HPFS® 8655 Fused Silica

Optical Materials Product Information
Specialty Materials Division

CORNING

HPFS® 8655 Fused Silica

HPFS® 8655 fused silica is an extremely pure synthetic glass with very low water content which leads to an exceptionally stable and predictable dynamic behavior under deep ultraviolet (DUV) laser exposures. It is a compaction only material, showing no expansion, with a much greater resistance versus the well-known standard compaction curve resulting in the lowest possible induced wave front distortion.

Glass Code 8655 is commonly utilized to manufacture optical lenses for use in state-of-the-art microlithography due to its minimized induced absorption and low polarization birefringence behaviors. In addition to its performance under DUV laser exposures, HPFS® 8655 fused silica meets microlithography's lowest static birefringence, absorption and uniform refractive index homogeneity specifications. Data and literature are available upon request.

Quality Grade Selection Chart

Inclusion Class			Homogeneity[3,4] [ppm]			
			Grade			
Class	Total Inclusion Cross Section[1] [mm]	Maximum Size[2] [mm]	AA ≤ 0.5	A ≤ 1	C ≤ 2	F ≤ 5
0	≤0.03	0.10	■	■	■	■
1	≤0.10	0.28		■	■	■
2	≤0.25	0.50			■	■

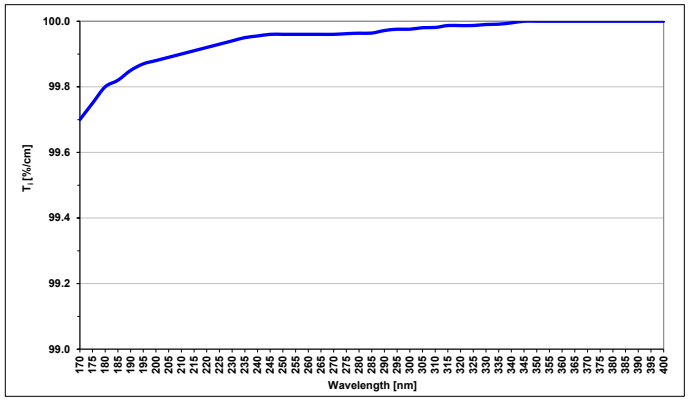
1. Defines the sum of the cross section in mm² of inclusions per 100 cm³ of glass. Inclusions with a diameter ≤ 0.10 mm are disregarded.
2. Refers to the diameter of the largest single inclusion.
3. Index homogeneity: the maximum index variation (relative), measured over the clear aperture of the blank.
4. Index homogeneity is certified using an interferometer at 632.8 nm. The numerical homogeneity is reported as the average through the piece thickness. Blanks with a diameter up to 450 mm can be analyzed over the full aperture. Larger parts can be analyzed using multiple overlapping apertures. The minimum thickness for index homogeneity verification is 20 mm. For thinner parts, the parent piece is certified.

Mechanical and Thermal Properties

Unless otherwise stated, all values @ 25 °C

Elastic (Young's) Modulus	73 GPa
Shear Modulus	31 GPa
Modulus of Rupture, abraded	52.4 MPa
Bulk Modulus	35.9 GPa
Poisson's Ratio	0.17
Density	2.2 g/cm³
Knoop Hardness (100g load)	489 kg/mm²
Tensile Strength	54 MPa
Compressive Strength	1.14 GPa
Specific Heat	0.770 J/(g K)
Thermal Conductivity	1.38 W/(m K)
Thermal Diffusivity	0.0075 cm²/s
Metallic Impurities	< 10 ppb

Internal Transmittance:



HPFS® 8655 Grade meets high $T_i \geq 99.75$ %/cm @193 nm.

Typical initial absorption k: ≤ 0.0005 ppm/cm at 193 nm.

Higher transmittance is available upon request.

Refractive Index and Dispersion

Conditions: 22 ˚C, 760 mm Hg, N_2

Wavelength [Vacuum] λ [nm]	Refractive Index[1] n	Thermal Coefficient[2] Δn/ΔT [ppm/K]	Sellmeier Dispersion Equation Constants[1], 20 ˚C	
2326.050	1.433027	8.7	A_1	7.033574317E-02
2058.650	1.437307	9.3	A_2	7.241205497E-01
1970.630	1.438601	9.6	A_3	3.097807778E-01
1813.570	1.440776	9.1	A_4	9.309957497E-01
1530.000	1.444337	9.7	B_1	-2.301552288E-03
1128.950	1.448930	9.7	B_2	6.272886117E-03
1014.26 n_t	1.450304	9.6	B_3	1.415449740E-02
852.344 n_s	1.452526	9.5	B_4	1.016434845E+02
780.237	1.453731	9.5		
706.714 n_r	1.455205	9.9	Sellmeier Dispersion Equation Constants[1], 22 ˚C	
656.454 n_C	1.456425	10.1	A_1	3.550277875E-02
644.025 $n_{C'}$	1.456763	10.1	A_2	7.353314507E-01
632.990	1.457077	9.9	A_3	3.334560303E-01
587.725 n_d	1.458522	10.2	A_4	9.269506614E-01
546.227 n_e	1.460135	10.5	B_1	-4.826183477E-03
486.269 n_F	1.463183	10.4	B_2	5.808687673E-03
480.126 $n_{F'}$	1.463561	10.4	B_3	1.399572492E-02
435.957 n_g	1.466751	10.7	B_4	1.012182926E+02
404.770 n_h	1.469674	10.9		
388.975	1.471446	10.9	Sellmeier Dispersion Equation Constants[1], 25 ˚C	
365.119 n_i	1.474599	11.3	A_1	2.623483282E-02
340.463	1.478646	11.6	A_2	7.306029048E-01
334.244	1.479824	11.7	A_3	3.475321572E-01
312.657	1.484554	12.0	A_4	9.216052441E-01
296.814	1.488798	12.5	B_1	-5.783959035E-03
289.444	1.491056	12.5	B_2	5.600103210E-03
253.728	1.505585	14.0	B_3	1.389808930E-02
228.872	1.521218	15.3	B_4	1.006578079E+02
226.572	1.523018	15.9		
214.506	1.533786	16.8	Δn/ΔT Dispersion Equation Constants[2], 20-25 ˚C	
213.923	1.534371	17.0	D_o	9.545124E+00
206.266	1.542731	18.2	D_1	-9.835579E-02
202.613	1.547213	18.3	D_2	2.003170E-01
194.227	1.558985	20.4	D_3	2.209816E-03
184.950	1.575091	22.1	D_4	1.980644E-04

Other Optical Properties	
V_e	67.8
nF'-nC'	0.006797
Stress Coefficient	35.0 nm/cm MPa
Striae	ISO 10110-4 Class 5 (None)
Birefringence	≤ 1 nm/cm, lower specifications available

**1 Sellmeier Equation: $n^2-1 = A_1 \lambda^2/(\lambda^2 - B_1) + A_2 \lambda^2/(\lambda^2 - B_2) + A_3 \lambda^2/(\lambda^2 - B_3) + A_4 \lambda^2/(\lambda^2 - B_4)$ with λ in μm*

**2 Δn/ΔT Equation: $\Delta n/\Delta T\ [ppm/K] = D_0 + D_1\lambda^2 + D_2\lambda^{-2} + D_3\lambda^{-4} + D_4\lambda^{-6}$ with λ in μm*

The above Sellmeier Dispersion Equation for SiO2 was used to fit the refractive indices of 35 wavelengths from 2326 nm to 185 nm.

Worldwide Accessibility

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