Vibro- SiL

SiLicon Vibration control products

Characteristic Properties

of Silicon Rubber Compounds
Characteristic Properties of Silicon vs other Rubber Compounds

**General properties of silicone**

**High binding energy**
The siloxane bonds (–Si–O–Si–) that form the backbone of silicone (dimethyl polysiloxane) are highly stable. At 433 kJ/mol, their binding energy is higher than that of carbon bonds (C–C), at 355 kJ/mol. Thus, compared to common organic polymers, silicone rubbers have higher heat resistance and chemical stability, and provide better electrical insulation.

- Heat resistance
- Flame retardancy
- Chemical stability
- Good weatherability
- Flame resistance
- Electrical properties

**Intermolecular force is low, and coil formation capacity is high.**
Silicone molecules are helical and intermolecular force is low, resulting in high elasticity, high compressibility, and excellent resistance to cold temperatures. Furthermore, the methyl groups located on the outside the coil structure can rotate freely. This characteristic gives silicone its distinctive interfacial properties, including water repellency and good realeasability.

- Water repellency
- Realeasability
- Cold resistance
- Good compressive characteristics

**Comparison of properties of various rubbers using natural rubber as a reference**

- Silicone rubber
- Ethylene propylene rubber
- Chloroprene rubber
- Fluoro-rubber
- Natural rubber

- Heat resistance
- Chemical stability
- Chemical resistance
- Electrical properties
- Flame retardancy
- Good weatherability
- Cold resistance
Silicone rubber withstands high and low temperatures far better than organic rubbers. Silicone rubber can be used indefinitely at 150°C with almost no change in its properties. It withstands use even at 200°C for 10,000 hours or more, and some products can withstand heat of 350°C for short periods. Silicone rubbers are thus suitable as a material for rubber components used in high temperature environments.

Silicone rubber also has excellent resistance to cold temperatures. The embrittlement point of typical organic rubbers is between -20°C and -30°C, compared to -60°C to -70°C for silicone rubbers. Even at temperatures at which organic rubbers turn brittle, silicone rubber remains elastic. Some products withstand extremely low temperatures of -100°C and below.

Generally speaking, silicone rubber hardens when heated in air, with decreasing elongation as it deteriorates; but in sealed conditions it softens as it deteriorates, and its operating life at high temperatures is shorter in sealed conditions than in air. This softening results from the degradation of the siloxane polymer. Adjusting the silicone rubber formula, using a different curing agent, and/or post-curing can help prevent softening in hot, sealed conditions. Such products are also available.

Even among general purpose silicone rubbers, heat resistance varies depending on the rubber formula, curing agent, and other factors.
Results of long-term outdoor exposure testing of various rubbers

<table>
<thead>
<tr>
<th>Rubber type</th>
<th>Location</th>
<th>Time until surface cracks are first apparent (years)</th>
<th>Time of sunlight exposure until elongation is 1/2 that of the initial value (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Panama</td>
<td>Rock Island</td>
<td></td>
</tr>
<tr>
<td>Styrene butadiene</td>
<td>2 - 3.5</td>
<td>Over 10 years</td>
<td>4</td>
</tr>
<tr>
<td>Nitrile</td>
<td>0.5 - 1</td>
<td>—</td>
<td>7</td>
</tr>
<tr>
<td>Chloroprene</td>
<td>—</td>
<td>—</td>
<td>8.5</td>
</tr>
<tr>
<td>Silicone (methyl vinyl)</td>
<td>Over 10 years</td>
<td>Over 10 years</td>
<td>Over 10 years to decline to 75%</td>
</tr>
<tr>
<td>Silicone (methylphenyl)</td>
<td>-</td>
<td>-</td>
<td>Over 10 years</td>
</tr>
<tr>
<td>Fluorosilicone</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Ethylene propylene</td>
<td>-</td>
<td>-</td>
<td>10 Over 8.5 years to decline to 75%</td>
</tr>
<tr>
<td>Fluorine</td>
<td>10</td>
<td>10</td>
<td>Over 10 years to decline to 90%</td>
</tr>
</tbody>
</table>
**Thermal conductivity**

The thermal conductivity of silicone rubber is about 0.2 W/m·K, a value higher than that of common organic rubbers. Some silicone rubbers contain a high proportion of special inorganic fillers to improve thermal conductivity (about 1.3 W/m·K), and these are used to make products including thermal interface sheets and heating rollers.

**Flame retardancy**

If silicone rubber is brought close to a flame, it will not ignite easily; but once ignited it will continue burning. It is possible to impart flame retardancy and/or self-extinguishing properties by adding a small amount of flame retardant. Some silicone rubber products have received UL94 V-0 certification according to the UL94 (USA) standards for flammability classification, shown at right. When they do burn, almost no black smoke or noxious gas is produced during combustion because these products contain none of the organic halogen compounds typically found in organic polymer rubbers. They are used in consumer electronics and business equipment; in closed spaces such as aircraft, subways, and building interiors. These silicone rubbers contribute to making all these environments safer.
Compression set

When using rubber materials for gaskets that will be under compression in heated conditions, the ability of these materials to recover from compression deformation is a crucial consideration. The compression set of silicone rubber is consistent over a wide temperature range, from -60° to +250°C. Although the compression set of typical organic rubbers is relatively low around room temperature, it increases significantly as temperatures rise. Silicone rubbers generally require post-curing. Post-curing and selection of a proper curing agent are particularly recommended when using silicone rubber to make molded items for which low compression set is desired.

Compression set at various temperatures (test conditions: 22 hours at each temperature)

Creep properties of rubbers* (temp.: 100°C)

- Natural rubber
- SBR rubber
- Chloroprene rubber
- Silicone rubber
- Fluoro-rubber
- Silicone rubber for low-temperature applications

Creep is the deformation of a plastic material under constant load. Typically, creep increases as temperature rises. Rubbers that are firm and have greater thermal stability tend to exhibit lower creep values at higher temperatures. Silicone rubber exhibits less creep than organic rubbers, and is more stable even than fluoro-rubber, which has good heat resistance.
Common silicon rubber (dimethyl silicone rubber) really has no better radiation resistance than other organic rubbers. Methylphenyl silicone rubber, which features phenyl groups added to the polymer molecules, resists radiation and is used in the manufacturing of the cables and connectors used in nuclear power plants.

Silicone rubber with added phenyl groups has the same fine heat resistance, electrical insulating properties, flame retardancy and chemical resistance intrinsic to other silicone rubbers.

Radiation resistance of rubbers

- Can be used safely
- Can be used normally
- Can be used only for limited applications

Radiation resistance of silicone rubber

- Methyl vinyl phenyl silicone rubber containing 12 mol% phenyl groups
- Methyl vinyl phenyl silicone rubber containing 5 mol% phenyl groups
- Methyl vinyl silicone rubber

- Methyl vinyl phenyl silicone rubber containing 12 mol% phenyl groups
- Methyl vinyl phenyl silicone rubber containing 5 mol% phenyl groups

At high temperatures, although natural rubber and other organic rubbers show a decline in performance due to thermal degradation, silicone rubber resists radiation even at high temperatures of 300°C to 350°C.
**Vibration absorption**

The loss modulus (tan δ) of silicone rubber is generally low, making it ill-suited for use as a vibration insulator. Products with enhanced vibration absorption performance, however, absorb vibration consistently over a wide temperature range, from -50°C to +100°C.

**Temperature dependence of vibration absorption of rubbers**

![Graph showing the temperature dependence of vibration absorption for different rubbers.](image)

- **Vibration-absorbing silicone rubber KE-5560**
- **Butyl rubber**
- **Natural rubber**
- **SEP rubber**
- **General purpose silicone rubber KE-951**

The loss modulus (tan δ) is expressed by the following equation:

\[
\tan \delta = \frac{G''}{G'}
\]

where \(G''\) is the loss modulus, \(G'\) the storage modulus.

The larger the value of tan δ, the greater the ability of a particular material to absorb energy (vibration, etc.).

Source: [www.silicon.jp](http://www.silicon.jp)
Silicone Sponge and Silicone Rubber Gaskets, Seals, Cushions, and Materials

Why Use Silicone Rubber?
Silicone rubber has the combined properties of resilience, high temperature stability, and general inertness, unavailable in any other elastomer. Silicones are generally unaffected by extended exposure to temperatures from -100° to 500°F, and are also resistant to aging and degradation from sunlight and ozone.

Material Properties of Silicone Rubber

Long Term Compression Set Resistance
Properly designed Silicone Foam and Silicone Sponge outdoor enclosure gaskets can effectively seal out wind driven rain and dust — helping the designer meet NEMA enclosure and IP specifications. Unlike most organic elastomers such as EPDM and neoprene, silicone maintains its resiliency over a broad temperature range and resists taking a permanent compression set.

Flame Retardant Capabilities
Silicone Rubber can be compounded to be flame retardant and achieve UL 94V0, UL94V1 and UL 94HF1 certifications. Flame retardant closed cell silicone sponge and silicone foam gaskets are used in analytical instrumentation, telecommunications equipment and controls used in Mass Transit systems. Even when silicone rubber burns under extreme temperatures, the by-products are non-toxic and any residual ash continues to provide electrical insulation properties.

FDA Regulations
Silicone Rubber can be compounded using ingredients that meet FDA regulations for properties such as high tear strength and flexing using platinum based catalysts. These silicone products are often specified for healthcare, instrumentation, food processing and medical diagnostic equipment applications.

Electrical Conductivity
Silicone Rubber can be blended with nickel-graphite or silver plated aluminum particles for electrically conductive gaskets that provide EMI (electro-magnetic interference) shielding for electronic communication equipment. Conductive silicone is available in sheets or custom molded shapes.

ESD (Electro-Static Discharge)
Solid silicone rubber can be blended with semi-conductive carbon for ESD properties. Further, closed cell silicone sponge will accept a surface coating of conductive silicone for soft gaskets and pads with ESD grounding properties.

Thermal Conductivity
Silicone Rubber can be blended with ceramic powders such as alumina and boron nitride for thermal interface pads that help to dissipate heat from power generating devices in electronics. Thermal interface pads are typically fabricated from gel based silicones which are very soft and conformable.

Silicone — The Versatile Elastomer
The designer has a wide range of choices when selecting silicone rubber gasketing and cushioning materials.
- Solid silicone rubber is available in sheets or continuous rolls from .010" thick to .500" thick, and hardness from 10 Shore A to 80 Shore A. Molding compounds — especially liquid silicones — are readily pigmented to match color chips or Pantone color designations.
- Closed cell silicone sponge and silicone foam is available in continuous rolls from .032" thick to .500" thick and densities ranging from ultra soft to extra firm.
- Silicone Rubber is available in a broader range of firmness and densities than any other engineering elastomer.
- Fuel, oil and chemical resistant fluoro-silicone is also available.

COHPlastic® is a Registered Trademark of CRH Industries, a unit of St. Gobain Performance Plastics
Biso™ Silicones are produced by Rogers Corporation

Stockwell Elastomerics - On-Site Production Capabilities
Stockwell Elastomerics has chosen to develop broad production capabilities for in-house, fast turn manufacturing of prototypes and low-to-mid volume production runs to serve the needs of customers in the Technology Equipment Sector. This broad range of capabilities enables multiple approaches in solving design challenges and supporting initial production requirements. Stockwell Elastomerics’ on-site manufacturing capabilities include:
- Compression Rubber Molding of Silicone, Fluoro-silicone and other specialty elastomers
- Injection Molding of Liquid Silicone Rubber into Gaskets and Components
- Water Jet Cutting of Gaskets from Silicone Foam, Silicone Sponge and Solid Silicone
- Die Cutting of Gaskets, Cushioning Pads and Insulators
- Application of Pressure Sensitive Adhesives onto Silicone Rubber
- Custom Laminations and Bonded Assemblies of Silicone Foam, Sponge and Solid
- Slitting to Width of Roll Materials into Adhesive Backed Silicone Foam Gasketing

Stockwell Elastomerics Can Help with Material Selection and Design
Stockwell Elastomerics stocks a full inventory of COHPlastic® solid and sponge silicone rubber and Biso™ silicone foam and cast liquid silicone rubber. And Stockwell Elastomerics has teamed up with several other manufacturers of silicone compounds and products to provide a broad selection of additional silicone materials.

For new product applications, Stockwell Elastomerics has developed this material selection guide to help determine the best material options to meet new product performance demands.

Need prototypes cut from silicone sheet material? Send a dxf file to service@stockwell.com for water jet cut samples.
## MATERIAL PROPERTIES

<table>
<thead>
<tr>
<th>Gel Type / Unit</th>
<th>A</th>
<th>B</th>
<th>1</th>
<th>7</th>
<th>5</th>
<th>6</th>
<th>8</th>
<th>Remark</th>
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<tbody>
<tr>
<td>Appearance</td>
<td>Transparent</td>
<td>White</td>
<td>Translucent</td>
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<td>Translucent</td>
<td>Translucent</td>
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<tr>
<td>Hardness</td>
<td>Needle Penetration (100g) (10) 150 100 - 100 55 - - JIS K 2207</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Asker C2</td>
<td>-</td>
<td>-</td>
<td>8-12</td>
<td>-</td>
<td>-</td>
<td>33</td>
<td>52.5</td>
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<td>Shore A Equivalent (appx)</td>
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<td>10</td>
<td>-</td>
<td>10</td>
<td>14</td>
<td>26</td>
<td>26</td>
<td>-</td>
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<tr>
<td>Specific Gravity</td>
<td>0.98</td>
<td>0.56</td>
<td>1.00 - 1.06</td>
<td>1.06</td>
<td>1.05</td>
<td>1.06</td>
<td>1.07</td>
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<tr>
<td>Tensile Strength</td>
<td>0.03</td>
<td>0.14</td>
<td>1.0</td>
<td>0.23</td>
<td>1.17</td>
<td>1.58</td>
<td>2.35</td>
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<tr>
<td>Elongation %</td>
<td>340</td>
<td>220</td>
<td>800</td>
<td>480</td>
<td>710</td>
<td>480</td>
<td>300</td>
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<td>Young Modulus (kPa)</td>
<td>28.9</td>
<td>150.7</td>
<td>150.2</td>
<td>37.5</td>
<td>119.4</td>
<td>670.3</td>
<td>1432.6</td>
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<tr>
<td>Specific Heat (kJ/K)</td>
<td>1.55</td>
<td>1.61</td>
<td>1.5</td>
<td>1.51</td>
<td>1.52</td>
<td>1.51</td>
<td>1.52</td>
<td>DSC</td>
</tr>
<tr>
<td>Thermal Conductivity (W/m.K)</td>
<td>0.18</td>
<td>0.10</td>
<td>0.80</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
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<tr>
<td>Specific Volume Resistance Ratio (GOhm.cm)</td>
<td>2.1 * 10^14</td>
<td>3.7 * 10^12</td>
<td>5.0 * 10^12</td>
<td>2.9 * 10^14</td>
<td>4.0 * 10^14</td>
<td>6.0 * 10^14</td>
<td>6.6 * 10^14</td>
<td>-</td>
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<tr>
<td>Dielectric Breakdown Strength (kV/m)</td>
<td>16.7</td>
<td>17.1</td>
<td>20.0</td>
<td>18.3</td>
<td>15.1</td>
<td>18.4</td>
<td>18.7</td>
<td>JIS K 2110</td>
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<tr>
<td>Chemical Resistance</td>
<td>Toluene</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
<td></td>
<td>Acetone</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Methanol</td>
<td>O</td>
<td>X</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Distilled H2O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Fuel</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Lubricant</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>NaCl (10%)</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
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<tr>
<td></td>
<td>HCl (10%)</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>NaOH (5%)</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Normal Temperature Range (°C)</td>
<td>-40 to 200</td>
<td>-40 to 120</td>
<td>-40 to 200</td>
<td>-40 to 200</td>
<td>-40 to 200</td>
<td>-40 to 200</td>
<td>-40 to 200</td>
<td>-</td>
</tr>
</tbody>
</table>

(1) The needle depth into the gel represents the hardness.
(2) Rubber Hardness Meter. Hardness is represented by rebounding distance when needle contacts the gel surface.

Properties of Silicon Rubber Compound

www.vibro.gr

ALPHA ACOUSTIKI Ltd
TYPICAL CHARACTERISTICS OF SILICON VS RUBBER VIBRATION MOUNTS

<table>
<thead>
<tr>
<th></th>
<th>Silicone</th>
<th>Rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resonance point</td>
<td>9.5 hZ</td>
<td>19.9 hZ</td>
</tr>
<tr>
<td>Resonance magnification</td>
<td>16.3 dB</td>
<td>18.5 dB</td>
</tr>
</tbody>
</table>

Source: GELMEC SA
**Vibro-mini.SiL**

**SILICON ANTIVIBRATION SUPPORTS**

**APPLICATIONS**
The silicon anti-vibration supports *Vibro-mini.SiL* can offer vibration protection for compressors, pumps, fans, muffler hanger, on-board computers and other sensitive electronic equipment, in avionic military and medical applications where a wide temperature range (-40 to +200°C) occurs. Suitable for food-industry applications.

*Note: Must be only used in compression.*

**DESCRIPTION**
- The *Vibro-mini.SiL* provides an effective shock and vibration isolation protection, as well as structure-borne noise reduction.
- It can achieve a large deflection capacity and a low resonance point. It is an ideal selection for mid and low frequency excitations.
- It offers very good weathering properties, ozone UV resistant, ideal for out-door use.
- It’s softer than traditional rubber and thermoplastic compounds.

**TECHNICAL CHARACTERISTICS**
- Wide operating temperature range: -40 to +200°C providing stable performance
- Very low compression set
- Long term durability and stability
- Applicable for light loads
- Environment-friendly. No harmful additives are contained
- Low odor
- Deflection (at maximum load) : 4 mm
- Natural Frequency: ≥ 15 Hz.

**LOAD CAPACITY**

<table>
<thead>
<tr>
<th>Type</th>
<th>Color Code</th>
<th>Maximum Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>mini – SiL.10</td>
<td>Natural (cream)</td>
<td>10 Kp*</td>
</tr>
<tr>
<td>mini – SiL.25</td>
<td>Red</td>
<td>25 Kp*</td>
</tr>
</tbody>
</table>

**EXAMPLE OF APPLICATION**

*Design and Production according to International Standard ISO 9001.2008.*