POL-O/425M-E
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SUPRASIL®311 and 312

1. GENERAL PRODUCT DESCRIPTION

Heraeus SUPRASIL 311 and 312 are high purity synthetic fused silica materials manufactured by flame hydrolysis of $SiCl_4$. They combine excellent physical properties with outstanding optical characteristics in the deep UV to the near IR. The most prominent property is the high degree of index homogeneity which is controlled and specified either in one direction (the direction of use or functional direction) or even in all three dimensions. In addition, the materials provide optimum resistance to damage by high energy UV laser radiation, especially Excimer lasers.

All synthetic fused silica SUPRASIL grades are practically free from bubbles and inclusions.

The optical homogeneity, which is the main criteria for very low transmitted wavefront distortion, refers to two categories:

- SUPRASIL 311 is an optically isotropic 3D-material. It is highly homogeneous and has no striations in all three dimensions. These properties are very important for multiple axis optics such as prisms, steep lenses, beam splitters or etalons.

- SUPRASIL 312 is homogeneous in the primary functional direction. Weak striations, if any, are parallel to the major faces and do not affect the optical performance.

SUPRASIL 311 and 312 are the preferred materials for UV-microlithography, interferometry, beam splitters, special laser, vacuum UV applications, high quality retroreflectors and prisms, etc. In the DUV, SUPRASIL 311 and 312 show the highest transmission of all SUPRASIL grades.

For general technical data please refer to our data sheet POL-O/107E "Quartz Glass for Optics - Data and Properties".

2. OPTICAL DATA OF SUPRASIL 311 and 312

2.1 Bubbles and Inclusions

(Bubbles ≤ 0.08 mm diameter are disregarded)

2.1.1 Bubble class : better than 0 (as per DIN 58927 2/70)

i. e. total bubble cross section within the volume is ≤ 0.03 mm^2/100 cm^3.

2.1.2 Maximum bubble diameter

SUPRASIL 311	:	≤ 0.1 mm	for pieces ≤ 6 kg
SUPRASIL 312	:	≤ 0.15 mm	for pieces ≤ 6 kg
		≤ 0.25 mm	for pieces > 6 - 30 kg

2.1.3 Inclusions : None

2.1.4 Spots : None

2.2 Refractive Index and Dispersion

2.2.1 Refractive Index

n_C = 1.45637 at 656.3 nm
n_d = 1.45846 at 587.6 nm
n_F = 1.46313 at 486.1 nm
n_g = 1.46669 at 435.8 nm
n = 1.50855 at 248 nm

At 20°C, 1 bar atmospheric pressure
Accuracy: $\pm 3 \bullet 10^{-5}$

2.2.2 Dispersion

$n_F - n_C = 0.00676$

$$n_d = \frac{n_d - 1}{n_F - n_C} = 67.8 \pm 0.5$$

2.3 Optical Homogeneity

2.3.1 Granular Structure: None

2.3.2 Striations

SUPRASIL 311 : In all three dimensions free from striations, i.e. better than grade A, MIL-G-174-B.

SUPRASIL 312 : In primary functional direction free from striations, i. e. grade A, MIL-G-174-B; weak striations, if any, are parallel to the major faces.

2.3.3 Index Homogeneity

Specified across 90% of diameter or sidelength for machined parts, respectively 80% for raw formed ingots.

SUPRASIL 311 : In all three dimensions guaranteed total $\Delta n \leq 3 \bullet 10^{-6}$; with power subtracted Δn (p.s.) $\leq 1 \bullet 10^{-6}$; on special request total $\Delta n \leq 1 \bullet 10^{-6}$.

(Maximum weight ca. 6 kg; larger pieces available on request).

SUPRASIL 312 : In primary functional direction guaranteed total $\Delta n \leq 4 \bullet 10^{-6}$; with power subtracted Δn (p.s.) $\leq 2 \bullet 10^{-6}$; on special request total $\Delta n \leq 1 \bullet 10^{-6}$.

(No special limits on size and weight).

Δn (p.s.) (power subtracted) is calculated by subtracting from a measured Δn distribution the proportion that gives an exactly spherical aberration of an originally plane optical phasefront. This subtraction procedure is built into most modern interferometer software as an option.

2.4 Residual Strain

SUPRASIL 311 and 312 : ≤ 5 nm/cm across 80% of diameter or side length
≤ 5...15 nm/cm in the rim area.

2.5 Spectral Transmittance

2.5.1 Typical transmission curves (including Fresnel reflection losses) for a 10 mm path length are shown in the figure.

2.5.2 Decadic Extinction Coefficient at 200 nm

$k_{200} < 0.005\ cm^{-1}$ (typical)
$k_{200} < 0.01\ cm^{-1}$ (guaranteed)

Using the definition:

Transmittance $T = 10^{-kd}$
with d = thickness of sample

2.5.3 Infrared Absorption

OH absorption bands occur at wavelengths around 1.39 μm, 2.2 μm, and 2.72 μm according to an OH content of approximately 200 ppm (weight).

2.6 Fluorescence: None

With 254 nm excitation (low pressure Hg lamp and Schott UG 5 filter) and visual inspection.

2.7 Radiation Resistance

Optimum resistance to damage by high energy UV-laser radiation.

High laser damage threshold.

No degradation of visible transmittance after exposure to Co^{60} γ-radiation (1.15 MeV) with 0.063 Mrad/h for 98 h.