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
- Matrix wetting
- Matrix adhesion
- Poor contact
- Good contact
- Bonded

Particle Size
Smaller is Better

Particle Surface Area
Bigger is Better
SiO₂ reinforces the networks with no increase in permittivity ($\varepsilon_{\text{rSiO}_2} \sim 3.9$).

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

Micron-sized CaCu₃Ti₄O₁₂ CCTO ($\varepsilon_{\text{rCCTO}} \sim 10000$) 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 $\varepsilon_r @ 0.1\text{Hz}$</th>
<th>Young’s modulus Y (MPa)</th>
<th>Breakdown strength (V/\text{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

Nano-sized: 25-250nm
Spherical particle