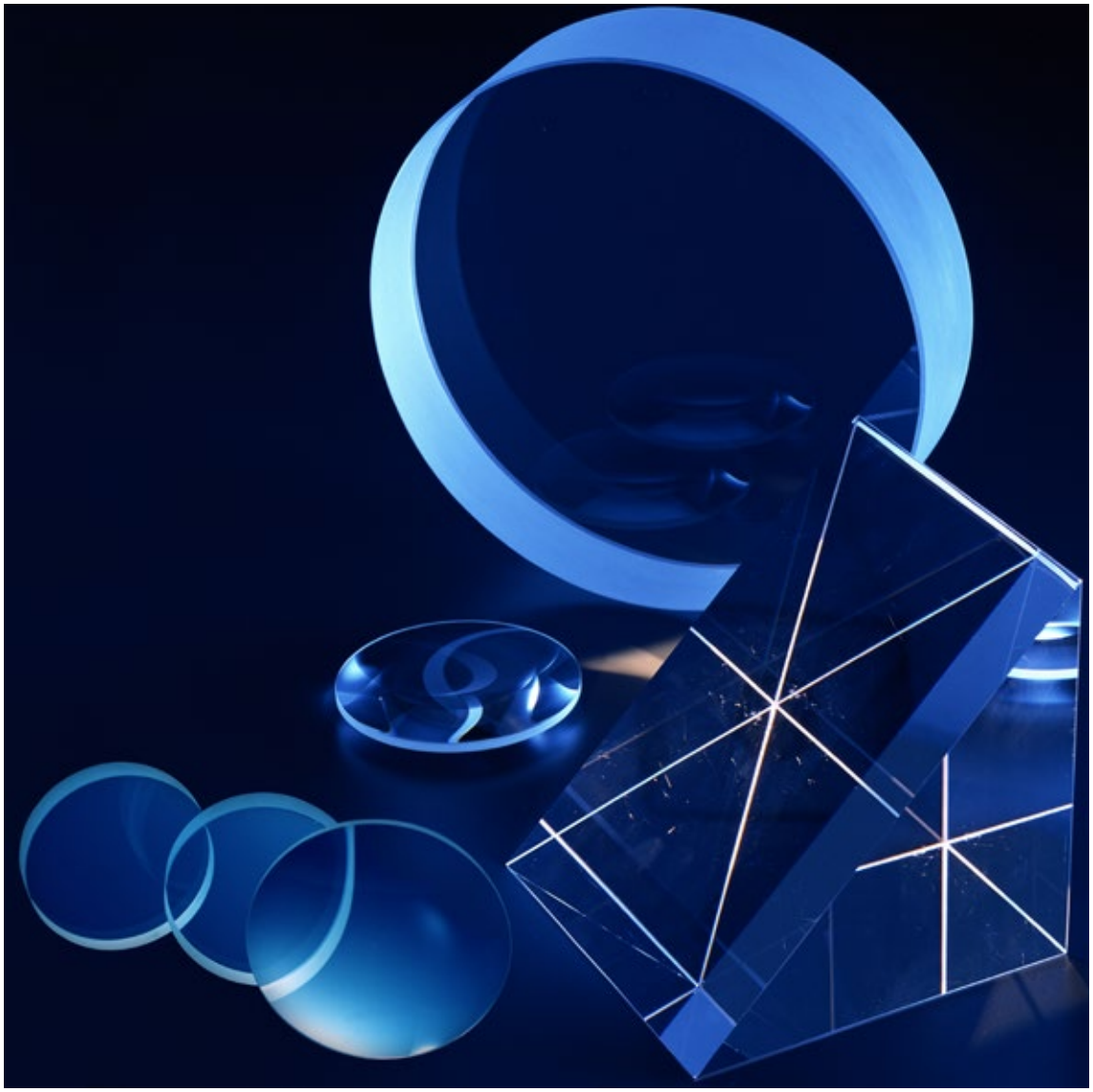
Quartz Glass for Optics

Quartz glass has outstanding optical properties such as light transmission and has characteristics such as high purity, high resistance to heat and radiation.
Shin-Etsu Quartz manufacture and sell the “SUPRASIL-P Series” of ultra-high purity and excellent homogenous synthetic quartz glass, and “SUPRASIL-F300”, an OH free synthetic quartz glass for optics.
We also offer “INFRASIL”, a natural quartz glass for optics manufactured by Heraeus.



Types of quartz glass for optics

"SUPRASIL-P Series" synthetic quartz glass

Shin-Etsu Quartz has access to advanced technologies to produce synthetic quartz glass for optics by collaborating with Heraeus and Shin-Etsu Group. Thus, we can create outstanding optical quartz glass such as "SUPRASIL-P Series".
This includes a lineup of products that can be used for a wide range of applications including all generations of microlithography equipment, from i-line systems used in semiconductor manufacturing processes up to cutting-edge ArF, and exposure equipment for FPD and printed circuit board processes.
Seven different grades are offered based on characteristics such as striae grade, transmission, and laser durabilities.

"SUPRASIL-F300" OH free synthetic quartz glass

SUPRASIL-F300 for optics is based on SUPRASIL-F300, which has superior near-infrared permeability that is needed in optical fiber applications, and has been given adjustments for optical properties using the unique manufacturing technologies of our group.

"INFRASIL, HOQ310" natural quartz glass

These products are quartz glass for optics that were made by Heraeus using natural crystal as a raw material.

■List of grades

Type	Grade	Characteristics
Synthetic quartz glass	**SUPRASIL-P248C**	This is high-end quartz glass for optics that has excellent transmission at a wide range of wavelengths. It is striae-free in all directions so is optimal for high-precision optics applications.
	SUPRASIL-P700	The homogeneity is even more excellent than that of SUPRASIL-P248C, and the ArF excimer laser durabilities have been improved.
	SUPRASIL-P710C	This has excellent transmission from visible through near infrared, and is compatible with large products of ϕ600 or above. It is offered as striae-free in three directions or in one direction.
	SUPRASIL-P20	This is striae-free in one direction, and is optimal for general optical elements, such as windows and lenses materials.
	SUPRASIL-P310C	This has more homogeneous than SUPRASIL-P20, and possesses transmission and laser durabilities equivalent to those of SUP-P248C.
	SUPRASIL-P210	The optical characteristics correspond to those of SUPRASIL-P310C, and the ArF excimer laser durabilities have been improved.
	SUPRASIL-P30	This is optimal for general optical elements regarding which high transmission is required.
	SUPRASIL-F300	This has both infrared permeability on par with optical fiber and the high homogeneity of quartz glass for optics.
Natural quartz glass	**INFRASIL 301/302**	This is quartz glass for optics for visible through near infrared that has been manufactured from carefully selected crystal and contains a low amount of OH base. It is possible to choose striae-free in three directions or in one direction in accordance with the application.
	HOQ310	This is quartz glass for optics manufactured with electrical melting using crystal as a raw material. It is outstanding with regard to economy, and is optimal for window applications with high replacement frequencies.

● Shapes and sizes

Our quartz glass for optics comes in a variety of shapes, including blocks, plates, prisms, lenses, and rods.
For detailed information regarding the sizes and shapes that can be manufactured, please contact the relevant sales department.

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List of the properties of quartz glass for optics

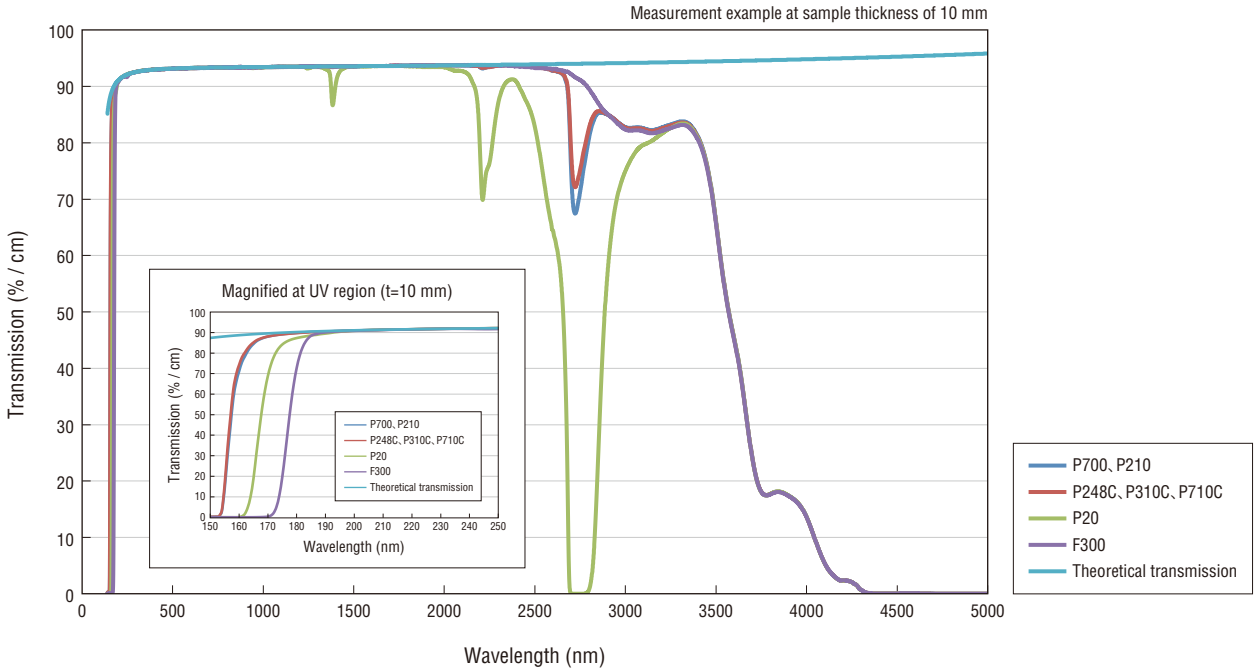
Type	Grade	Striae grade*1	Striae intensity*1	Size (mm)	Homogeneity(⊿n)*2		Residual Strain*3 (nm/cm)	Bubble grade*4	Fluorescence*5	Excimer laser tolerance
					Nominal	On request				
Synthetic quartz glass	**SUPRASIL-P248C**	3D	A	< 200 < 300	2×10^{-6} 3×10^{-6}	1×10^{-6} 2×10^{-6}	2 3	0	Free	KrF (248nm)*6
	SUPRASIL-P700	3D	A	< 200 < 300	1×10^{-6} 2×10^{-6}	0.5×10^{-6} 1×10^{-6}	2 2	0	Free	ArF (193nm)*7
	SUPRASIL-P710C	3D 1D	A A	< 600 < 750	5×10^{-6} 8×10^{-6}	Negotiable	8 10	0	Free	—
	SUPRASIL-P20	1D	A	< 150 < 400	20×10^{-6} 20×10^{-6}	— —	8 10	0	Free	KrF (248nm)*6
	SUPRASIL-P310C	1D	A	< 150 < 400	2×10^{-6} 5×10^{-6}	1×10^{-6} 2×10^{-6}	2 5	0	Free	KrF (248nm)*6
	SUPRASIL-P210	1D	A	< 150 < 300	2×10^{-6} 3×10^{-6}	1×10^{-6} 2×10^{-6}	2 3	0	Free	ArF (193nm)*7
	SUPRASIL-P30	—	B-C	—	—	—	—	0	Free	—
	SUPRASIL-F300	3D	A	< 200 < 300	4×10^{-6} 6×10^{-6}	2×10^{-6} 4×10^{-6}	8 10	0	Light blue	—
		1D	A	< 150 < 400	5×10^{-6} 10×10^{-6}	2×10^{-6} 4×10^{-6}	8 10	0		—
Natural quartz glass	**INFRASIL 301**	3D	A	—	5×10^{-6}	—	5	0	Blue-violet	—
	INFRASIL 302	1D	A	—	6×10^{-6}	—	5	0～1	Blue-violet	—
	HOQ310	—	—	—	—	—	10	2～3	Blue-violet	—

(The values are not specification values.)

*1 "3D" means striae-free in three directions. "1D" means striae-free in one direction.
This is according to the United States military standard MIL-G-174. The evaluation is made via the main surface.
*2 This value is valid for 90% of the outer diameter. In the periphery, the actual value may exceed this stated value.
*3 For large-sized products, this value may be slightly higher in the edge zone, which is the outer 20% of the diameter.
*4 Conforms to DIN 58927.
*5 Excitation wavelength is 253.7 nm. For quartz glass, there is almost never excitation at a wavelength of 290 nm or above.
*6 The transmission loss is less than 0.1%/cm (less than 0.2%/cm for P20) after 1.8×10^{7} pulses of KrF excimer laser (λ=248nm,100mJ/cm^2/pulse) irradiation.
*7 The transmission loss is less than 1%/cm after 6×10^{6} pulses of ArF excimer laser (λ=193nm, 20mJ/ cm^2/pulse) irradiation.

* For detailed information regarding the sizes and properties that can be manufactured, please contact us.
* We can make custom-designed products for specific applications.

Initial transmission of quartz glass for optics including reflection loss at surface



Refractive index of quartz glass for optics

Wavelength (nm)	SUPRASIL-P
184.9	1.57518
193.4	1.56036
206.2	1.54281
214.4	1.53386
228.8	1.52129
248.3	1.50852
253.7	1.50565
289.4	1.49112
334.1	1.47989
365.0	1.47466
404.7	1.46974
435.8	1.46681
486.1	1.46324
587.6	1.45858

Wavelength (nm)	SUPRASIL-P
632.8	1.45714
656.3	1.45649
706.5	1.45526
780.0	1.45379
852.1	1.45259
1014.0	1.45036
1128.6	1.44899
1529.6	1.44440
1813.1	1.44084
1970.1	1.43867
2058.1	1.43737
2325.4	1.43309
*v*d	67.9±0.2

✻ This is the value at 25°C and 1,013h Pa.
✻ The refractive index measurement error is $\pm 3\times10^{-5}$.
✻ The refractive index of SUPRASIL-F300 is about 2×10^{-4} higher than the above value.
✻ For detailed values, please contact us.

- The optimal product varies depending on the method/purpose of use, including light source (CW light, laser), illuminance, irradiation conditions, and optical path length.
- We can offer the best material for each application from our range of products.
- We can also accommodate custom designed products in accordance with preferences regarding homogeneity and size.

Properties of quartz glass for optics

Relative temperature coefficients of the refractive index in 10^{-6} K^{-1}				
Wavelength	SUPRASIL-P		INFRASIL	
nm	0 to 20°C	20 to 40°C	0 to 20°C	20 to 40°C
237.8	14.6	14.9	15.2	15.3
365.0	11.0	11.2	11.5	11.6
546.1	9.9	10.1	10.6	10.7
587.6	9.8	10.0	10.5	10.6
643.8	9.6	9.8	10.4	10.5

Measurement accuracy: $\pm 0.5\times10^{-6}$

Abbe constant		
$v_d = \frac{n_d - 1}{n_F - n_C}$	67.9±0.2	67.8±0.5

Birefringence constant @ 633 nm		
$\frac{\text{nm/cm}}{\text{kg/cm}^2}$	3.47±0.05	3.61±0.05

Metal impurities		Unit: ppm
Elements	SUPRASIL-P	INFRASIL
Al	< 0.005	20
Ca	< 0.005	1
Cr	< 0.001	0.1
Cu	< 0.001	0.1
Fe	< 0.001	0.8
K	< 0.001	0.8
Li	< 0.01	1
Mg	< 0.001	0.1
Na	< 0.04	1
Ti	< 0.005	1
OH	1-1000*	< 8

✻ The OH content of SUPRASIL-F300 is to below 1 ppm.

Mechanical properties		Value at 20°C
Density	g/cm^3	2.20
Longitudinal elastic modulus	MPa	7.0×10^4
Torsional rigidity	MPa	3.0×10^4
Poisson's ratio		0.17
Compressive strength	MPa	1150
Tensile strength	MPa	67
Bending strength	MPa	50
Torsional strength	MPa	30
Mohs-hardness		5.5 to 6.5
Micro-hardness	MPa	8600 to 9800
Knoop-hardness (load of 100 g)	MPa	5800 to 6100
Internal damping		1×10^{-5}
Sound wave (longitudinal wave)	m/s	5720

The analysis values on this list are not standard values (guaranteed values)

Thermal properties		
	SUPRASIL-P	INFRASIL
Strain temperature °C	1000	1075
Annealing temperature °C	1100	1180
Softening temperature °C	1600	1730
Operating temperature limit		
Continuous °C	950	1150
Short term °C	1200	1300
Mean specific heat		J/kg·K
0 to 100°C	772	
0 to 500°C	964	
0 to 900°C	1052	
Heat conductivity		W/m·K
20°C	1.38	
100°C	1.47	
200°C	1.55	
300°C	1.67	
400°C	1.84	
950°C	2.68	
Mean thermal expansion coefficient		K^{-1}
-50 to 0°C	0.27×10^{-6}	
0 to 100°C	0.51×10^{-6}	
0 to 200°C	0.58×10^{-6}	
0 to 300°C	0.59×10^{-6}	
0 to 600°C	0.54×10^{-6}	
0 to 900°C	0.48×10^{-6}	

Electrical properties		
Resistivity Ω·m	SUPRASIL-P	INFRASIL
20°C	1.0×10^{18}	1.0×10^{16}
400°C	1.0×10^{6}	1.0×10^{8}
800°C	6.3×10^{4}	6.3×10^{4}
1200°C	1.3×10^{3}	1.3×10^{3}
Dielectric loss angle tanδ		
1 kHz	5.0×10^{-4}	
1 MHz	1.0×10^{-4}	
3×10^{10} Hz	4.0×10^{-4}	
tanδ at 1 MHz is nearly constant up to 200°C, and it becomes gradually higher above 200°C. tanδ at 10^{10} Hz becomes gradually lower up to 350°C, and it becomes gradually higher above 350°C.		
Dielectric constant ε		
20°C、0 to 1×10^6 Hz	3.70	
23°C、9×10^8 Hz	3.77	
23°C、3×10^{10} Hz	3.81	
Dielectric strength (kV/mm) In the case of a thickness of 5 mm or above		
20°C	25 to 40	
500°C	4 to 5	

■Product inquiries

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https://www.sqp.co.jp/e/

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