

# SQ Fused Silica for Fiber Optics

## Ordering Information

To order SQ please call, fax or email us and specify the following parameters:

Rod Type:	SQ
Rod Diameter:	mm
Rod Length:	mm
Rod Quantity:	kg
Surface Quality	Quality grade
Other:	desired ship date, special requests

All j-plasma products are subject to j-plasma's ongoing process and quality improvement programs ensuring excellent performance and high reliability. We reserve the right to make changes to the above specification without notice.

DB-KAP-002-03-0112 Issued January 2012

Supersedes DB-KAP-002-02-0311 Issued March 2011

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For further information about our SQ rods and other j-plasma products and services, please contact us:

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SQ ultra-pure synthetic fused silica for fiber optics is our new offering to preform and fiber manufacturers.

SQ inclusion free fused silica provides for high laser durability which makes it the first choice material for fiber optics. The amorphous synthetic fused silica SiO<sub>2</sub> of highest purity completes the application range of optical materials from DUV to IR with excellent transmission performance in the 185 nm to 2.5 μm range.

SQ fused silica supports the design and make of specialty applications preforms as well as the parameter controlled drawing of high-performance optical fibers for use in advanced specialty and photonic devices.

## Key quality features are

- Inclusion / bubble free
- Excellent UV transmittance
- Very low fluorescence
- High laser durability
- Low stress birefringence
- Very low thermal expansion coefficient
- High temperature stability

## Application

- Specialty applications preform design and make
- Parameter controlled making of high-performance optical fibers

## Material Properties

### Bubbles, Inclusions, Homogeneity, and Stress Birefringence

Grade	Bubbles and Inclusions <sup>3)</sup>		Homogeneity Data	Stress Birefringence <sup>4)</sup>
	according to ISO 10110-3	max. Diameter [mm]	local inhomogeneities striae and striations <sup>1)</sup> according to ISO 10110-4	standard <sup>2)</sup> [nm/cm]
SQ	1/ 1 x 0.063	0.07	2/- ; 5 functional directions	≤ 5

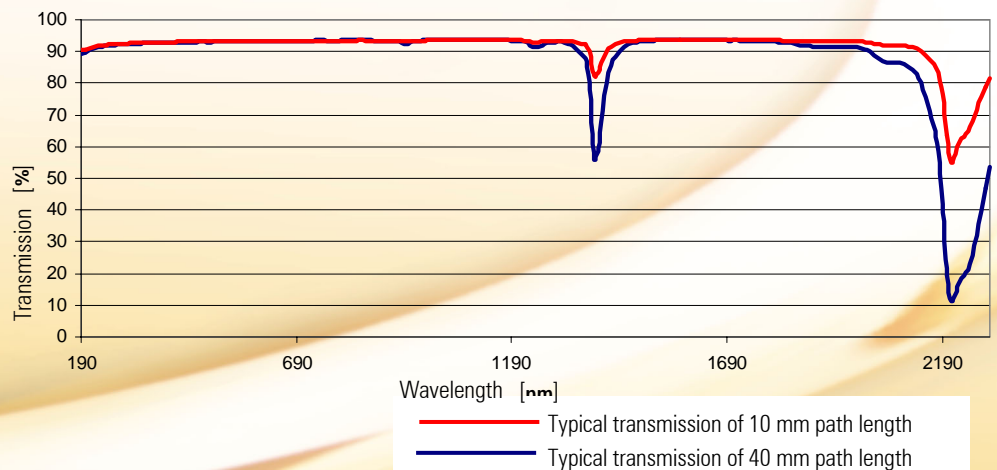
<sup>1)</sup> Shadow method, polarizer and interferometer are used for striae and striation detection.

<sup>2)</sup> Lower values available on request.

<sup>3)</sup> Bubbles and inclusions < 0.05 mm in diameter are not considered in these cases.

<sup>4)</sup> Value for 90% of diameter.

## Spectral Transmission



— Typical transmission of 10 mm path length  
— Typical transmission of 40 mm path length

Grade	Internal Transmittance [%] per 10 mm sample thickness			OH Content	Other Contaminants
	$\lambda=193$ nm	$\lambda=248$ nm	$\lambda=300$ nm	[ppm]	[ppm]
SQ	$\geq 98.0$	$\geq 99.5$	$\geq 99.9$	appr. 1200	$\leq 0.05$

- Internal transmittance  $\geq 99.9\%$  in the wavelength range of 300...900 nm.
- Hydrogen content of appr.  $1 \cdot 10^{18}$  Mol. /  $\text{cm}^3$   $\text{H}_2$

Refractive Indices n (at 20 °C, nitrogen atmosphere, 1013 hPa)			Variation over Temperature
	$\lambda_{\text{vac}}$ [nm]	n	$\frac{\Delta n}{\Delta T}$ [ $10^{-6}/\text{K}$ ]
$n_{2325}$	2325.59	1.43290	-
$n_{1970}$	1970.56	1.43849	-
$n_{1530}$	1530	1.44424	-
$n_{1060}$	1060	1.44965	-
$n_f$	1014.25	1.45021	9.6
$n_s$	852.35	1.45243	9.7
$n_r$	706.71	1.45511	9.8
$n_c$	656.45	1.45633	9.9
$n_{c'}$	644.03	1.45667	9.9
$n_{\text{He-Ne}}$	632.98	1.45698	9.9
$n_D$	589.46	1.45837	10.0
$n_d$	587.73	1.45843	10.0
$n_e$	546.23	1.46004	10.1
$n_f$	486.27	1.46309	10.3
$n_{F'}$	480.13	1.46347	10.3
$n_g$	435.96	1.46666	10.5
$n_h$	404.77	1.46958	10.8
$n_i$	365.12	1.47450	11.2
$n_{334}$	334.24	1.47973	11.6
$n_{312}$	312.66	1.48446	12.1
$n_{296}$	296.82	1.48870	12.5
$n_{280}$	280.43	1.49401	13.0
$n_{248}$	248.35	1.50837	14.5

All refractive indices are interpolated from values measured under dry nitrogen;  $\lambda_{\text{vac}}$  = vacuum wavelength. Tolerances of refractive indice:  $\pm 2.0 \cdot 10^{-5}$

Abbe Numbers		
$n_d = 1.45843$	$v_d = 67.83$	$n_f - n_c = 0.00676$
$n_e = 1.46004$	$v_d = 67.68$	$n_{F'} - n_{c'} = 0.00680$

Typical Trace Contaminants [ppm]	
Trace Elements	SQ
Al	$\leq 0.05$
Na	$\leq 0.02$
Ca	$\leq 0.02$
K	$\leq 0.01$
Fe	$\leq 0.005$
Ti	$\leq 0.01$
Cu	$\leq 0.005$
Cr	$\leq 0.005$
Mn	$\leq 0.005$

Thermal Properties		Unit
Strain point $T_{10}^{14.5}$	980	°C
Annealing point $T_{10}^{13.0}$	1080	°C
Softening point $T_{10}^{7.6}$	1600	°C
Max working temperatures		
Continuously	930	°C
Short-term	1180	°C
Mean specific heat $C_p$ (20°C-100°C)	0.79	J/g·K
Heat conductivity $\lambda$ (32°C)	1.31	W/(m·K)
Linear thermal expansion coefficient		
$\alpha$ (25°C-100°C)	0.5	$10^{-6}/\text{K}$
$\alpha$ (25°C-200°C)	0.52	$10^{-6}/\text{K}$
$\alpha$ (25°C-300°C)	0.55	$10^{-6}/\text{K}$
$\alpha$ (25°C-600°C)	0.51	$10^{-6}/\text{K}$

Mechanical Properties		Unit
Young's modulus (25°C)	72	GPa
Shear modulus	31	GPa
Compressive strength	1250	N/mm <sup>2</sup>
Bending strength	80-100	N/mm <sup>2</sup>
Poisson's ratio $\mu$	0.17	
Knoop HK 0.1/20	580	
Mohs	5-6	
Density $\rho$	2.2	g/cm <sup>3</sup>
Stress optical coefficient	$3.4 \cdot 10^{-12}$	1/Pa
Longitudinal ultrasonic velocity	5940	m/s
Transversal ultrasonic velocity	3770	m/s
Internal damping (25°C-500°C)	$2.0 \cdot 10^{-5}$	

Geometrical Properties <sup>1)</sup>		Unit
Rod diameter	20 to 60	mm
Diameter tolerance	1	mm
Rod length	1000 $\pm$ 200	mm
Cylinder surface quality available as	ground (Ra < 5 $\mu\text{m}$ )	
	flame transparent	
	flame polished	

<sup>1)</sup> Other dimensions and tolerances are available upon request.