HPFS® 8650 Fused Silica for ArF Applications

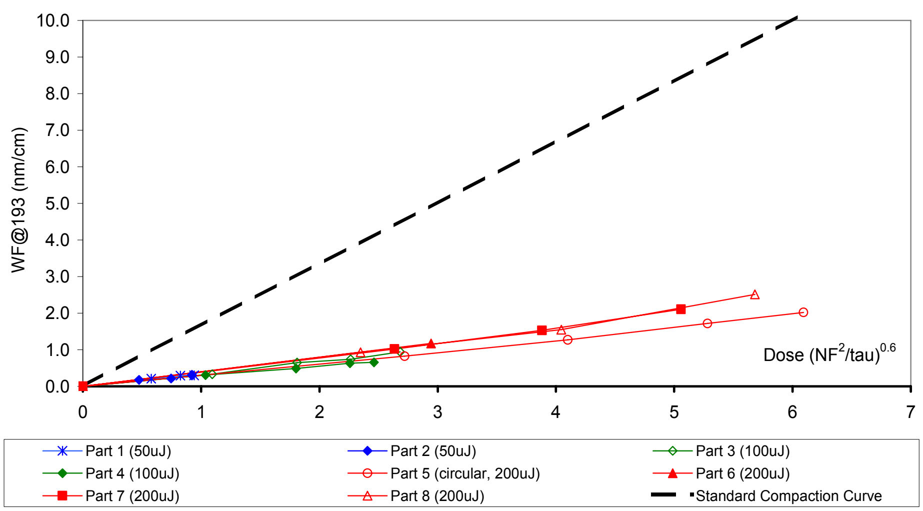
Semiconductor Optics

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.



CORNING

Quality Grade Selection Chart — HPFS® 8650

Inclusion Class			Index Homogeneity [3,4] ppm			
			Grade			
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 ≤ 0.10 mm 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 aperature 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.

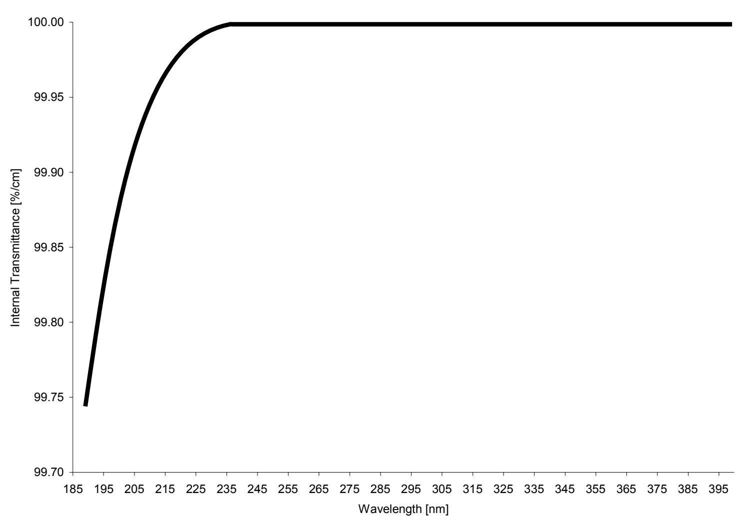
Mechanical and Thermal Properties:

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/cm^3
Knoop Hardness (100 g load)	489 kg/mm^2

Tensile Strength	54 MPa
Compressive Strength	1.14 GPa
Specific Heat	.770 J/gK
Thermal Conductivity	1.38 W/m K
Thermal Diffusivity	0.0075 cm^2/s

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 at left.

Refractive Index and Dispersion

Conditions: 22°C, 760mm Hg

Wavelength [air] λ [nm]	Refractive Index [*2] n	Thermal Coefficient Δn/ΔT[*3] (ppm/K)
1813.08	1.440791	9.8
1529.58	1.444352	9.5
1128.64	1.448944	9.8
1013.98 n_t	1.450317	9.8
852.11 n_s	1.452538	9.7
780.02	1.453742	9.9
643.85 $n_{C'}$	1.456775	10.1
546.07 n_e	1.460148	10.3
479.99 $n_{F'}$	1.463572	10.5
404.66 n_h	1.469686	11.0
340.36	1.478656	11.8
312.57	1.484564	12.3
289.36	1.491067	12.8
253.65	1.505595	14.2
228.80	1.521228	15.7
214.44	1.533799	17.1
206.20	1.542744	18.2
194.17	1.558999	20.3
184.89	1.575106	22.6

Polynomial Dispersion Equation Constants, 20°C[1]

A_0	2.104229389E+00
A_1	-1.002155533E-04
A_2	-9.121749105E-03
A_3	8.782635767E-03
A_4	8.780464839E-05
A_5	1.307069116E-06
A_6	5.398453121E-09
A_7	1.786158843E-10
A_8	7.514786588E-12

Sellmeier Dispersion Equation Constants, 20°C[2]

B_1	1.589275328E-01
B_2	6.229767186E-01
B_3	3.223549560E-01
B_4	9.122465810E-01
C_1	8.861164451E-04
C_2	6.595885054E-03
C_3	1.401773626E-02
C_4	9.972998819E+01

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

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

Worldwide Accessibility

United States/Canada Sales Office
Corning Incorporated
Semiconductor Optics Business
334 County Route 16
Canton, NY 13617

t: 315.379.3600
f: 315.379.3317
e-mail: hpfs@corning.com

European Sales Office
Corning GmbH
Corning International
Abraham-Lincoln-Strasse 30
D-65189 Wiesbaden
Germany

t: 49.611.7366.100
f: 49.611.7366.143
e-mail: CIgermany@corning.com

Asia Sales Offices
Corning International K.K.
No. 35 Kowa Building, 3F
14-14, Akasaka 1-chome
Minato-Ku, Tokyo 107-0052
Japan

t: 81.3.3586.1052
f: 81.3.3587.0906

Corning International
1 Kim Seng Promenade
#12-12
GreatWorld City
West Tower
Singapore 237994
Republic of Singapore

t: 65.733.6511
f: 65.861.7310

Corning Korea Company Ltd.
10th Floor, Kukje Center Bldg.
191, Hangangro 2-Ka
Yongsan-Ku
Seoul, Korea 140-702

t: 82.2.796.9500
f: 82.2.796.9300

Corning Glass Taiwan Co. Ltd.
Room # 1023, 12F No. 205
Tun Hua North Road
Taipei, Taiwan

t: 886.2.2716.0338
f: 886.2.2716.0339

Australia Sales Office
Corning International Australia
Suite 18
12, Tryon Road
Lindfield, NSW 2070
Australia

t: 61.2.9416.0492
f: 61.2.9416.0493

World Headquarters
Corning Incorporated
One Riverfront Plaza
Corning, New York 14831-0001

t: 607.974.9000

Corning Incorporated

One Riverfront Plaza
Corning, NY 14831
607.974.9000

www.corning.com or
www.hpfs.corning.com

February 2008