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
- Smaller is Better
- Bigger is Better

Particle Shape
- Broader (and Longer) is Better
- Platy
- Isometric
- Fiber
- Acicular
- Cluster

Particle Surface Activity
- (Compatibility With/Adhesion To Matrix)
- More is Better
- Poor contact
- Good contact
- Bonded
- Matrix wetting
- Matrix adhesion
SiO$_2$ reinforces the networks with no increase in permittivity ($\varepsilon_{r_{SiO2}} \sim 3.9$).

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

Micron-sized CaCu$_3$Ti$_4$O$_{12}$ CCTO ($\varepsilon_{r_{CCTO}} \sim 10000$) decreases the mechanical properties of the composites.

Polymer with chemical crosslinks (red) forms a filled, elastic network.
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Nano-sized: 25-250nm
Spherical particle

Rutile $\varepsilon_r : 114-180$

Hydrophobic: modified polysiloxane

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