

# Spectrosil®

## Optical Fused Silica

**Spectrosil®** is a highly homogeneous synthetic fused silica glass available in a range of grades, including **2000** for the majority of deep UV optical applications and **2200 - ArF** and **2200 - KrF** excimer laser grades, which are optimised for use in microlithography and other critical high-energy deep UV optical systems.

All **Spectrosil®** grades are totally free of bubbles and inclusions and due to their ultra-high purity, have exceptional optical transmission in the deep ultraviolet and visible, with a useful range from below 180 nm through to 2 000 nm.

### Available Forms

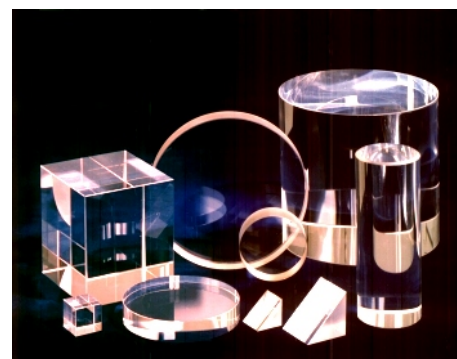
<b>Ingot</b>	Spectrosil® 2000 is available as round ingots in a range of diameters and lengths.
<b>Blanks/Components</b>	Spectrosil® 2000 and 2200 are available as Discs, Plates, Blocks, Core-drilled rods and other shapes with a machined or polished surface finish.
<b>Re-drawn Rod</b>	Spectrosil® 2000 is also available as re-drawn rod in a range of diameters. <b>F Grade</b> rod is specially prepared for the manufacture of optical fibres and <b>R Grade</b> is for non-fibre applications.

### Optical Properties

Spectrosil® Grade	2000	2000 F & R Grade Rod	2200 ArF & KrF Grades
<b>Available Forms</b>	Ingots Core Drilled Rods Blanks Components	Re-drawn Rods	Core Drilled Rods Blanks Components
<b>Bubbles</b>			
Bubble class (DIN 58927)	0	0	0
<b>Maximum number of inclusions</b>	0	0	0
<b>Striae</b>			
Visible striae ISO 10110-4 MIL-G-174B	3 Directions Free Class 5 A	1 Direction Free Class 5 A	3 Directions Free Class 5 A
<b>Refractive index homogeneity</b>			
<b>Homogeneity Grade</b>	Homogeneity (ppm)	Not specified	Homogeneity (ppm)
HG-6	<= 0.5		<= 0.5
HG-5	<= 1.0		<= 1.0
HG-4	<= 2.5		<= 2.5
HG-3	<= 3.0		<= 3.0
HG-2	<= 5.0		<= 5.0
HG-1	<= 10.0		<= 10.0
<b>Birefringence / Residual strain*</b> (Typical values)	<= 2 nm/cm	Not specified	<= 1 nm/cm
<b>Fluorescence</b> (254 nm excitation)	None	None	None
<b>Typical diameters†</b>	350+ mm	50 mm (max)	300+ mm

\* Residual strain is stress induced birefringence and the values shown are typical for the inner 90% of a 100 mm diameter machined component

† Larger sizes of Spectrosil® 2000 & 2200 are available on request.



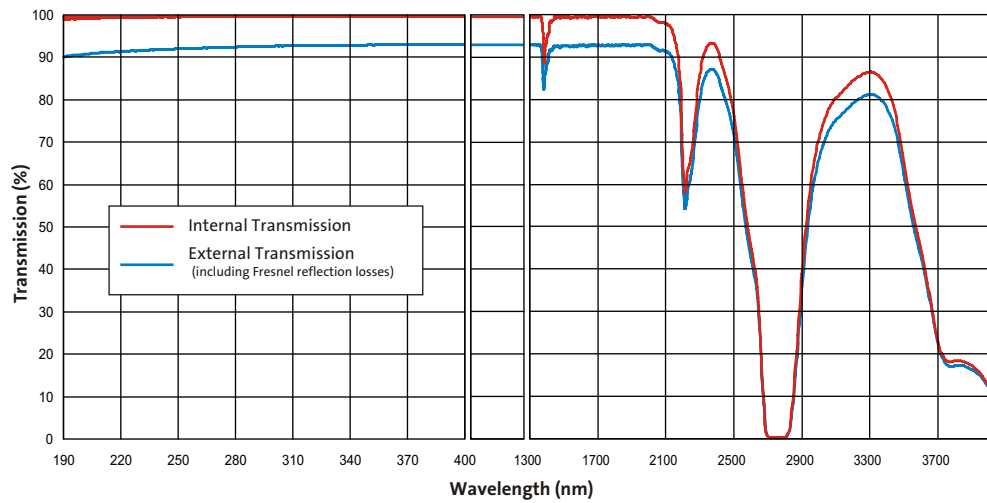
- Spectrosil®** synthetic fused silica is manufactured using a patented, environmentally friendly process resulting in a glass of exceptional purity and excellent visual quality.
- Spectrosil®** is bubble-free and inclusion-free (DIN 58927 - Bubble Class 0) and also fluorescence-free.
- Spectrosil®** is chlorine-free resulting in outstanding laser damage resistance due to the reduced tendency to form E' centre.
- Spectrosil® 2000** has excellent deep UV transmission and is for use in most deep UV applications including lenses, windows, prisms, etalons, etc.
- Spectrosil® 2200 - ArF** and **Spectrosil® 2200 - KrF** are premium grades that have been specially developed, and are manufactured under specific conditions, to ensure maximum transmission and prolonged life in ArF (193 nm) and KrF (248 nm) lithography systems and other critical deep UV excimer laser applications.

## Transmission

### Typical Internal Transmission (10 mm path length)

	$\lambda = 193.4 \text{ nm}$	$\lambda = 248 \text{ nm}$
Spectrosil® 2200 – ArF Grade	> 99.5 %	–
Spectrosil® 2200 – KrF Grade	–	> 99.9 %
Spectrosil® 2000	> 99 %	> 99.5 %

### Typical Internal & External Transmission Curve (10 mm path length)



## Typical Chemical Analysis

Spectrosil® 2000/2200	Typical trace elements in ppb
Al	<10
Ca	<10
Co	<10
Cr	<10
Cu	<10
Fe	<10
K	<10
Li	<10
Mg	<10
Mn	<10
Na	<10
Ti	<10
V	<10
Zn	<10
Zr	<10
ppm	
Cl	<0.15 (limits of detection)
OH	1000

## Other Properties

Abbe Number	67.8
Density	2.2 g/cm <sup>3</sup>
Hardness (Mohs scale)	6 - 7

## Standard Polishing Specification Plate Glass Finish (PGF)

Where the ratio of diameter to thickness (or diagonal to thickness) does not exceed 20:1 the standard specification is:

Parallelism:	5 minutes of arc
Flatness:	1 $\lambda$ at 589 nm
Scratch-dig:	60-40

Please enquire if an improved polishing specification is required

## Refractive Index & Thermal Coefficient

(at 20°C & 1 bar/760mm Hg)

	Wavelength (nm)	Refractive Index n	Thermal Coefficient dn/dT (ppm/K)
	1128.95	1.44887	9.6
	1064.00	1.44963	9.6
	1060.00	1.44968	9.6
n t	1013.98	1.45024	9.6
n s	852.11	1.45247	9.7
n r	706.52	1.45515	9.9
n c	656.27	1.45637	9.9
n c'	643.85	1.45670	10.0
n He-Ne	632.80	1.45702	10.0
n D	589.29	1.45840	10.1
n d	587.56	1.45846	10.1
n e	546.07	1.46008	10.2
n F'	486.13	1.46313	10.4
n g	435.83	1.46669	10.6
n h	404.66	1.46962	10.8
n l	365.01	1.47454	11.2
	334.24	1.47975	11.6
	312.66	1.48447	12.0
	253.73	1.50547	13.9
n KrF	248.30	1.50838	14.2
	248.00	1.50855	14.2
	228.87	1.52109	15.5
	214.51	1.53365	17.0
	206.27	1.54259	18.1
	194.23	1.55884	20.3
n ArF	193.40	1.56014	20.5
	193.00	1.56077	20.6
	184.95	1.57495	22.7

## Thermal Properties

Strain Point: †	950°C
Annealing Point: †	1100°C
Softening Point: †	1710°C

Coefficient of Thermal Expansion:  
(Average K<sup>-1</sup> 0-600°C) 0.54 x 10<sup>-6</sup>

† Note that these values may vary, depending on the thermal history of the glass



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