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>Product name</th>
<th>QSG-10</th>
<th>QSG-30</th>
<th>QSG-100</th>
<th>QSG-170</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average particle size (nm)</td>
<td></td>
<td>10</td>
<td>30</td>
<td>110</td>
<td>170</td>
</tr>
<tr>
<td>Bulk density (g/cm³)</td>
<td></td>
<td>0.46</td>
<td>0.46</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>True specific gravity</td>
<td></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></td>
<td>172</td>
<td>143</td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>Hydrophobicity, Methanol wettability (%)</td>
<td></td>
<td>67</td>
<td>67</td>
<td>67</td>
<td>67</td>
</tr>
</tbody>
</table>

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

**Particle Size Distribution QSG-100**

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

[Contact to Sales and Marketing Department I Phone: +81-(0)3-3246-5132]
Silicones for Acrylic Resin Modification

Shin-Etsu can provide a number of products suitable for modification of various types of acrylic resins, including water-based, solvent-based and UV-cure products. These function in various ways and can be used to improve durability (by improving adhesion to substrates, light resistance and heat resistance), for surface modification (e.g. by imparting water repellency and increasing hardness), or for reducing viscosity or increasing fill factor (by improving dispersion of fillers).

Inorganic – Organic Coupling Agent (Alkoxyl groups + Acrylic groups)

**KBM-5103, KBM-503** Monomer Type

- **Chemical structure**
  - KBM-5103 (Acryloyl type)
    - \((\text{MeO})_3\text{Si}\)
  - KBM-503 (Methacryloyl type)
    - \((\text{MeO})_3\text{Si}\)

- **Features & Benefits**
  - High radical reactivity (especially the acrylics)
  - Higher strength and durability through improved adhesion

- **Comparison with other radically reactive silane coupling agents**
  - R (Functional groups) | Minimum curing dose
    - Vinyl | >10
    - Methacryloyl | 5
    - Acrylic | 2

*Silicones having aliphatic groups require smaller doses to cure completely than those with vinyl or methacryloyl groups, which is an indicator of their exceptionally high radical reactivity.

**KBM-5803** Long-chain Spacer Type

- **Chemical structure**
  - (MeO)3Si
  - Elongated Alkyl chain (C8)

- **Features & Benefits**
  - High number of functional groups, good reactivity
  - Improved durability

**X-12-1048, X-12-1050** Polymer type

- **Chemical structure**
  - Siliorganic chain

- **Features & Benefits**
  - High number of functional groups, good reactivity
  - Improved durability

**KR-513** Siloxane type

- **Chemical structure**
  - R = Me

- **Features & Benefits**
  - High number of functional groups, good reactivity
  - Improved durability

**Related materials (siloxane+acrylic groups)**

**X-12-2475 Siloxane Type**

- **Chemical structure**
  - \(-\text{Si} - \text{O} - \text{Si} - \text{O} - \text{Si} - \text{O} - \text{Si}\)

- **Features & Benefits**
  - High number of functional groups
  - High hardness
  - Durable against heat & light

**X-12-2430C Fluorine Contained Type**

- **Chemical structure**
  - \(=\text{Fluorine}\)

- **Features & Benefits**
  - Main chain of siloxane skeleton
  - Durable against heat & light

**Test result of higher hardness**

- **Product name** | **Pencil hardness** | **Taber abrasion test**
  - X-12-2475 | 3H | 2.5
  - X-12-2430C | 2H | 3.0
  - Blank | H | 4.5

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---

**Acrylic Coating Material Blend Ratio**

- **Open-cup flash temperature**: 94 °C, part
- **Heat-resistant acrylic**: 30 wt. %
- **Phenolic resin**
- **Acrylic resins**: 30 wt. %
- **Silica filler**: 40 wt. %

**Film Thickness**: about 2.5 μm

**Acrylic Coating Material Blend Ratio**

- **KBM-503 by improving dispersion, transparency was improved**

- **Formulation**
  - Some mixed silica 10wt% Multifunctional acrylic compounds 90wt%

---

**Formula**

\[
\text{Material A} + \text{Material B} + \text{Material C} + \text{Material D}
\]

**Note**

- Materials A, B, C, and D are acrylic resins.
- **Product name** | **Volatility content %**
  - X-12-1050 | 105°C<3h | 150°C<3h | 180°C<3h
  - KR-513 | 3 | 6 | 7
  - KBM-5103 | 71 | 100 | 100

---

**Acrylic Coating Material Blend Ratio**

- **Open-cup flash temperature**: 94 °C, part
- **Heat-resistant acrylic**: 30 wt. %
- **Phenolic resin**
- **Acrylic resins**: 30 wt. %
- **Silica filler**: 40 wt. %

**Film Thickness**: about 2.5 μm

**Acrylic Coating Material Blend Ratio**

- **KBM-503 by improving dispersion, transparency was improved**

**Formulation**

- Some mixed silica 10wt% Multifunctional acrylic compounds 90wt%
Silicones for Epoxy Resin Modification

Shin-Etsu can provide a number of products suitable for modification of various types of acrylic resins, including water-based, solvent-based and UV-cure products. These function in various ways and can be used to improve durability (by improving adhesion to substrates, light resistance and heat resistance), for surface modification (e.g. by imparting water repellency and increasing hardness), or for reducing viscosity or increasing fill factor (by improving dispersion of fillers).

Inorganic - Organic Coupling Agent (Alkoxyl groups + Epoxy groups)

| Features & Benefits | 
|---------------------|---
| **KBM-303, KBM-403 Monomer Type** | 
| Features | Benefits |
| Containing epoxy groups | Higher strength and durability through improved adhesion |

| Features & Benefits | 
|---------------------|---
| **KBM-4803 Long-chain Spacer Type** | 
| Features | Benefits |
| Improved hydrophobicity | Improved dispersion of inorganic fillers (enables lower viscosity, higher fill factors) |
| Improved flexibility | Imparting water and alkali resistance |

| Features & Benefits | 
|---------------------|---
| **X-12-981S, X-12-984S Polymer Type** | 
| Features | Benefits |
| High number of functional groups, good reactivity | Improved durability |
| High number of functional groups | Improved surface hardness |
| Low volatility, active ingredient functions | Active ingredient functions even at high temps. |
| Film forming properties | Also works well as a primer |
| Main chain of organic groups | Excellent compatibility |

| Features & Benefits | 
|---------------------|---
| **KR-516, KR-517 Siloxane type** | 
| Features | Benefits |
| High number of functional groups, good reactivity | Higher strength and durability through improved adhesion |
| Low volatility | Good reaction stability |
| Main chain of siloxane skeleton | Durable against heat & light |

| Features & Benefits | 
|---------------------|---
| **Related materials** | 
| Features | Benefits |
| Aliphatic epoxy groups | High reactivity, high Tg |
| Siloxane skeleton | Durable against heat & light |
| Cyclic siloxane structure | Low cure shrinkage |
| Single structure | Excellent compatibility makes it easy to control reactivity. |

| Features & Benefits | 
|---------------------|---
| **X-40-2670 Aliphatic epoxy silicone** | 
| Features | Benefits |
| High phenyl content | Excellent compatibility |
| Siloxane skeleton | Durable against heat & light |
| High molecular resin structure | Imparting flame retardancy |

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Silicone Powders

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.

**Enhanced Properties**

- **Stress Relaxation • Impact Resistance**
  - No additive: silicone rubber & hybrid silicone powder added
  - Resin & Coating: silicone rubber & hybrid silicone powder absorbs the pressure of impact and retains the shape.

- **Lubricity • Wear Resistance**
  - Hybrid powder: ++
  - Resin powder: +
  - Rubber powder: –

- **Soft-feel Property**
  - Hybrid powder: ++
  - Resin powder: –
  - Rubber powder: –

**General Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>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</th>
<th>Refractive index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hybrid silicone powder</td>
<td>KMP-600</td>
<td>Spherical powder</td>
<td>5</td>
<td>1–15</td>
<td>0.99</td>
<td>0.1</td>
<td>70</td>
<td>1.41</td>
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<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>70</td>
<td>1.41</td>
<td>1.43</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>70</td>
<td>1.41</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>KMP-605</td>
<td>Spherical powder</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>
<tr>
<td></td>
<td>X-52-100</td>
<td>Spherical powder</td>
<td>0.3</td>
<td>1–6</td>
<td>1.3</td>
<td>1</td>
<td>75</td>
<td>1.42</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>X-52-50</td>
<td>Spherical powder</td>
<td>0.7</td>
<td>0.5–2</td>
<td>1.3</td>
<td>1</td>
<td>75</td>
<td>1.42</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>KMP-597</td>
<td>Spherical powder</td>
<td>5</td>
<td>1–10</td>
<td>0.97</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
<td>1.43</td>
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<tr>
<td></td>
<td>Spherical powder</td>
<td>12</td>
<td>2–30</td>
<td>0.97</td>
<td>0.1</td>
<td>30</td>
<td>1.41</td>
<td>1.43</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X-52-575</td>
<td>Spherical powder</td>
<td>30</td>
<td>1–100</td>
<td>0.97</td>
<td>0.1</td>
<td>35</td>
<td>1.41</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>X-52-1125</td>
<td>Spherical powder</td>
<td>5</td>
<td>1–30</td>
<td>0.97</td>
<td>0.1</td>
<td>35</td>
<td>1.41</td>
<td>1.43</td>
</tr>
</tbody>
</table>

*There are also aqueous dispersion of silicone rubber powder.

*Aqueous dispersion of silicone rubber powder. By drying spherical powders are obtained. (Not specified values)

**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**

- **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.
UV Cure Silicone Products

UV Addition Cure Type Liquid Silicone Rubber KER-4690-A/B

KER-4690-A/B is a UV addition cure type liquid silicone rubber.

**Features**

- The material loses its stickiness and becomes non-flowable after a few minutes of UV exposure.
- Visible light to wavelength 250nm is transmissive before and after cured.
- In the curing process this material is curable under room temperature.
  
  User does not need to be concerned about volume expansion.

**General Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Grade</th>
<th>KER-4690-A</th>
<th>KER-4690-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td></td>
<td>Colorless transparent</td>
<td></td>
</tr>
<tr>
<td>Viscosity after mixed</td>
<td>mPa·s</td>
<td>3,000</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>g/ml</td>
<td>1.03</td>
<td></td>
</tr>
<tr>
<td>Hardness Durometer A</td>
<td>23℃</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>Elongation at break</td>
<td>%</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Tensile strength</td>
<td>MPa</td>
<td>7.9</td>
<td></td>
</tr>
<tr>
<td>Tear strength, crescent piece</td>
<td>kN/m</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Cure shrinkage</td>
<td>%</td>
<td>0.1</td>
<td></td>
</tr>
</tbody>
</table>

* Cure condition: UV2,000mJ/cm² (365nm) + 25℃ × 24h
  
  (Not specified values)

**Reducing curing time by heating**

UV Radial Cure Type Liquid Silicone Rubber KED Series

KED Series is a UV radical cure type liquid silicone rubber.

**Features**

- Rapid cure by UV irradiation
- Molding can be made owing to non-adhesive type.
- Product line-up with different hardness is prepared.
- Physical properties can be adjusted by mixing KED-1P and KED-2P.

**General Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Product name</th>
<th>KED-1P</th>
<th>KED-2P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>mm²/g</td>
<td>1,380</td>
<td>540</td>
</tr>
<tr>
<td>Refractive index</td>
<td></td>
<td>1,457</td>
<td>1,462</td>
</tr>
<tr>
<td>Hardness Durometer A</td>
<td></td>
<td>19</td>
<td>64</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>MPa</td>
<td>1.2</td>
<td>6.5</td>
</tr>
<tr>
<td>Elongation at break</td>
<td>%</td>
<td>2.30</td>
<td>3.10</td>
</tr>
<tr>
<td>Specific gravity at 25℃</td>
<td></td>
<td>1.044</td>
<td>1.056</td>
</tr>
</tbody>
</table>

* Cure conditions: 1. Pouring the sample into the case to make its thickness 2.0mm.
  2. Iradiating UV light under N₂ atmosphere from the both of the top of the sample and back.
  3. The amount of irradiating UV is 2,000mJ/cm² for each side.

(Not specified values)

Contact to:

Sales and Marketing Department IV
Phone:+81-(0)3-3246-5152

Silicone Division
6-1, Ohtemach 2-chome, Chiyoda-ku Tokyo, Japan

Shin-Etsu Chemical Co., Ltd.

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

Gunma Complex
ISO 9001 ISO 14001
(JQA-0094 JQA-E-0002)

Naetsu Plant
ISO 9001 ISO 14001
(JQA-0018 JQA-E-0064)

Takefu Plant
ISO 9001 ISO 14001
(JQA-0479 JQA-EM0298)

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