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
  - Platy
  - Isometric
  - Fiber
  - Acicular
  - Cluster

Particle Surface Activity
- More is Better
  - Poor contact
  - Good contact
  - Bonded
  - Matrix wetting
  - Matrix adhesion

Particle Size
- Smaller is Better

Particle Shape
- Broader (and Longer) is Better

Particle Surface Activity
- More is Better

Particle Surface Area
- Bigger is Better

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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$_{12}$ \textbf{CCTO} ($\varepsilon_{r,\text{CCTO}} \sim 10000$) decreases the mechanical properties of the composites.
1.2.3 Effects of fillers on the properties of liquid silicone rubbers (LSRs)

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<table>
<thead>
<tr>
<th></th>
<th>Tear strength (N/mm)</th>
<th>Relative permittivity $\varepsilon_r$ @ 0.1Hz</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>
<td>130</td>
</tr>
<tr>
<td>LSR/TiO$_2$</td>
<td>20</td>
<td>5.5</td>
<td>1.0</td>
<td>150</td>
</tr>
</tbody>
</table>

Nano-sized: 25-250nm
Spherical particle

Rutile $\varepsilon_r$: 114-180
Hydrophobic: modified polysiloxane

TiO$_2$ Rutile
ε$_r$: 114-180

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Spherical particle

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ε$_r$: 114-180

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