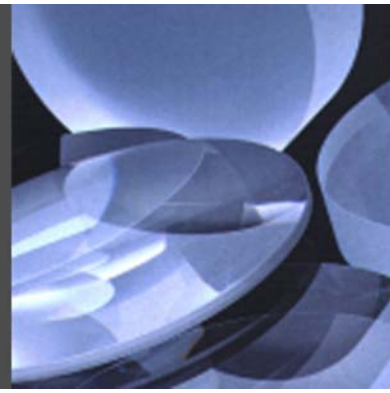
HPFS® 8650 Fused Silica for ArF Applications

CORNING
Discovering Beyond Imagination



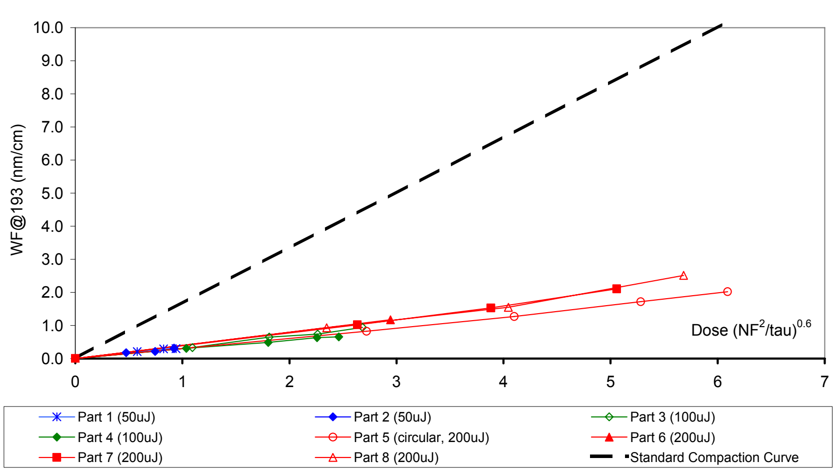
Semiconductor Optics

Corning Semiconductor Materials has developed a new optical material, HPFS® 8650, that meets the specification demands of ArF immersion scanner and stepper exposure systems, allowing the semiconductor industry to push its capabilities as required per the International Technology Roadmap for Semiconductors (ITRS). Our strength is in material chemistry and development, and we are committed to be the technology leader for next generation steppers by continuing our development of new materials.

HPFS® 8650 fused silica has a very stable and predictable behavior under ArF laser exposure and is a low compaction, zero expansion material with minimized polarization induced birefringence. It can be used to manufacture state-of-the-art optical lenses for use in polarized immersion systems that require low wavefront distortion, higher laser damage resistance, low residual birefringence, and high transmission specifications**.**

Laser Resistance

HPFS® 8650 has a much greater laser resistance at 193nm versus the standard compaction curve. It is a compaction only material, showing no expansion. These results were summarized from exposures at Corning under the conditions of 193nm, 22ns pulse width, and within fluences in the range of 50-200uJ/cm2/pulse.



Quality Grade Selection Chart-HPFS® 8650

Inclusion Class			Index Homogeneity Grade[3,4] ppm			
Class	Total inclusion[1] cross section [mm^2]	Maximum[2] size [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			■	■

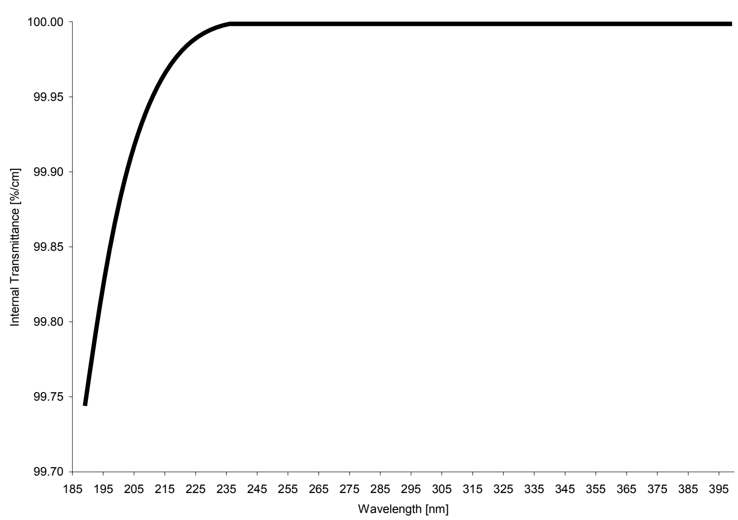
Notes:
1. Defines the sum of the cross-section in mm^2 of inclusions per 100 cm^3 of glass. Inclusions with a diameter equal to or less than 0.10 mm diameter are disregarded.
2. Refers to the diameter of the largest single inclusion.
3. Index Homogeneity Grade: The maximum index variation (relative) 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 clear aperture up to 450 mm can be analyzed over the full aperture. The minimum thickness for index homogeneity verification is 20 mm. For thinner parts, the parent piece is certified.

Mechanical and Thermal Properties Note: Unless otherwise stated, all values @ 25°C

Elastic (Young's) Modulus	73 GPa	Tensile Strength	54 MPa
Shear Modulus	31 GPa	Compressive Strength	1.14 GPa
Modulus of Rupture, abraded	52.4 MPa	Specific Heat	0.770 J/g K
Bulk Modulus	35.9 GPa	Thermal Conductivity	1.38 W/m K
Poisson's Ratio	0.17	Thermal Diffusivity	0.0075 cm^2/s
Density	2.2 g/cm^3		
Knoop Hardness (100 g load)	489 kg/mm^2		

Internal Transmittance

HPFS® 8650 Grade is certified to meet high transmission requirements @ 193nm, when measured through a polished, uncoated sample. Higher transmittance is available upon request. A typical internal transmittance curve for HPFS® 8650 ArF is below.



Refractive Index and Dispersion

Conditions: 22°C, 760mm Hg

Wavelength λ [air, nm]	Refractive Index[2] n	Thermal Coefficient $\Delta n/\Delta T$[3] [ppm/K]	Polynomial Dispersion Equation Constants, 20°C[1]	
1813.08	1.440791	9.8	A_0	2.104229389E+00
1529.58	1.444352	9.5	A_1	-1.002155533E-04
1128.64	1.448944	9.8	A_2	-9.121749105E-03
1013.98 n_t	1.450317	9.8	A_3	8.782635767E-03
852.11 n_s	1.452538	9.7	A_4	8.780464839E-05
780.02	1.453742	9.9	A_5	1.307069116E-06
643.85 $n_{C'}$	1.456775	10.1	A_6	5.398453121E-09
546.07 n_e	1.460148	10.3	A_7	1.786158843E-10
479.99 $n_{F'}$	1.463572	10.5	A_8	7.514786588E-12
404.66 n_h	1.469686	11.0	**Sellmeier Dispersion Equation Constants, 20°C[2]**	
340.36	1.478656	11.8	B_1	1.589275328E-01
312.57	1.484564	12.3	B_2	6.229767186E-01
289.36	1.491067	12.8	B_3	3.223549560E-01
253.65	1.505595	14.2	B_4	9.122465810E-01
228.80	1.521228	15.7	C_1	8.861164451E-04
214.44	1.533799	17.1	C_2	6.595885054E-03
206.20	1.542744	18.2	C_3	1.401773626E-02
194.17	1.558999	20.3	C_4	9.972998819E+01
184.89	1.575106	22.6	**$\Delta n/\Delta T$ Dispersion Equation Constants, 20-25°C[3]**	
			C_0	9.4950
			C_1	0.2622
			C_2	-0.00231
			C_3	0.0002944
			Other Optical Properties	
			ν_e	67.70
			$n_{F'}-n_{C'}$	0.006797
			Stress Coefficient	35.0 nm/cm MPa
			Striae	ISO 10110-4 Class 5
			Birefringence	≤ 1 nm/cm , lower specifications available

[1] Polynomial Equation: $n^2 = A_0 + A_1\lambda^4 + A_2\lambda^2 + A_3\lambda^{-2} + A_4\lambda^{-4} + A_5\lambda^{-6} + A_6\lambda^{-8} + A_7\lambda^{-10} + A_8\lambda^{-12}$ with λ, µm

[2] Sellmeier Equation: $n^2 - 1 = B_1\lambda^2/(\lambda^2 - C_1) + B_2\lambda^2/(\lambda^2 - C_2) + B_3\lambda^2/(\lambda^2 - C_3) + B_4\lambda^2/(\lambda^2 - C_4)$ with λ, µm

[3] $\Delta n/\Delta T$ Equation: $\Delta n/\Delta T$ [ppm/K] $= C_0 + C_1\lambda^{-2} + C_2\lambda^{-4} + C_3\lambda^{-6}$ with λ, µm

We are here to help you specify the best product for your application. For further information, please contact:

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