td>100</td>
<td>None</td>
<td>UV</td>
<td>10-50</td>
<td>Condensation cure type of KBM-5103</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>X-40-9308</td>
<td>Acrylic</td>
<td>100</td>
<td>None</td>
<td>UV</td>
<td>10-50</td>
<td>High hydrolyzability</td>
<td>Listed</td>
</tr>
<tr>
<td>Modified silicone fluids</td>
<td>X-22-164A/B</td>
<td>Dual-end Methacrylic</td>
<td>100</td>
<td>None</td>
<td>UV</td>
<td>10-50</td>
<td>Slip property</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>X-22-2445</td>
<td>Dual-end acrylic</td>
<td>100</td>
<td>None</td>
<td>UV</td>
<td>10-50</td>
<td>Leveling property</td>
<td>Listed</td>
</tr>
</tbody>
</table>

(Not specified values)

---

**Process of Silicone Hyblidization : UV Type**

- **Acrylic Silane Coupling Agents**
- **Oligomer Containing Acrylic Groups**
- **Single-end (metha) Acrylic Modified Fluid**

- **Properties Improved**
  - Adhesion
  - High Hardness, Adhesion
  - Water Repellency, Wear Resistance

---

**Hard Coating Application**

Silicone oligomers containing acrylic groups can be used with acrylic coating resins to produce coatings with higher hardnesses. In addition to the products described above, Shin-Etsu has other with unique molecular structures like those shown below.

---

**Chemical Structures**

- **X-12–2475**
- **X-12–2430C**

X-12-2475 and X-12-2430C are not listed in TSCA.

---

**Acrylic Coating Material Blend Ratio**

Dipentaerythritol triacrylate : 80 wt. part
Hexanediol diacrylate : 20 wt. part
2-Hydroxy-2-methyl-1 phenyl-plopane-1-one : 10 wt. part
The above acrylic coating / Si material = 100 / 50 wt. part

---

**Application / Cure Method**

- **Film thickness** : about 20μm
- **Substrate** : POLYCASE made by Sumitomo Bakelite Co., Ltd.
  - ECK100 clear 2mm thickness
- **UV curing condition** : High-pressure mercury vaper lump 600mJ/cm² Nitrogen substitution

---

**Durability Testing**

<table>
<thead>
<tr>
<th>Product name</th>
<th>Pencil hardness</th>
<th>Taber abrasion test (Haze/500g load, 100 rotations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KR-513</td>
<td>2H</td>
<td>3.0</td>
</tr>
<tr>
<td>X-12-1050</td>
<td>2H</td>
<td>3.0</td>
</tr>
<tr>
<td>X-40-9308</td>
<td>2H</td>
<td>3.0</td>
</tr>
<tr>
<td>X-12-2475</td>
<td>3H</td>
<td>2.5</td>
</tr>
<tr>
<td>X-12-2430C</td>
<td>2H</td>
<td>3.0</td>
</tr>
<tr>
<td>Blank</td>
<td>H</td>
<td>4.0</td>
</tr>
</tbody>
</table>

(Not specified values)
Polyester and alkyd resins are inherently flexible and chemically resistant. By giving these the heat resistance and weatherability of a silicone, we create a much more durable resin.

### Resulting Properties
- Better heat resistance
- Higher weatherability
- Increased flexibility
- Enhanced wear resistance
- Better water resistance
- Better cold resistance
- Improved adhesion

### Properties that can be Imparted to Polyester & Alkyd Resins

<table>
<thead>
<tr>
<th>Heat Resistance</th>
<th>Weatherability</th>
<th>Flexibility</th>
<th>Adhesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Additive</td>
<td>Silane Coupling Agents</td>
<td>Silicone Oligomers</td>
<td>Silicone Resins</td>
</tr>
</tbody>
</table>

### Product List

<table>
<thead>
<tr>
<th>Product category</th>
<th>Product name</th>
<th>Type</th>
<th>Active ingredient %</th>
<th>Solvent</th>
<th>Applicable type</th>
<th>Recommended loading %</th>
<th>Features</th>
<th>TSCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silane Coupling Agents</td>
<td>KBM-503</td>
<td>Methacrylic</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>0.5-2.0</td>
<td>Methox tri-functional</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KBE-503</td>
<td>Methacrylic</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>0.5-2.0</td>
<td>Ethox tri-functional</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KBM-502</td>
<td>Methacrylic</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>0.5-2.0</td>
<td>Methox di-functional</td>
<td>Not listed</td>
</tr>
<tr>
<td></td>
<td>KBE-502</td>
<td>Methacrylic</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>0.5-2.0</td>
<td>Ethox di-functional</td>
<td>Not listed</td>
</tr>
<tr>
<td></td>
<td>KBM-5103</td>
<td>Acrylic</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>0.5-2.0</td>
<td>Excellent reactivity</td>
<td>Listed</td>
</tr>
<tr>
<td>Silicone Oligomers</td>
<td>KC-89S</td>
<td>Methyl</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>10-20</td>
<td>Low DP (degree of polymerization)</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KR-515</td>
<td>Methyl</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>10-20</td>
<td>Medium DP</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KR-500</td>
<td>Methyl</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>10-20</td>
<td>Medium DP</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KR-510</td>
<td>Methyl / Phenyl</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>10-20</td>
<td>Compatibility</td>
<td>Listed</td>
</tr>
<tr>
<td>Silicone Resins</td>
<td>KR-211</td>
<td>Methyl / Phenyl</td>
<td>70</td>
<td>Xylene</td>
<td>Solvent</td>
<td>10-50</td>
<td>Excellent compatibility</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KR-212</td>
<td>Methyl / Phenyl</td>
<td>70</td>
<td>Xylene</td>
<td>Solvent</td>
<td>10-50</td>
<td>Excellent flexibility, compatibility</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KR-216</td>
<td>Propyl / Phenyl</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>10-50</td>
<td>Solid type</td>
<td>Listed</td>
</tr>
<tr>
<td>Modified Silicone Fluids</td>
<td>KF-2201</td>
<td>Phenol modified</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>0.5-10</td>
<td>Heat resistance, Excellent flexibility</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>X-22-3701E</td>
<td>Carboxylic acid modified</td>
<td>100</td>
<td>None</td>
<td>Solvent</td>
<td>0.5-10</td>
<td>Release property</td>
<td>Listed</td>
</tr>
</tbody>
</table>

### Application Examples
- Building exterior parts (Rolled Steel)
- Consumer electronics parts (Facility, Equipment)
- Construction parts
- Automotive paints (Car, Train)

![Painted Steel](image1.png)  ![ Tanks](image2.png)
### Weatherability Test Result of Silicone Modified Polyester Resin

**Parameter** | **KR-510** | **KR-510**
---|---|---
Appearance | Colorless to pale yellow slightly cloudy liquid | (Not specified values)
Viscosity at 25℃, mm²/s | 100 | 100
Specific gravity at 25℃ | 1.16 | 100
Refractive index at 25℃ | 1.509 | (Not specified values)
Active ingredient | 100% | (Not specified values)

**Cure condition** | **285℃×1min** | **285℃×10min**
---|---|---
Pencil hardness | 2H | 4H
Adhesion (cross cut adhesion test) | 100/100 | 100/100
Impact resistance DuPont test cm | Min.50 | Min.50
MEK* rubbing times | 100 | Min.100
Xylene rubbing times | 10 | Min.100

*MEK : Methyl ethyl ketone

**Weatherability Test Result of Silicone Modified Polyester Resin**

- **Silicone content 50%**
- **Silicone content 30%**
- **Silicone content 0%**

Test method: Sunshine weatherometer

Heat resistance is improved by inserting a high-molecular-weight silicone resin into the alkyd resin.

#### Reaction Mechanisms

**Dehydration condensation**

- **Alkyd Resins**
  - **C-OH + HO-Si≡** → **Alkyd Resins**
  - **C-O-Si≡ + H₂O**

#### Alkyd Resin Modification with Silicone Oligomer

**Room Temperature Reaction**

- **Alkyd Resins**
  - 50-70 wt. parts

**Heat Reaction**

- **Alkyd Resins**
  - 30-50 wt. parts

- **KR-216**
  - 50-70 wt. parts

**Silicone Modified Alkyd Resins**

**Product Type**

- **KR-211**
  - Higher molecular weight, higher phenyl content (Improved flexibility, compatibility)

- **KR-212**
  - Solidification (Solventless)

- **KR-216**
Resin Hybridization Agents  Epoxy Resins

Shin-Etsu produces a line of silane coupling agents and silicone oligomers that help improve adhesion to substrates, and silicone oligomers and silicone resins that help improve the heat resistance and weatherability of epoxy resins.

Resulting Properties
- Better heat resistance
- Higher weatherability
- Improved adhesion
- Better water resistance

Properties that can be Imparted to Epoxy Resins

<table>
<thead>
<tr>
<th>Product List</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product category</strong></td>
</tr>
<tr>
<td>Silane Coupling Agents</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Silicone Oligomers</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Silicone Resins</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Application Examples
- Heavy-duty
  - (Bridges, Tanks, Steel structures)
- Marine paint

Bridge

Pipes

Marine Paint
Protected Functional Group Silane Coupling Agent KBE-9103P

The functional group is protected in KBE-9103P, which means the silane can be mixed with materials that are chemically incompatible. The user can also expect improved adhesion.

**General Properties**
- **Parameter**
  - Purity at 25℃ GC%
  - Viscosity at 25℃ mm²/s
- **Product name**
  - KBE-9103P
  - KBE-903
- **Condition**
  - No additive

![Chemical Structure of KBE-9103P](image)

**Features and Resulting Properties**
- Many sites for reaction with resins → Improved coupling performance
- Low volatility → Less silane required
- Film-forming ability → Can be used as primer
- Contain trialkoxysilyl groups → Improved adhesion

**Adhesion Tests with Epoxy Internal-addition Adhesives**
- **Condition**
  - Initial strength MPa
  - After water resistance test (95℃×10h) MPa
- **Substrate**
  - Aluminium
  - Steel

![Table of Adhesion Test Results](image)

**Interface Adhesion Test of Glass / Epoxy Resin**
- **Test method**
  - (1) 1% aqueous solution applied to glass substrate.
  - (2) Cured material [EPIKOTE 828 (epoxy resin made by Mitsubishi Chemical Corp.) / triethylenetetramine] is prepared, adhesive strength is tested.
- *Calculated against baseline value of 100 for adhesion to untreated substrate.

Multi Functional Silane Coupling Agent

These silane coupling agents contain an organic polymer chain with alkoxy groups and several organic functional groups. Their large number of reaction sites helps guarantee better adhesion. Because their main components are low in volatility and have good film-forming ability, these silane coupling agents can also be used as primers.

**Chemical Structure of Multi Functional Silane Coupling Agents**

![Chemical Structure Diagram](image)

**Features and Resulting Properties**
- Many sites for reaction with resins → Improved coupling performance
- Low volatility → Less silane required
- Film-forming ability → Can be used as primer
- Contain trialkoxysilyl groups → Improved adhesion

**General Properties**
- **Parameter**
  - Viscosity at 25℃ mm²/s
  - Specific gravity at 25℃
- **Product name**
  - KBE-9103P
  - KBE-903

**Interface Adhesion Test of Glass / Epoxy Resin**
- **Test method**
  - (1) 1% aqueous solution applied to glass substrate.
  - (2) Cured material [EPIKOTE 828 (epoxy resin made by Mitsubishi Chemical Corp.) / triethylenetetramine] is prepared, adhesive strength is tested.
  - *Calculated against baseline value of 100 for adhesion to untreated substrate.

**Product List**

![Product List Table](image)

**Synthesis Example**

Heat resistance is improved by inserting KR-212 into the epoxy resin.

**Modification Example with Silicone Resins**

![Modification Example Diagram](image)
Many types of polyurethane (e.g. thermoplastic polyurethane and synthetic leathers) can be modified with silicones to improve adhesion, flexibility, wear resistance and slip property.

### Resulting Properties
- Better heat resistance
- Higher weatherability
- Increased flexibility
- Enhanced wear resistance
- Improved adhesion
- Better water resistance
- Improved slip property

### Properties that can be Imparted to Urethane Resins

<table>
<thead>
<tr>
<th>Heat Resistance</th>
<th>Water Resistance</th>
<th>Flexibility</th>
<th>Adhesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Product List

<table>
<thead>
<tr>
<th>Product category</th>
<th>Product name</th>
<th>Type</th>
<th>Active ingredient %</th>
<th>Solvent</th>
<th>Applicable type</th>
<th>Recommended adding amount %</th>
<th>Features</th>
<th>TSCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silane Coupling Agents</td>
<td>KBE-9103P</td>
<td>Amino</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Protected functional group</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KBM-9659</td>
<td>Isocyanurate</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Multi-functional</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>X-12-5263HP</td>
<td>Amino</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Bis amine</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>X-12-1056ES</td>
<td>Mercaptopyrool</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Protected functional group, low odor</td>
<td>Not Listed</td>
</tr>
<tr>
<td></td>
<td>KBE-9007</td>
<td>Isocyanate</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Ethoxy tri-functional</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KBM-403</td>
<td>Epoxy</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-2.0</td>
<td>Methoxy tri-functional</td>
<td>Listed</td>
</tr>
<tr>
<td>Modified Silicone Fluids</td>
<td>KF-6000</td>
<td>Dual-end carbinol</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-20</td>
<td>Excellent compatibility</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KF-6001</td>
<td>Dual-end carbinol</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-20</td>
<td>Flexibility, wear resistance</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>KF-6002</td>
<td>Dual-end carbinol</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-20</td>
<td>Flexibility, wear resistance</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>X-22-170BX</td>
<td>Single-end carbinol</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-10</td>
<td>Excellent compatibility</td>
<td>Not Listed</td>
</tr>
<tr>
<td></td>
<td>X-22-176DX</td>
<td>Single-end diol</td>
<td>100</td>
<td>None</td>
<td>Water or solvent</td>
<td>0.5-10</td>
<td>Surface slick property</td>
<td>Not Listed</td>
</tr>
</tbody>
</table>

### Application Examples
- Construction parts
- Consumer electronics parts
- Automotive interior parts

- Synthetic Leathers for Automotive
- Interior Sealant
Resin Hybridization Agents

Protected Functional Group Silane Coupling Agent X-12-1056ES

The organic functional group in X-12-1056ES is protected. This means the user may be able to use a one-component formulation where a two-component formulation was once required, or that the Silane Coupling Agent can be added at the same time as reactive materials because unwanted reactions are prevented. It also means a greatly increased shelf life.

**Application Example of Protected Mercapto Group Silane Coupling Agent X-12-1056ES**

\[
\begin{align*}
\text{OCN} & \quad \text{NCO} \\
\text{(MeO)\text{Si}} & \quad \text{S(\text{OEt})}_3 \\
\text{X-12-1056ES} & \quad \xrightarrow{\text{1 part moisture cure}} \\
\text{H}_2\text{O} & \\
\text{Deprotection of S-Si} & \quad \text{Reaction of SH and NCO} \\
\text{Two-component polyol cure} & \quad \text{Hydrolyzable groups react with substrate} \\
\text{HO—R—OH} & \quad \text{Isocyanate crosslinking} \\
\text{Improved adhesion} & \quad \text{to substrate}
\end{align*}
\]

**Stability with Isocyanate Compounds**

![Graph showing change in viscosity over time](image)

Change in viscosity when mixed with aromatic isocyanate (M-200)

Condition: Silane 5 wt% added, storage at 50°C

Change in viscosity when mixed with aromatic isocyanate (TLA-100)

Condition: Silane 5 wt% added, storage at 50°C

**Synthesis Examples**

**Modification Example with Single-end Diol Fluids**

<table>
<thead>
<tr>
<th>Urethane Resins</th>
<th>X-22-176DX</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-99 wt. parts</td>
<td>1-10 wt. parts</td>
</tr>
</tbody>
</table>

**Resulting Properties**

1. Slip property
2. Wear resistance

**Model of Graft Copolymer**

Structure of X-22-176DX

\[
\text{Silicone} \quad \text{R} \quad \text{Silicone} \\
\text{O—H} \quad \text{O—H}
\]

**Modification Example with Dual-end Carbinol Fluids**

<table>
<thead>
<tr>
<th>Urethane Resins</th>
<th>KF-6001</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-99 wt. parts</td>
<td>1-20 wt. parts</td>
</tr>
</tbody>
</table>

**Resulting Properties**

1. Flexibility
2. Wear resistance

**Model of Block Copolymer**

Structure of KF-6001

\[
\text{Silicone} \quad \text{R} \quad \text{Silicone} \\
\text{H—O—R} \quad \text{R—O—H}
\]

**Synthesis Examples**
Shin-Etsu has developed a unique line of silicone powders which fall into three categories: Hybrid Silicone Powder, Silicone Rubber Powder and Silicone Resin Powder. These products impart a variety of properties (i.e. lubricity, wear resistance and light diffusion) into coating agents and paints.

**Silicone Resin Powder**
- Molecular structure: 3D network structure
- **Features**
  - Heat resistance: ++
  - Weatherability: ++
  - Dispersibility into resins: ++
  - With organic solvents: No swelling

**Silicone Rubber Powder**
- Molecular structure: Straight-chain crosslinked polymer
- **Features**
  - Heat resistance: +
  - Weatherability: ++
  - Dispersibility into resins: ±
  - With organic solvents: Swelling

**Hybrid Silicone Powder**
- Form: Rubber powders covered with resin
- **Features**
  - Heat resistance: +
  - Weatherability: ++
  - Dispersibility into resins: ++
  - With organic solvents: Rubber part swells

**Enhanced Properties**

**Stress Relaxation, Impact Resistance**
- No additive
- **Silicone Rubber & Hybrid Silicone Powder added**
- **Resin Powder**
  - Resin Powder: -
  - Rubber Powder: ++
  - Hybrid Powder: ++

**Lubricity, Wear Resistance**
- Silicone Resin Powder
- **Resin Powder**
  - Resin Powder: ++
  - Rubber Powder: +
  - Hybrid Powder: ++

**Soft-feel Property**
- **Silicone Rubber Powder**
  - Silicone Rubber Powder: ++

**Light Diffusion Property**
- **Silicone Resin Powder**
  - Silicone Resin Powder: ++
  - Silicone Rubber Powder: ++
  - Hybrid Silicone Powder: ++
### Product List

<table>
<thead>
<tr>
<th>Parameter Type</th>
<th>Product name</th>
<th>Shape</th>
<th>Average particle size (μm)</th>
<th>Particle size distribution (μm)</th>
<th>True specific gravity</th>
<th>Moisture content (%)</th>
<th>Rubber hardness Durometer A</th>
<th>Refractive index</th>
<th>TSCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone resin powder</td>
<td>KMP-706</td>
<td>Spherical</td>
<td>2</td>
<td>1-4</td>
<td>1.3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>KMP-701</td>
<td>Spherical</td>
<td>3.5</td>
<td>1-6</td>
<td>1.3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>X-52-1621</td>
<td>Spherical</td>
<td>5</td>
<td>1-8</td>
<td>1.3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>X-52-654</td>
<td>Spherical</td>
<td>0.7</td>
<td>0.2-5</td>
<td>1.3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1.43</td>
</tr>
<tr>
<td>Silicone rubber powder</td>
<td>KMP-594</td>
<td>Spherical</td>
<td>5</td>
<td>1-10</td>
<td>0.97</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>KMP-597</td>
<td>Spherical</td>
<td>5</td>
<td>1-10</td>
<td>0.97</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>KMP-598</td>
<td>Spherical</td>
<td>13</td>
<td>2-30</td>
<td>0.97</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
<td>-</td>
</tr>
<tr>
<td>Hybrid silicone powder</td>
<td>KMP-600</td>
<td>Spherical</td>
<td>5</td>
<td>1-15</td>
<td>0.99</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>KMP-601</td>
<td>Spherical</td>
<td>12</td>
<td>2-25</td>
<td>0.98</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>KMP-602</td>
<td>Spherical</td>
<td>30</td>
<td>4-60</td>
<td>0.98</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>KMP-605</td>
<td>Spherical</td>
<td>2</td>
<td>0.7-5</td>
<td>0.99</td>
<td>0.1</td>
<td>75</td>
<td>1.42</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>X-52-7030</td>
<td>Spherical</td>
<td>0.8</td>
<td>0.2-2</td>
<td>1.01</td>
<td>0.1</td>
<td>75</td>
<td>1.42</td>
<td>1.43</td>
</tr>
</tbody>
</table>

(Not specified values)

### Product Data

- **Silicone Resin Powder**
  - KMP-706 Particle Size Distribution
  - KMP-706 Heat Resistance
  - KMP-706 Heat Resistance (Weight changes vs. temperatures)

- **Silicone Rubber Powder**
  - KMP-594 Particle Size Distribution
  - KMP-594 Heat Resistance
  - KMP-594 Heat Resistance (Weight changes vs. temperatures)

- **Hybrid Silicone Powder**
  - KMP-600 Particle Size Distribution
  - KMP-600 Heat Resistance
  - KMP-600 Heat Resistance (Weight changes vs. temperatures)

### Dispersibility

Dispersibility in liquid epoxy resin

- Hybrid Silicone Powder KMP-601
- Silicone Rubber Powder *

*Applying a shearing force improves dispersibility of silicone rubber powders in resin.
Surface Modifiers for Coating KP Series

The KP Series of coating surface modifiers are highly effective in small amounts. They can be added to paints and coatings to help prevent defects and for surface modification.

Features of Polysiloxane

1. Low surface tension
   Silicone fluids have very low surface tension.
   - Types of liquid
     - Dimethyl silicone KF-96: 21 mN/m
     - Toluene: 28 mN/m
     - Mineral oil: 30 mN/m
     - Glycerin: 63 mN/m
     - Water: 72 mN/m

2. Surface migration
   They migrate easily to the surface of resins.

3. Length of siloxane chains can be controlled
   - Shorter chains: Better compatibility with resins, solvents, lower surface tension and improved flow properties.
   - Longer chains: May be incompatible with resin, solvents, and produce hammer tone effects (cissing).

Features Provided by the Organic Reactive Groups

Compatibility with organic resin solutions. Surface tension can be controlled by changing the type of organic functional group.

<table>
<thead>
<tr>
<th>Type</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyether</td>
<td>Organic groups consisting of chains of repeated ethylene oxide units (EO) or propylene oxide units (PO), or a combination of the two. A high proportion of EO units translates to strong hydrophilicity and water solubility, and good compatibility with acrylic and urethane resins. A high proportion of PO units translates to strong hydrophobicity.</td>
</tr>
<tr>
<td>Polyol</td>
<td>Organic groups having a relatively compact structure with large numbers of hydroxyl groups. Silicone rich, and yet strongly hydrophilic with high polarity.</td>
</tr>
<tr>
<td>Acrylic</td>
<td>Organic groups composed of acrylic polymers. Have good film-forming ability and compatibility with acrylic resins.</td>
</tr>
<tr>
<td>Fatty acid ester</td>
<td>Organic groups with the same basic structure as alkyd resins. Highly compatible especially with alkyd resins.</td>
</tr>
<tr>
<td>Phenyl</td>
<td>Highly compatible with resins having large numbers of aromatic rings (e.g. epoxies). Because they are hydrophobic, these groups have poor compatibility with hydrophilic resins.</td>
</tr>
<tr>
<td>Fluorine</td>
<td>Silicons dissolve very well in aromatic solvents and thus show little activity in aromatic solvent-based paints. Fluorine modification will produce an agent with a surface tension-reducing and defoaming effect in aromatic solvent-based paints and coatings. Poor compatibility with many resins means there can be a risk of cissing or other problems.</td>
</tr>
<tr>
<td>Alkyl</td>
<td>Introducing alkyl or aralkyl groups will produce an additive with balanced performance and higher hydrophobicity.</td>
</tr>
<tr>
<td>Aralkyl</td>
<td></td>
</tr>
<tr>
<td>Polyester</td>
<td>Organic groups composed of polyester polymers. Higher molecular weights than most other organic groups. Have good film-forming ability and particularly good compatibility with polyester paints and coatings.</td>
</tr>
</tbody>
</table>
Main Applications and Functional Mechanism

- **Leveling Agent (Improves Flowability)**

  - Roller coating: Silicone migrates to the surface. The leveling effect of the silicone helps produce a smoother coating surface.
  - Spray coating: The flow properties of the silicone help improve the wetting and spreading properties of the paint.

- **Defoaming Agent**

  - Silicone moves to the surface of air bubbles. Moving to the surface, bubbles are broken by the following mechanism:
    1. Adhesion
    2. Penetration
    3. Diffusion
    4. Defoaming

- **Slip Agent (Releasability Imparter)**

- **Anti-floating / Anti-flooding Agents**

- **Hammertone Agent**

- **Main Chain Length of Silicone**

- **SP value difference**

- **Relationship between Silicone Structure and Development Property**

  Depending on the silicone chain length and the difference between the solubility parameters (SP) of the KP series and paint/coating, the KP series can show leveling, defoaming or slip improvement.

- **Silicone migrates to the surface.** Long-chain silicones can encourage cissing and can thus be added to paints when a hammertone finish is desired.

- **Imparting water repellency**

- **Reducing coefficient of friction**

- **Hammer tone forming property**

- **Leveling property**

- **Defoaming property**

- **Slip property (Releasability)**

- **Silicone Film-forming Property**

- **Silicone Surface Migration Speed**

- **Slow**

- **Fast**

- **Long-chain Silicone**

- **Appearance of Hammertone**

- **Relationship between Silicone Structure and Development Property**

  - Based on the silicone chain length and the difference between the solubility parameters (SP) of the KP series and paint/coating, the KP series can show leveling, defoaming or slip improvement.
**Product List**

<table>
<thead>
<tr>
<th>Application</th>
<th>Type</th>
<th>Product name</th>
<th>Solubility parameter</th>
<th>Molecular weight level (Length of siloxane main chain)</th>
<th>Active Ingredient %</th>
<th>Solvent</th>
<th>Water type applicability</th>
<th>Standard adding amount Wt%</th>
<th>TSCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyether modified</td>
<td>KP-124</td>
<td>8.2</td>
<td>Medium</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>±</td>
<td>0.005-1.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyether modified</td>
<td>KP-109</td>
<td>8.2</td>
<td>High</td>
<td>50 PGM²</td>
<td>-</td>
<td>±</td>
<td>0.01-1.0</td>
<td>Not Listed</td>
<td></td>
</tr>
<tr>
<td>Polyether modified</td>
<td>KP-110</td>
<td>8.3</td>
<td>Small</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>++</td>
<td>0.05-5.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyether modified</td>
<td>KP-121</td>
<td>8.4</td>
<td>Medium</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>±</td>
<td>0.01-1.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyether modified</td>
<td>KP-118</td>
<td>8.4</td>
<td>Medium</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>±</td>
<td>0.01-1.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyether modified</td>
<td>KP-341</td>
<td>8.6</td>
<td>Medium</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>±</td>
<td>0.01-2.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyether modified</td>
<td>KP-112</td>
<td>8.7</td>
<td>High</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0.01-1.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyether modified</td>
<td>KP-125</td>
<td>8.7</td>
<td>Medium</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>±</td>
<td>0.01-1.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polystyrene modified</td>
<td>KP-101</td>
<td>8.7</td>
<td>High</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>0.01-1.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polystyrene modified</td>
<td>KP-106</td>
<td>8.9</td>
<td>Small</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>++</td>
<td>0.01-2.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polystyrene modified</td>
<td>KP-120</td>
<td>10.0</td>
<td>High</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>±</td>
<td>0.02-4.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Acrylic resin modified</td>
<td>KP-105</td>
<td>10.4</td>
<td>Medium</td>
<td>30 PGM²</td>
<td>-</td>
<td>-</td>
<td>++</td>
<td>0.05-10.0</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Acrylic resin modified</td>
<td>KP-104</td>
<td>11.6</td>
<td>Medium</td>
<td>30 PGM²</td>
<td>-</td>
<td>-</td>
<td>++</td>
<td>0.1-15.0</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Fatty acid ester modified</td>
<td>KP-611</td>
<td>9.2</td>
<td>High</td>
<td>50 Butyl acetate</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.1-10.0</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Phenyl modified</td>
<td>KP-327</td>
<td>7.7</td>
<td>Small</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.001-2.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Phenyl modified</td>
<td>KP-323</td>
<td>8.2</td>
<td>Small</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.002-0.5</td>
<td>Listed</td>
</tr>
<tr>
<td>Phenyl modified</td>
<td>KP-322</td>
<td>8.4</td>
<td>Medium</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.005-1.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Fluorine modified</td>
<td>KP-625</td>
<td>7.1</td>
<td>Small</td>
<td>5 DAA³</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.001-2.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Alkyl or Aralkyl modified</td>
<td>KP-623</td>
<td>8.5</td>
<td>High</td>
<td>10 Isododecane</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.002-4.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Alkyl or Aralkyl modified</td>
<td>KP-624</td>
<td>8.8</td>
<td>Medium</td>
<td>10 ECH⁴</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.001-2.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Alkyl or Aralkyl modified</td>
<td>KP-620</td>
<td>9.2</td>
<td>Medium</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.0002-0.4</td>
<td>Listed</td>
</tr>
<tr>
<td>Fluorine modified</td>
<td>KP-625</td>
<td>7.1</td>
<td>Small</td>
<td>5 DAA³</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.001-2.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Fluorine modified</td>
<td>KP-651</td>
<td>7.2</td>
<td>High</td>
<td>8 MXHF⁵</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.003-0.5</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyamide resin modified</td>
<td>KP-652</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.001-0.1</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyamide resin modified</td>
<td>KP-650</td>
<td>-</td>
<td>-</td>
<td>55 Water</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.001-0.2</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyamide resin modified</td>
<td>KP-310</td>
<td>7.4</td>
<td>Ultra high</td>
<td>10 Toluene</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.0005-2.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyamide resin modified</td>
<td>KP-109</td>
<td>8.2</td>
<td>High</td>
<td>50 PGM²</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.02-2.0</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Polyamide resin modified</td>
<td>KP-306</td>
<td>8.3</td>
<td>High</td>
<td>10 Xylene</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.1-1.0</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Polyamide resin modified</td>
<td>KP-301</td>
<td>8.7</td>
<td>Medium</td>
<td>10 Toluene</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.2-2.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyamide resin modified</td>
<td>KP-621</td>
<td>9.1</td>
<td>High</td>
<td>10 Toluene / Xylene</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.2-10.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyamide resin modified</td>
<td>KP-369</td>
<td>7.4</td>
<td>Small</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.05-2.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyamide resin modified</td>
<td>KP-368</td>
<td>7.4</td>
<td>Medium</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.05-2.0</td>
<td>Listed</td>
</tr>
<tr>
<td>Polyamide resin modified</td>
<td>KP-126</td>
<td>8.6</td>
<td>High</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.2-10.0</td>
<td>Listed</td>
</tr>
</tbody>
</table>

* ++ = Excellent  + = Good  ± = Satisfactory  - = Not applicable  
*¹ DAA = Diacetone alcohol  
*² PGA = Propylene glycolmonomethyl ether  
*³ ECH = Ethylcyclohexane  
*⁴ Acrylic resin (Polyester resin modified)  
*⁵ Acrylic resin (Polyamide resin modified)  

**Reference: SP values (solvents & polymers)**

*The SP values are reference values. Values may vary depending on calculation method.*

<table>
<thead>
<tr>
<th>Types of solvent</th>
<th>SP value</th>
<th>Boiling point °C</th>
<th>Silicone Solubility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isooctane</td>
<td>7.0</td>
<td>99</td>
<td>++</td>
</tr>
<tr>
<td>n-heptane</td>
<td>7.4</td>
<td>95</td>
<td>++</td>
</tr>
<tr>
<td>Diethyl ether</td>
<td>7.4</td>
<td>35</td>
<td>+</td>
</tr>
<tr>
<td>3-methoxy-3-methyl-butyl acetic acid</td>
<td>8.5</td>
<td>188</td>
<td>+</td>
</tr>
<tr>
<td>Methyl isobutyl ketone</td>
<td>8.4</td>
<td>116</td>
<td>+</td>
</tr>
<tr>
<td>Ethyl acetate-n-butyl</td>
<td>8.5</td>
<td>126</td>
<td>+</td>
</tr>
<tr>
<td>Propylene glycol monomethyl ether acetic acid</td>
<td>8.7</td>
<td>146</td>
<td>+</td>
</tr>
<tr>
<td>Xylene</td>
<td>8.8</td>
<td>138</td>
<td>++</td>
</tr>
<tr>
<td>Toluene</td>
<td>8.9</td>
<td>111</td>
<td>++</td>
</tr>
<tr>
<td>Ethyl acetate</td>
<td>9.1</td>
<td>77</td>
<td>+</td>
</tr>
<tr>
<td>Diacetone alcohol</td>
<td>9.2</td>
<td>168</td>
<td>+</td>
</tr>
<tr>
<td>Methyl ethyl ketone</td>
<td>9.3</td>
<td>80</td>
<td>+</td>
</tr>
<tr>
<td>Ethyleicosolvent</td>
<td>9.9</td>
<td>136</td>
<td>+</td>
</tr>
<tr>
<td>Acetone</td>
<td>10.0</td>
<td>56</td>
<td>+</td>
</tr>
<tr>
<td>Propylene glycol monomethyl ether</td>
<td>10.5</td>
<td>120</td>
<td>-</td>
</tr>
<tr>
<td>Tert-butanol</td>
<td>10.6</td>
<td>83</td>
<td>-</td>
</tr>
<tr>
<td>Isobutanol</td>
<td>11.0</td>
<td>107</td>
<td>+</td>
</tr>
<tr>
<td>n-butanol</td>
<td>11.1</td>
<td>118</td>
<td>+</td>
</tr>
<tr>
<td>Isopropyl alcohol</td>
<td>11.5</td>
<td>82</td>
<td>+</td>
</tr>
<tr>
<td>Dimethylformamide</td>
<td>12.0</td>
<td>153</td>
<td>-</td>
</tr>
<tr>
<td>Ethanol</td>
<td>12.8</td>
<td>78</td>
<td>-</td>
</tr>
<tr>
<td>Propylene carbonate</td>
<td>13.3</td>
<td>242</td>
<td>-</td>
</tr>
<tr>
<td>Ethylene glycol</td>
<td>14.2</td>
<td>198</td>
<td>-</td>
</tr>
<tr>
<td>Methanol</td>
<td>14.8</td>
<td>65</td>
<td>-</td>
</tr>
<tr>
<td>Water</td>
<td>23.4</td>
<td>100</td>
<td>-</td>
</tr>
</tbody>
</table>

*² Dimethyl silicone fluid has an SP value of 7.2, while the SP value of a methyl phenyl silicone fluid can be 9 or higher, depending on phenyl content.*

---

**Surface Modifiers for Coating**

**KP Series**

---

26
**KP Series Selection Guide, Arranged by Purpose**

*This map is offered as a guide for product selection.*

**For Solvent-based Paints**

- **Polyester Paints**
  - KP-626
  - KP-104
  - KP-105
- **Epoxy Paints**
  - KP-323
  - KP-623
  - KP-322
- **Alkyd Paints**
  - KP-626
  - KP-623
  - KP-624
- **Cellulose Paints**
  - KP-104
  - KP-105
  - KP-625
- **Urethane Paints**
  - KP-112
  - KP-118
  - KP-369
  - KP-625
- **Aromatic Solvent-based Paints**
  - KP-623
  - KP-323
  - KP-327
  - KP-626
- **Glycol Ethers Solvent-based Paints**
  - KP-112
  - KP-318
  - KP-109
- **Alcohol-based Paints**
  - KP-125
  - KP-101
  - KP-104

**All-round Product**

- **All-round Product**
  - KP-341

*To eliminate cissing, first try adding a smaller amount of product.

**Improved Anti-cissing Property**

- KP-611
- KP-120
- KP-620

**Improved Anti-forming Property**

- KP-623
- KP-625
- KP-620
(Add Additional KP-651, KP-652)

**Improved Leveling Ability**

- 2nd Option
  - KP-124
  - KP-106

- 1st Option
  - KP-341

**Improved Releasability**

- KP-369, KP-368
  - (For Urethanes)
- KP-611 (For Acrylics)

**Improve Releasability**

- KP-326

**Increase Slip Property**

- KP-109
- KP-101
- KP-105

**Reduce Slip Property**

- KP-624
- KP-106

**For Water-based Paints**

- **Imparting Anti-cissing Property**
  - KP-120

- **Standard Products**
  - KP-110
  - KP-106
  - KP-104 *

- **Imparting Anti-forming Property**
  - Additional amount KP-650

- **Increase Slip Property**
  - KP-109

- **Imparting Anti-cissing Property**
  - KP-104 *

  * KP-104: Works especially well with water-soluble resins such as Polyvinyl Alcohol.

**Ranking of Slip Agents**

- KP-341
- KP-301
- KP-105
- KP-305
- KP-369
- KP-368
- KP-310

*Low* - *Slick Property* - *High*
Surface Modifiers for Coating

Other Highly Functional Products

Ionic Silicone Oligomer X-40-2450

X-40-2450 is a silicone oligomer created through the silicone modification of an ionic liquid. When added in small amounts to resins, X-40-2450 migrates easily to the coating surface, improving its heat resistance, and provides long-lasting antistatic properties.

- **Resulting Properties**
  - Excellent antistatic agent

- **Test Result of Antistatic Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>X-40-2450</th>
<th>Ionic liquid*1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>4 x 10¹⁰</td>
<td>&gt; 10¹³</td>
</tr>
<tr>
<td>After water wiping test*2</td>
<td>1 x 10¹¹</td>
<td>&gt; 10¹³</td>
</tr>
<tr>
<td>After immersion test in water*3</td>
<td>3 x 10¹¹</td>
<td>&gt; 10¹³</td>
</tr>
<tr>
<td>After heating test*4</td>
<td>8 x 10¹¹</td>
<td>&gt; 10¹³</td>
</tr>
</tbody>
</table>

*1: After rubbing the cured specimen 50 times with wet absorbent cotton, wiped off remaining water and took the measurements.
*2: After submerging the cured specimen into water (25°C×5h), wiped off remaining water and took the measurements.
*3: Measured after heating the cured specimen (105°C×1 day).
*4: (n-C₈H₁₇)₃(CH₃)N⁺(CF₃SO₂)₂N⁻

- **General Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>X-40-2450</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form of silicone</td>
<td>Siloxane</td>
</tr>
<tr>
<td>Appearance</td>
<td>Colorless transparent liquid</td>
</tr>
<tr>
<td>Non-volatile content</td>
<td>% 55</td>
</tr>
<tr>
<td>Viscosity</td>
<td>mm/s 2.5</td>
</tr>
<tr>
<td>Specific gravity 25°C</td>
<td>0.97</td>
</tr>
<tr>
<td>Solvent</td>
<td>Methyl ethyl ketone</td>
</tr>
<tr>
<td>TSCA</td>
<td>Not Listed</td>
</tr>
</tbody>
</table>

- **Comparison of Antistatic Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface resistivity (Ω)</td>
<td>Untreated 1×10¹³, Treated &gt;10¹³</td>
</tr>
<tr>
<td>After water wiping test*2</td>
<td>Untreated 1×10¹³, Treated &gt;10¹³</td>
</tr>
<tr>
<td>After immersion test in water*3</td>
<td>Untreated 1×10¹³, Treated &gt;10¹³</td>
</tr>
<tr>
<td>After heating test*4</td>
<td>Untreated 1×10¹³, Treated &gt;10¹³</td>
</tr>
</tbody>
</table>

- **Mechanism of Silicone Action**

Photostabilizing Group Silane TMPS-E

TMPS-E is a silane coupling agent that contains photostabilizing groups. TMPS-E neutralizes free radicals formed through exposure to light, thus protecting resins against degradation.

- **Resulting Properties**
  - Improves UV resistance
  - Improves adhesion

- **General Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TMPS-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity at 25°C</td>
<td>mm²/s 8.0</td>
</tr>
<tr>
<td>Specific gravity at 25°C</td>
<td>0.95</td>
</tr>
<tr>
<td>Refractive index at 25°C</td>
<td>1.44</td>
</tr>
<tr>
<td>Active ingredient</td>
<td>% 100</td>
</tr>
<tr>
<td>TSCA</td>
<td>Not Listed</td>
</tr>
</tbody>
</table>

- **Chemical Structure of TMPS-E**

(EtO)₃SiO-\(\text{N}^+\)-(CH₃)N^+(CF₃SO₂)₂N^-

- **Reaction Mechanism**

- **Adhesion Test Data of Glass / Epoxy Resin Interface**

<table>
<thead>
<tr>
<th>Interface shear strength (Relative value)</th>
<th>Untreated</th>
<th>KBM-403</th>
<th>TMPS-E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>80</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>110</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>130</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>140</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>
Surface Modifiers for Coating

**Hydrophilic Anti-stain Agents KP-912, KP-913, KP-914**

KP-912, KP-913 and KP-914 are silicone oligomers that contain alkoxysilyl groups. When mixed with water, alkoxysilyl groups hydrolyze to form hydrophilic silanol groups, properties which allow these products to function as antifouling agents in paints for construction materials. KP-913 shows its hydrophilic properties earlier.

**●General Properties**

<table>
<thead>
<tr>
<th>Product name</th>
<th>Parameter</th>
<th>Alkoxy Groups</th>
<th>Viscosity at 25°C mm²/s</th>
<th>Refractive index at 25°C</th>
<th>Alkoxy group content wt%</th>
<th>TSCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>KP-912</td>
<td>Parameter</td>
<td>Methoxy / Ethoxy</td>
<td>12</td>
<td>1.414</td>
<td>50</td>
<td>Not Listed</td>
</tr>
<tr>
<td>KP-913</td>
<td>Parameter</td>
<td>Methoxy</td>
<td>350</td>
<td>1.448</td>
<td>9.5</td>
<td>Not Listed</td>
</tr>
<tr>
<td>KP-914</td>
<td>Parameter</td>
<td>Methoxy / Ethoxy</td>
<td>20</td>
<td>1.418</td>
<td>50</td>
<td>Not Listed</td>
</tr>
</tbody>
</table>

(Not specified values)

**●Antifouling Mechanism**

**●Hydrophilicity of Coatings with Oligomers Added**

![Water contact angle graph]

**Benzotriazole Group Silane X-12-1214A**

X-12-1214A contains a common corrosion inhibitor (benzotriazole) plus an alkoxysilyl group. By improved adhesion to metals, X-12-1214A helps ensure long-lasting protection against corrosion.

**●Resulting Properties**

- Protects metal against corrosion (Especially for copper, silver and aluminum)

**●General Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Product name</th>
<th>X-12-1214A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity at 25°C mm²/s</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>Active ingredient %</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>TSCA</td>
<td>Not Listed</td>
<td></td>
</tr>
</tbody>
</table>

(Not specified values)

**●Chemical Structure of X-12-1214A**

![Chemical structure]

**●Anti Rust Treatment on Copper plates**

**<Specimen preparation>**

1. Copper plate is cleaned to remove sulfur and washed with water.
2. Plate is immersed in a 1 wt% solution of benzotriazole or a silane coupling agent for 5 min.
3. Drying

**●Heat Resistance Test**

1. Plate was left in a constant temperature chamber at 150°C for 5 hours.
2. Copper plate surface is observed.

**●Sulfide Corrosion Test**

1. Plates were immersed in a 100 ppm Na₂S aqueous solution for 5 min.
2. After drying, plate surface is observed.

![Before and after photographs]

*BT: benzotriazole*
Silanes and silane coupling agents can be used as surface treatments for pigments and fillers to improve their compatibility with resins and improve adhesion.

### Product List

<table>
<thead>
<tr>
<th>Product category</th>
<th>Functional group</th>
<th>Product name</th>
<th>Chemical structure</th>
<th>Features</th>
<th>TSCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silane coupling agents</td>
<td>Alkenyl</td>
<td>KBM-1003</td>
<td>(MeO)₃Si</td>
<td>Vinyl silane, standard product</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>Epoxy</td>
<td>KBM-1083</td>
<td>(MeO)₃Si</td>
<td>Long-chain spacer type of KBM-1003</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KBM-403</td>
<td>(EtO)₃Si</td>
<td>Epoxy silane, standard product</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>Methacrylic</td>
<td>KBM-4803</td>
<td>(MeO)₃Si</td>
<td>Long-chain spacer type of KBM-403</td>
<td>Not Listed</td>
</tr>
<tr>
<td></td>
<td>Amines</td>
<td>KBM-503</td>
<td>(MeO)₃Si</td>
<td>Methacrylic silane, standard product</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KBM-5803</td>
<td>(MeO)₂Si</td>
<td>Long-chain spacer type of KBM-503</td>
<td>Not Listed</td>
</tr>
<tr>
<td></td>
<td>Alkoxy silanes</td>
<td>KBM-603</td>
<td>(MeO)₃Si</td>
<td>Diamino silane</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KBE-903</td>
<td>(EtO)₃Si</td>
<td>Monoamino silane</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KBM-6803</td>
<td>(MeO)₃Si</td>
<td>Long-chain spacer type of KBM-603</td>
<td>Not Listed</td>
</tr>
<tr>
<td></td>
<td>Alkyl</td>
<td>KBE-3063</td>
<td>(EtO)₃Si</td>
<td>Long chain alkyl (C6), ethoxy type</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KBE-3063</td>
<td>(MeO)₃Si</td>
<td>Long chain alkyl (C6), methoxy type</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KBE-3083</td>
<td>(EtO)₃Si</td>
<td>Long chain alkyl (C8), ethoxy type</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td>Fluoroalkyl</td>
<td>KBE-3103C</td>
<td>(MeO)₃Si</td>
<td>Long chain alkyl (C10), methoxy type</td>
<td>Listed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KBM-7103</td>
<td>(MeO)₃Si - CF₃</td>
<td>Fluorinated silane. Water repellency, oil repellency</td>
<td>Listed</td>
</tr>
</tbody>
</table>

### Fractured Composite Resin Compounded with Spherical Silica

- Silica Treated with KBM-503. Base Resin is Unsaturated Polyester.
- Untreated Silica

### Surface Treatment of Organic Filler with Long-chain Spacer Silane Coupling Agents

#### Evaluation of Inorganic Filler Dispersion

- **Product name**
- **Appearance**
- **KBM-5803**
- **KBM-503** (Conventional silane)

*Left: KBM-5803 by improving dispersibility, transparency was improved.*

#### Formulation

Silane treated silica 10wt%
Multifunctional acrylic compounds 90wt%
Spherical Silica Fine Particles are extremely small and have a narrow particle size distribution. Particle surfaces have been treated to be extra hydrophobic. The particles thus have excellent dispersibility, water repellency, lubricity, flow properties, and can be added to other powders, in a dry process, to improve those powder's performance. Spherical Silica Fine Particles can be used with organic pigments and fillers as well as inorganic ones.

**Product List**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Product name</th>
<th>QSG-100</th>
<th>QSG-80</th>
<th>QSG-30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>White powder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td>Spherical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average particle size (nm)</td>
<td>110</td>
<td>80</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Bulk density (g/cm³)</td>
<td>0.44</td>
<td>0.44</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>True specific gravity</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Specific surface area (m²/g)</td>
<td>25</td>
<td>40</td>
<td>143</td>
<td></td>
</tr>
<tr>
<td>Hydrophobicity (%)</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Production method</td>
<td>Sol-Gel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSCA</td>
<td>Listed</td>
<td>Listed</td>
<td>Listed</td>
<td></td>
</tr>
</tbody>
</table>

* The average particle size measured by dynamic light scattering (Laser Doppler)

**Adhesion on various surfaces by QSG-100**

- Metal Silicons
- Glass Frits
- Surface of Nylon
- Styrene Particle
Silicone Division
6-1, Ohtemachi 2-chome, Chiyoda-ku Tokyo, Japan

<Modified Silicone Fluids> <Silicone Powders> <Spherical Silica Fine Particles>

Sales and Marketing Department I
Phone : +81-(0)3-3246-5132 Fax : +81-(0)3-3246-5361

<Silicone Resins> <Silicone Oligomers> <Alkoxyasilanes> <Silane Coupling Agents> <KP Series>
Sales and Marketing Department II
Phone : +81-(0)3-3246-5131 Fax : +81-(0)3-3246-5361

Shin-Etsu Silicones of America, Inc.
1150 Damar Drive, Akron, OH 44305, U.S.A.
Phone : +1-330-630-9860 Fax : +1-330-630-9855

Shin-Etsu Silicone do Brasil Representação de Produtos Químicos Ltda.
Rua Coronel Oscar Porto, 736 11º Andar - 114/115 Paraíso São Paulo - SP Brasil CEP: 04003-003
Phone : +55-11-3939-0690 Fax : +55-11-3052-3904

Shin-Etsu Silicones Europe B. V.
Bolderweg 32, 1332 AV, Almere, The Netherlands
Phone : +31-(0)36-593170 Fax : +31-(0)36-5326459
Products & Services : Fluid products

Germany Branch
Rheingastraussere 190-196, 65203 Wiesbaden, Germany
Phone : +49-(0)611-962-5366 Fax : +49-(0)611-962-9266
Products & Services : Elastomer products

Shin-Etsu Silicone Taiwan Co., Ltd.
Hung Kuo Bldg. 11F-D, No. 167, Tun Hua N. Rd., Taipei, 10549 Taiwan, R.O.C.
Phone : +886-(0)2-2715-0055 Fax : +886-(0)2-2715-0066

Shin-Etsu Silicone Korea Co., Ltd.
GT Tower 15F, 411, Seecho-daero, Seecho-gu, Seoul 06615, Korea
Phone : +82-(0)2-590-2500 Fax : +82-(0)2-590-2501

Shin-Etsu Singapore Pte. Ltd.
4 Shenton Way, #10-03/06, SGX Centre, Singapore 068807
Phone : +65-6743-7277 Fax : +65-6743-7477

Shin-Etsu Silicones India Pvt. Ltd.
Flat No.712, 7th Floor, 24 Ashoka Estate, Barakhamba Road New Delhi 110001, India
Phone : +91-11-43623081 Fax : +91-11-43623084

Shin-Etsu Silicones (Thailand) Ltd.
7th Floor, Harinathorn Tower, 54 North Sathorn Road, Bangkok 10500, Thailand
Phone : +66-(0)2-632-2941 Fax : +66-(0)2-632-2945

Shin-Etsu Silicone International Trading (Shanghai) Co., Ltd.
29F Junyao International Plaza, No.789, Zhao Jia Bang Road, Shanghai 200032, China
Phone : +86-(0)21-6443-5550 Fax : +86-(0)21-6443-5868

Guangzhou Branch
B-2409, 2410, Shine Plaza, 9 Linhexi Road, Tianhe, Guangzhou, Guangdong 510610, China
Phone : +86-(0)20-3831-0212 Fax : +86-(0)20-3831-0207

● The data and information presented in this catalog may not be relied upon to represent standard values. Shin-Etsu reserves the right to change such data and information, in whole or in part, in this catalog, including product performance standards and specifications without notice.

● Users are solely responsible for making preliminary tests to determine the suitability of products for their intended use. Statements concerning possible or suggested uses made herein may not be relied upon, or be construed, as a guaranty of no patent infringement.

● The silicone products described herein have been designed, manufactured and developed solely for general industrial use only; such silicone products are not designed for, intended for use as, or suitable for, medical, surgical or other particular purposes. Users have the sole responsibility and obligation to determine the suitability of the silicone products described herein for any application, to make preliminary tests, and to confirm the safety of such products for their use.

● Users must never use the silicone products described herein for the purpose of implantation into the human body and/or injection into humans.

● Users are solely responsible for exporting or importing the silicone products described herein, and complying with all applicable laws, regulations, and rules relating to the use of such products. Shin-Etsu recommends checking each pertinent country’s laws, regulations, and rules in advance, when exporting or importing, and before using the products.

● Please contact Shin-Etsu before reproducing any part of this catalog. Copyright belongs to Shin-Etsu Chemical Co., Ltd.

“Shin-Etsu Silicone” is a registered trademark of Shin-Etsu Chemical Co., Ltd.

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

©Shin-Etsu 2016.3/2017.8②2.M.G.Printed in Japan

This is an edited version of the product data released on Aug. 2017.