OPTICAL SILICONE – Liquid Silicone Rubber (LSR)

Physical and mechanical properties: Silicone Rubber is an elastomer composed of silicone—itself a polymer—containing silicon together with carbon, hydrogen, and oxygen. In its uncured state, silicone rubber is a highly-adhesive gel or liquid. In order to convert to a solid, it must be cured, vulcanized, or catalyzed. The optical grade of LSR is the purest one, clear and transparent. The main mechanical and physical properties and advantages of optical LSR are:

- Lighter than glass and many other plastics, keeping the overall weight of a product down (density around 1 gr/cm3).
- More flexible than glass but stiffer than other plastics, which reduces the risk of breaking, particularly when exposed to continuous vibrations or other stresses.
- It is almost as transparent as the best glass across both visible and UV spectra. Caution should be taken in powerful UV application though (less than 3 W/cm² at 365 nm).
- It does not discolor or lose transparency with age (in recommended conditions, *i.e.* clean and dry environment) or with exposure to heat or UV (until a certain amount).

The refractive index can be between 1.4 and 1.6, and the Shore A hardness can be chosen between 60 and 90.

Chemical properties: Water absorption is inferior to 0.1%. However, the surface is quite sticky and can become opaque due to dust, so products should remain protected if possible. In comparison with other rubber materials, LSR is exceptionally compatible with many diluted solutions of inorganic acids and bases (e.g., acetic acid, arsenic acid, boric acid, sulfuric acid, tartaric acid). Extending the variety of uses of LSR products, such as hosing and seals, to the medical, food manufacturing, and automotive industries, LSR can be used as a propellant in food products, as filler for vehicle airbags or for silicone prototyping. The extensive list of LSR-compatible materials also includes ammonium hydroxide, ammonium phosphate, and alcohol bases, which are common ingredients of many household products. However, it should not be used with a certain amount of common chemicals. For a complete list, please refer to the manufacturer or Gaggione. On the main lines, it concerns many solvents (Acetone), oil, concentrated acids or dilute sodium hydroxide.

Electrical properties: Silicone-based elastomers are widely used in dielectric elastomer formulation due to their favorable electro-mechanical properties. Dielectric elastomers which consist of an elastomer film with deposited electrodes on both sides have lately gained increased interest as materials for actuators, generators, and sensors.

Thermal properties: The main advantage of optical LSR is its incomparable resistance to high temperature (> 150°C) whereby PC (130°C) and PMMA (90°C) breakdown. The other side of the coin is that it possesses a quite high thermal expansion coefficient (3 mm expansion for a 10 °C gradient on a 1-meter bar), 5 times higher as the one of optical thermoplastics. As these latter, LSR is combustible and burns without producing an excessive amount of smoke (UL 94 HB).

Printing and marking properties: Optical LSR is suitable for silk-screening, but is still under tests for vacuum metallization, the issue coming from its high deformation with temperature changes.

Implementation properties:

- Injection: The very high fluidity of LSR, way higher than optical thermoplastics', makes it possible for design and injection of complex parts, than can contain undercuts or micro-structures.
- Machining: The softness of silicone makes it a complicated material to machine.
- Gluing and welding: As the surface energy of silicone is very high, it is very easy to make it adhere to other materials, by plenty of means.

Summary by GAGGIONE SAS
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