Modified Silicone Fluids

Modified Silicone Fluids which bind various reactive groups exhibit a variety of properties by reacting with organic resin.

<table>
<thead>
<tr>
<th>Reactive groups</th>
<th>Types of resins</th>
<th>Thermoet resin</th>
<th>Thermoplastic resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino groups</td>
<td>Polyurethane</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Epoxy groups</td>
<td>Epoxy</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Hydroxyl groups</td>
<td>Carbinol type</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td></td>
<td>Diol type</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td></td>
<td>Polyether type</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td></td>
<td>Phenol type</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Methacryl groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carboxy groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercapto groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acidanhydride groups</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By blending few amounts of Silicone Master Pellets with resin, it is easy to obtain a compound in which the silicone is evenly dispersed.

Enhanced properties

- Lubricating property, Release property
- Anti-blocking property, Impact resistant
- Stress relaxation, Coloring property

**Silicone Master Pellets**

- Enhance properties
  - Lubricating property
  - Release property
  - Anti-blocking property
  - Impact resistant
  - Stress relaxation
  - Coloring property

**Silicone Content**

<table>
<thead>
<tr>
<th>Product name</th>
<th>Resin</th>
<th>Silicone content %</th>
<th>MFRg / 10mins</th>
<th>MFR Test condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-22-2101</td>
<td>Homo Polypropylene</td>
<td>50</td>
<td>33</td>
<td>210°C / 2.16kg</td>
</tr>
<tr>
<td>X-22-2125H</td>
<td>Low density polyethylene</td>
<td>50</td>
<td>20</td>
<td>190°C / 2.16kg</td>
</tr>
<tr>
<td>X-22-2138B</td>
<td>Ethylene vinyl acetate copolymer</td>
<td>40</td>
<td>5</td>
<td>190°C / 2.16kg</td>
</tr>
<tr>
<td>X-22-2102</td>
<td>Polycetal</td>
<td>40</td>
<td>55</td>
<td>190°C / 2.16kg</td>
</tr>
<tr>
<td>X-22-2184-30</td>
<td>ABS</td>
<td>30</td>
<td>45</td>
<td>220°C / 2.16kg</td>
</tr>
</tbody>
</table>

(Not specified values)

We can discuss the Silicone formulation with your preferred resin. Please do not hesitate to contact us.

Contact to → Sales and Marketing Department | Phone:+81-(0)3-3246-5132
Shin-Etsu has developed a unique line of silicone powders which fall into three categories: Hybrid Silicone Powder, Silicone Resin Powder and Silicone Rubber Powder.

**Hybrid Silicone Powder**
- Form: Rubber powders covered with resin
- KMP-600 by scanning with electron micro scope

**Silicone Resin Powder**
- Molecular structure: 3D network structure
- KMP-706 by scanning with electron micro scope

**Silicone Rubber Powder**
- Molecular structure: Straight-chain crosslinked polymer
- KMP-597 by scanning with electron micro scope

### Enhanced Properties

- **Stress Relaxation • Impact Resistance**
  - No additive
  - Siloxane rubber & Hybrid silicone powder
  - Resin & Coating

- **Lubricity • Wear Resistance**
  - Silicone rubber powder
  - Resin & Coating

- **Soft-feel Property**
  - Silicone rubber powder
  - Resin & Coating

- **Light Diffusion Property**
  - Silicone resin powder
  - Hybrid silicone powder

### General Properties

<table>
<thead>
<tr>
<th>Parameter</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</th>
<th>Refractive index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid silicone powder</td>
<td>KMP-600</td>
<td>Spherical powder</td>
<td>5</td>
<td>1-1.5</td>
<td>0.99</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
</tr>
<tr>
<td></td>
<td>KMP-601</td>
<td>Spherical powder</td>
<td>12</td>
<td>2.25</td>
<td>0.98</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
</tr>
<tr>
<td></td>
<td>KMP-602</td>
<td>Spherical powder</td>
<td>30</td>
<td>4.60</td>
<td>0.98</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
</tr>
<tr>
<td></td>
<td>KMP-605</td>
<td>Spherical powder</td>
<td>2</td>
<td>0.75</td>
<td>0.99</td>
<td>0.1</td>
<td>75</td>
<td>1.42</td>
</tr>
<tr>
<td></td>
<td>KMP-706</td>
<td>Spherical powder</td>
<td>0.8</td>
<td>0.2</td>
<td>1.02</td>
<td>0.1</td>
<td>75</td>
<td>1.42</td>
</tr>
<tr>
<td></td>
<td>KMP-701</td>
<td>Spherical powder</td>
<td>2</td>
<td>1.4</td>
<td>1.03</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>KMP-702</td>
<td>Spherical powder</td>
<td>2</td>
<td>1.4</td>
<td>1.03</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>KMP-703</td>
<td>Spherical powder</td>
<td>2</td>
<td>1.4</td>
<td>1.03</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Silicone resin powder</td>
<td>KMP-597</td>
<td>Spherical powder</td>
<td>5</td>
<td>1.1-10</td>
<td>0.97</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
</tr>
<tr>
<td></td>
<td>KMP-598</td>
<td>Spherical powder</td>
<td>13</td>
<td>2.3</td>
<td>0.97</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
</tr>
<tr>
<td></td>
<td>KMP-9729*</td>
<td>Spherical powder</td>
<td>13</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>X-52-1133*</td>
<td>Emulsion</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Aqueous dispersion of silicone rubber power. By drying spherical powders are obtained.

### Product Data

**Hybrid silicone powder**
- KMP-600 Particle size distribution
- KMP-600 Heat resistance (Weight changes vs. temperatures)

**Silicone resin powder**
- KMP-706 Particle size distribution
- KMP-706 Heat resistance (Weight changes vs. temperatures)

**Silicone rubber powder**
- KMP-597 Particle size distribution
- KMP-597 Heat resistance (Weight changes vs. temperatures)

### Dispersibility

**Silicone rubber powder**
- Hybrid silicone powder KMP-601

*Hybrid silicone powder*

*Applying a shearing force improves dispersibility of silicone rubber powders in resin.

*There are also aqueous dispersion of silicone rubber power.*

---

Contact to — Sales and Marketing Department I Phone:+81-(0)3-3246-5132
Long-Chain Spacer Silane Coupling Agents

With maximum freedom of functional group, Long-Chain Spacer Silane Coupling Agents improve reactivity. It improves flexibility and impact resistance in hybrid of resin and inorganic filler. And, with increased compatibility, it is possible to improve transparency of reactant in resin and inorganic filler, and high load inorganic filler into resins.

**Features**

- Increased hydrophobicity (Lipophilicity)
- Increased flexibility

**Applications**

- Organic / Inorganic adhesion improver

Glass/Epoxy, coupling performance evaluation

**Features**

- Increased hydrophobicity (Lipophilicity)
- Increased flexibility

**General Properties**

<table>
<thead>
<tr>
<th>Product name</th>
<th>Chemical name</th>
<th>Organic functional groups</th>
<th>Chemical structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>KBM-1083</td>
<td>7-Octenyltrimethoxysilane</td>
<td>Olefin</td>
<td><img src="image" alt="Chemical Structure" /></td>
</tr>
<tr>
<td>KBM-4803</td>
<td>8-Glycidoxyoctyltrimethoxysilane</td>
<td>Epoxy</td>
<td><img src="image" alt="Chemical Structure" /></td>
</tr>
<tr>
<td>KBM-5803</td>
<td>8-Methacryloxyoctyltrimethoxysilane</td>
<td>Methacrylic</td>
<td><img src="image" alt="Chemical Structure" /></td>
</tr>
<tr>
<td>KBM-6803</td>
<td>N-2-(aminoethyl)-8-aminoctyltrimethoxysilane</td>
<td>Amine</td>
<td><img src="image" alt="Chemical Structure" /></td>
</tr>
</tbody>
</table>

**Applications**

- Organic / Inorganic adhesion improver

Glass/Epoxy, coupling performance evaluation

**General Properties**

<table>
<thead>
<tr>
<th>Product name</th>
<th>Chemical name</th>
<th>Chemical structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-12-1056ES</td>
<td>3-(Triethoxysilyl)propyltrimethoxysilane</td>
<td><img src="image" alt="Chemical Structure" /></td>
</tr>
<tr>
<td>KBE-9103P</td>
<td>3-(Triethoxysilyl)N-(1,3 dimethyl-butyldiene) propylamine</td>
<td><img src="image" alt="Chemical Structure" /></td>
</tr>
<tr>
<td>X-12-967C</td>
<td>3-(Trimethoxysilyl)propylsuccinic anhydride</td>
<td><img src="image" alt="Chemical Structure" /></td>
</tr>
</tbody>
</table>

**Comparison of adhesion of X-12-1056ES and KBM-803(conventional grade)**

![Comparison of adhesion](image)

**Protected Functional Group Silanes**

Protected functional group silanes have protected organic reactive groups. With protected functional group silanes, creating 1 component materials, which were formerly 2 component materials, or simultaneously adding a reaction system is possible, but was difficult due to the reactivity of silanes. And protected functional group silanes exhibit highly improved storage stability.

**General Properties**

<table>
<thead>
<tr>
<th>Product name</th>
<th>Chemical name</th>
<th>Chemical structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-12-1056ES</td>
<td>3-(Triethoxysilyl)propyltrimethoxysilane</td>
<td><img src="image" alt="Chemical Structure" /></td>
</tr>
<tr>
<td>KBE-9103P</td>
<td>3-(Triethoxysilyl)N-(1,3 dimethyl-butyldiene) propylamine</td>
<td><img src="image" alt="Chemical Structure" /></td>
</tr>
<tr>
<td>X-12-967C</td>
<td>3-(Trimethoxysilyl)propylsuccinic anhydride</td>
<td><img src="image" alt="Chemical Structure" /></td>
</tr>
</tbody>
</table>

**Contact to**
Sales and Marketing Department II  Phone:+81-(0)3-3246-5131
Shin-Etsu Chemical developed 2 types of coupling agents (polymer type) containing a number of reactive organic groups.

1) Coupling Agents (Alkoxy Oligomer Type) which are partial hydrolysates of conventional coupling agent
2) Silane Coupling Agents (Multifunctional Group Type) with organic backbone

### Coupling Agents (Alkoxy Oligomer Type)

Owing to 100% of active ingredients, Coupling Agents (Alkoxy Oligomer Type) with siloxane back bone reduce generation quantity of alcohol. By choice of organic groups, it can achieve hydrophilic treatment on surfaces of coating as paint additives, or adapt adhesion (rework property) as additives for adhesive.

#### Features
- Partial hydrolysis condensation of silane coupling agent
- Large numbers of reactive functional groups with resins
- Film formulation property
- Low volatility

#### Structural model of alkoxy oligomers

![Structural model of alkoxy oligomers](image)

#### Silane Coupling Agents (Multifunctional Group Type)

Silane coupling agent with organic backbone contains a number of alkoxy groups and organic functional groups. Owing to a number of reaction points, the user can expect improved adhesion. It is useful for primer, since its primary component is low volatility and it has a film formulation property.

#### Features
- Hydrolyzable groups are trialkoxysilyl groups.
- Large numbers of reactive functional groups with resins
- Film formulation property
- Low volatility

#### Structural model of silane coupling agents (multifunctional group type)

![Structural model of silane coupling agents](image)
With its cyclic siloxane structure, KR-470 exhibits almost no shrinkage during curing. Its molecular structure is specified, meaning that reactions are easy to control. Cures with light or heat with the addition of an acid generator, acid anhydride, or amine-type catalyst. Excellent compatibility owing to low molecular weight.

**Features**

- When added in small amounts to resins, X-40-2450 migrates easily to the coating surface.

**General properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>X-40-9510</th>
<th>X-40-2450</th>
<th>X-40-2750</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of silicone</td>
<td>Silicone</td>
<td>Siloxane</td>
<td>Siloxane</td>
</tr>
<tr>
<td>Appearance</td>
<td>Clear, colorless liquid</td>
<td>Colorless, transparent liquid</td>
<td>Colorless, transparent liquid</td>
</tr>
<tr>
<td>Non-volatile content</td>
<td>99</td>
<td>55</td>
<td>99</td>
</tr>
<tr>
<td>Viscosity (mPa.s)</td>
<td>160</td>
<td>2.5</td>
<td>750</td>
</tr>
<tr>
<td>Solvent</td>
<td>None</td>
<td>None</td>
<td>MEK-1</td>
</tr>
<tr>
<td>Expected properties</td>
<td>Antistatic property, antistatic property, antistatic property,</td>
<td>Antistatic property, releasability, Antistatic property, releasability,</td>
<td>Antistatic property, releasability,</td>
</tr>
<tr>
<td>Application examples</td>
<td>Adding into coatings, dispersing into resins</td>
<td>Adding into coatings, dispersing into resins</td>
<td>Adding into coatings, dispersing into resins</td>
</tr>
</tbody>
</table>

**Silicone Oligomers Containing Alicyclic Epoxy Groups**

Silicone oligomers contain only epoxy groups as their reactive functional groups, and can be formulated to cure by way of an acid anhydride, photo-cationic or thermal-cationic curing system. Silicone oligomers cure by the same mechanisms as do epoxy resins, while offering excellent heat resistance and high Tg (glass-transition temperature) that are characteristic of siloxane bonds. The cyclosiloxane-based oligomers exhibit low shrinkage during curing.

**Features**

- With its cyclic siloxane structure, KR-470 exhibits almost no shrinkage during curing. Its molecular structure is specified, meaning that reactions are easy to control. Cures with light or heat with the addition of an acid generator, acid anhydride, or amine-type catalyst. Excellent compatibility owing to low molecular weight.

**General Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>KR-470</th>
<th>X-40-2678</th>
</tr>
</thead>
<tbody>
<tr>
<td>One point</td>
<td>Low cure shrinkage</td>
<td>(Improved crack resistance)</td>
</tr>
<tr>
<td>Numbers of Epoxy functional groups</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Viscosity</td>
<td>mPa.s</td>
<td>3,000</td>
</tr>
<tr>
<td>Epoxy equivalent</td>
<td>g/mol</td>
<td>220</td>
</tr>
</tbody>
</table>

**Comparison of cured material**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>KR-470</th>
<th>Epoxy</th>
<th>Alicyclic epoxy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cure system</td>
<td>Acid anhydride curing</td>
<td>Acid anhydride curing</td>
<td></td>
</tr>
<tr>
<td>Hardness Shore D</td>
<td>87</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Tensile modulus</td>
<td>MPa</td>
<td>2,500</td>
<td>2,040</td>
</tr>
<tr>
<td>Curing shrinkage</td>
<td>%</td>
<td>2.1</td>
<td>-1.7</td>
</tr>
<tr>
<td>Boiling water absorption ratio</td>
<td>%</td>
<td>0.46</td>
<td>0.28</td>
</tr>
<tr>
<td>Tg</td>
<td>°C</td>
<td>181</td>
<td>138</td>
</tr>
<tr>
<td>Coefficient of linear expansion</td>
<td>&lt; Tg</td>
<td>9.7</td>
<td>7.7</td>
</tr>
<tr>
<td>&gt; Tg</td>
<td>15.4</td>
<td>17.4</td>
<td>16.2</td>
</tr>
</tbody>
</table>
Silicone Oligomer Type Coatings

Silicone Oligomer Type Coating Agents contain alkoxyisilyl groups and cure at ambient temperatures and humidities with the use of a curing agent. They form very hard, glossy coatings that are highly resistant to heat and light, owing to their 3D siloxane structures.

Cross linking mechanism:

\[ 2 \text{Si-OH} + 2\text{ROH} \rightarrow \text{(Si-O-Si)} + \text{H}_2\text{O} \]

Model of after Curing

Contact to - Sales and Marketing Department II, Phone: +81-(0)3-3246-5131

Product & Catalyst line up

By using different types of silicone oligomers and curing agents, the user can obtain coatings that vary widely in their curing speed and hardness or flexibility.

Methyl Type

- Features: Water repellency, Excellent curability
- KR-251
- X-40-9250
- X-40-9246
- X-40-9225
- KR-500
- KR-515
- KC-898

Methyl / Phenyl Type

- Features: Gloss, Excellent flexibility
- KR-4001N
- KR-40-2027
- KR-500
- KR-9210
- KR-9210 (alcohol)

Catalyst Line Up

- Product name
- Type
- Addition amount
- Features
- D-20: Phosphoric acid
- D-20: Methyl silicone resin
- D-25: Titanium
- D-25: Methyl silicone resin
- D-20: Methyl silicone resin
- D-20: Methyl silicone resin
- D-20: Methyl silicone resin
- D-20: Methyl silicone resin

Formulation Example and Film Properties

- Parameter
- Product name
- Appearance
- Non-volatile content 105℃ × 3h
- Viscosity 25℃
- Specific gravity 25℃
- Acid value
- Solvent

Common methyl silicone resins
- Very hard film
- Easy to crack
- Heat cure is necessary

KR-251
- The coating film is hard to crack.
- Form the coating film by air drying
- Form the harder coating film by heating

Ultra High Molecular Weight Silicone Resin KR-251

KR-251 is a methyl silicone resin with a very high molecular weight. With KR-251, the molecular weight has been increased as much as possible without causing gelation.

Features

- Common methyl silicone resins
  - Very hard film
  - Easy to crack
  - Heat cure is necessary

- KR-251
  - The coating film is hard to crack.
  - Form the coating film by air drying
  - Form the harder coating film by heating

Model of Coating Structure

- Common grade silicone resin
  - Low molecular weight
  - Poor film forming properties when dried
  - Heat cure for Catalyst

- KR-251
  - High molecular weight
  - Forms a high quality film by air drying alone
  - Forms a harder coating. The collection of large molecules translates to excellent crack resistance, film forming ability, and toughness.

General property

- Parameter
- Appearance
- Non-volatile content 105℃ × 3h
- Viscosity 25℃
- Specific gravity 25℃
- Acid value
- Solvent

Film properties

- Curing condition
- Film thickness
- Pencil hardness
- Substrate: Polished steel sheet

Result: + = Excellent  ± = Satisfactory  − = Poor

*Substrate: Polished steel sheet, Cure conditions: 25℃ / 70% RH×7days (Tack-free time varies depending on temperature and humidity)
With very small average particle size, narrow distribution and its hydrophobized surface, Spherical Silica Fine Particles have a superior flowability, dispersion, water repellency and lubricity.

**Features**

- Narrow particle size distribution, monodisperse and no aggregation.
- Fine adhesion to various powders and it improves the flowability.

**General Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>QSG-170</th>
<th>QSG-100</th>
<th>QSG-90</th>
<th>QSG-80</th>
<th>QSG-30</th>
<th>QSG-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td></td>
<td>Spherica</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average particle size* (nm)</td>
<td>170</td>
<td>110</td>
<td>90</td>
<td>80</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Bulk density (g/cm³)</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.22</td>
<td>0.22</td>
</tr>
<tr>
<td>True specific gravity</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Specific surface area (m²/g)</td>
<td>16</td>
<td>25</td>
<td>30</td>
<td>40</td>
<td>150</td>
<td>160</td>
</tr>
<tr>
<td>Hydrophobicity, Methanol wettability (%)</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>72</td>
</tr>
<tr>
<td>Production method</td>
<td>Sol-Gel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

**Particle Size Distribution QSG-100**

**Adhesion State with Various Powders QSG-100**

- Metal silicons
- Glass frits
- Surface of Nylons
- Polyester particles
Silicone Division
Marunouchi Eiraku Bldg., 4-1, Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-0005, Japan

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< Modified Silicone Fluids, Silicone Master Pellets, Silicone Powders, Spherical Silica Fine Particles >

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This is an edited version of the product data released on Feb. 2019. https://www.shinetsusilicone-global.com/