Effects of fillers on the properties of liquid silicone rubbers (LSRs)

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1.2.3 Effects of fillers on the properties of liquid silicone rubbers (LSRs)

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Effects of Fillers Depend On

- **Particle Size**
  - >10μm: Degradants
  - 1-10μm: Diluents
  - 0.1-1μm: Semi-reinforcing
  - 0.01-0.1μm: Reinforcing

- **Particle Surface Area**
  - Bigger is Better

- **Particle Shape**
  - Broader (and Longer) is Better

- **Particle Surface Activity**
  - (Compatibility With/Adhesion To Matrix)
  - More is Better

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Particle Shape

- Broader (and Longer) is Better
  - Platy
  - Fiber
  - Cluster

Particle Surface Activity

- More is Better
  - Poor contact
  - Good contact
  - Bonded
  - Matrix wetting
  - Matrix adhesion

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Particle Size

- Smaller is Better

Particle Surface Area

- Bigger is Better

size \downarrow \text{surface area}
SiO$_2$ reinforces the networks with no increase in permittivity ($\varepsilon_{r, \text{SiO}_2} \sim 3.9$).

The inhomogeneous compatibility of the unmodified multiwalled carbon nanotubes (MWCNTs) causes the risk of conductivity.

Micron-sized CaCu$_3$Ti$_4$O$_{12}$ CCTO ($\varepsilon_{r, \text{CCTO}} \sim 10000$) decreases the mechanical properties of the composites.
### Effects of fillers on the properties of liquid silicone rubbers (LSRs)

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**TiO₂**

**Rutile** \( \varepsilon_r : 114-180 \)

**Hydrophobic**: modified polysiloxane

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**Nano-sized**: 25-250nm

**Spherical particle**

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<table>
<thead>
<tr>
<th></th>
<th>Tear strength (N/mm)</th>
<th>Relative permittivity ( \varepsilon_r @ 0.1\text{Hz} )</th>
<th>Young’s modulus Y (MPa)</th>
<th>Breakdown strength (V/μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSR</td>
<td>6.6</td>
<td>2.8</td>
<td>0.8</td>
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</tr>
<tr>
<td>LSR/TiO₂</td>
<td>20</td>
<td>5.5</td>
<td>1.0</td>
<td>150</td>
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