

OHARA QUARTZ

High Quality Silica Glass

<< for Optical Elements, Windows, Lenses, etc. >>

DUV ~ NIR



SK-1300

VAD-Process Synthetic Fused Silica

Our Company successfully developed synthetic fused silica SK-1300 as a result of significant improvements made to the conventional VAD (vapor-phase axial deposition) method of optical fiber manufacturing technology.

SK-1300 is extremely high in purity and much lower in OH content than the traditional direct method, thus making it the first synthetic fused silica usable in the semiconductor and liquid crystal display industries.

SK-1300 is the state-of-the-art technology in optical characteristics because it provides a high ultraviolet transmission, no micro inclusion and a solarization resistance, in addition to heat resistance, mechanical strength, and chemical resistance.

These products can be used in a wide variety of industrial applications for semiconductors, optical and all physical or chemical related research featuring these applications:

1. Wafers for various types of devices such as TFT (poly-Si thin-film transistor LCD.), SOI (Silicon on Insulator) etc.
2. Photomask substrates for ultra-LSI and LCD.
3. Reactor furnace tubes, jigs and tools for ULSI manufacturing processes.
4. Electrical-discharge lamp tubes.
5. Optical elements, lenses, mirrors and windows, for ultraviolet and vacuum ultraviolet.



SK-1300 Series Grade and Quality

Grade	Max Size (mm)	Striae ¹⁾	Homogeneity ²⁾	Birefringence ²⁾ (nm/cm)	Inclusion ³⁾ (mm ² /100cm ³)	Fluorescence ⁴⁾	Optimum Transmission Range (nm) (>80%)
SK-1300	φ850 ×t150	Class 1 Grade "A"	Not Specified	≤10	0 ~ 0.03	Not Specified	170 ~ 2500
SK-1320L ⁵⁾	φ600 ×t100	Class 1 Grade "A"	Not Specified	≤5	0 ~ 0.03	Free	170 ~ 2500
SK-1321	φ500 ×t150	Class 1 Grade "A"	$1D \leq 2 \times 10^{-6}$	≤3	0 ~ 0.03	Not Specified	170 ~ 2500
SK-1321L ⁵⁾	φ500 ×t100	Class 1 Grade "A"	$1D \leq 2 \times 10^{-6}$	≤3	0 ~ 0.03	Free	170 ~ 2500
SK-1322	φ500 ×t150	Class 3 Grade "A"	$3D \leq 2 \times 10^{-6}$	≤3	0 ~ 0.03	Not Specified	170 ~ 2500
SK-1322L ⁵⁾	φ500 ×t100	Class 3 Grade "A"	$3D \leq 2 \times 10^{-6}$	≤3	0 ~ 0.03	Free	170 ~ 2500
SK-1310	φ60 0×t150	Class 1 Grade "A"	Not Specified	Not Specified	0 ~ 0.03	Not Specified	185 ~ 2700

Notes:

1)MIL-G-174 Definition

2)Effective area for 10% of diameter respective. High homogeneity and birefringence are available upon request.

3)Inclusion correspond to grade "A" for DIN58927 Definition.

4)Energy density $\leq 30 \text{ mJ/cm}^2$ at $\lambda=248 \text{ nm}$. High energy laser use are available upon request.

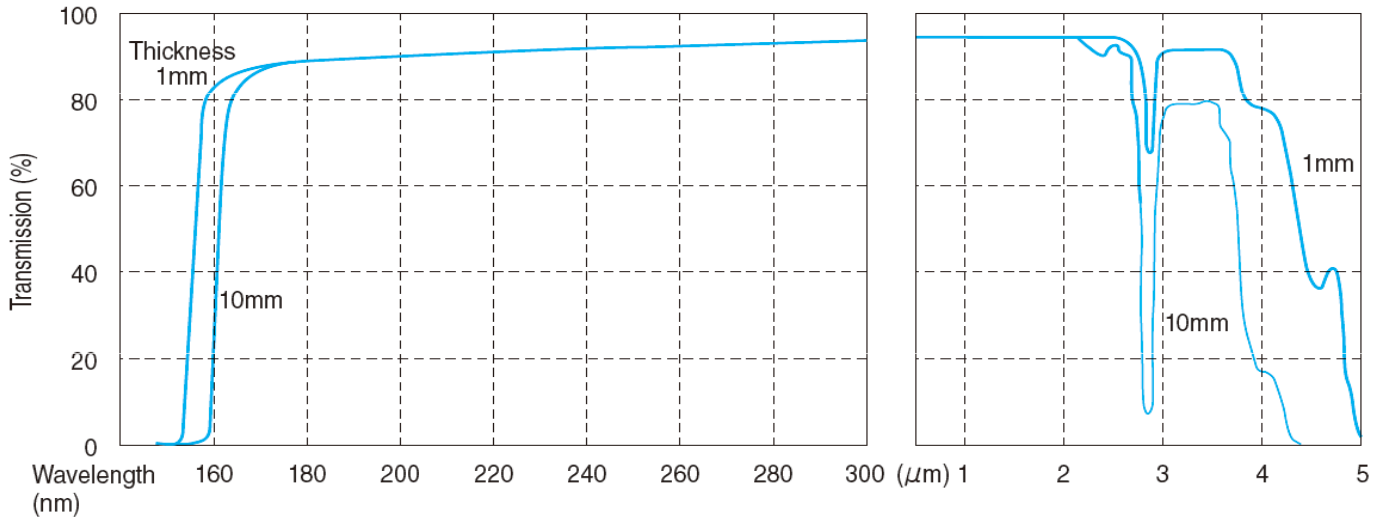
5)Durability : $\leq 0.1\%/\text{cm}$ after $30 \text{ mJ/cm}^2 \cdot 200 \text{ Mshot}$ irradiation at $\lambda=248 \text{ nm}$



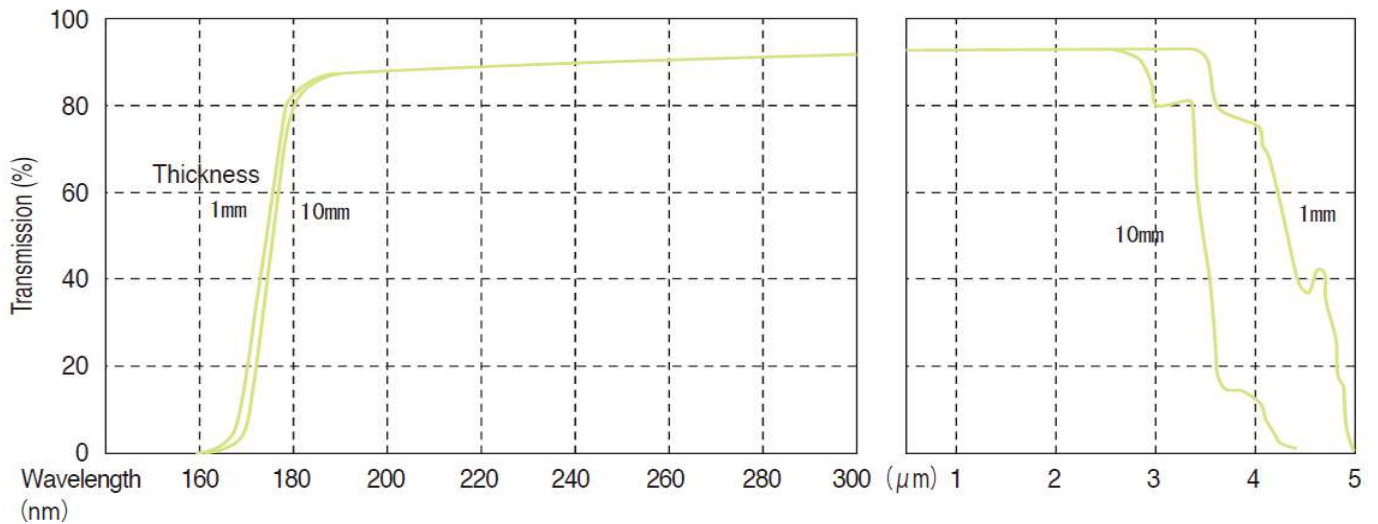
SK-1300 Series Spectral Transmission

Typical Characteristics

《SK-1300, 1320L, 1321, 1321L, 1322, 1322L》



《SK-1310》



Grade	Internal Transmittance(%/cm)								OH Content (ppm)	Impurity others (ppm)
	193nm (ArF)	248nm (KrF)	365nm (i)	588nm (d)	633nm (He-Ne)	1060nm	1530nm	2325nm		
SK-1300	≥99.7	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.4	≤200	≤0.05
SK-1320L	≥99.7	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.4	≤200	≤0.05
SK-1321	≥99.7	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.4	≤200	≤0.05
SK-1321L	≥99.7	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.4	≤200	≤0.05
SK-1322	≥99.7	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.4	≤200	≤0.05
SK-1322L	≥99.7	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.4	≤200	≤0.05
SK-1310	≥98.8	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.9	≥99.8	≤1	≤0.05



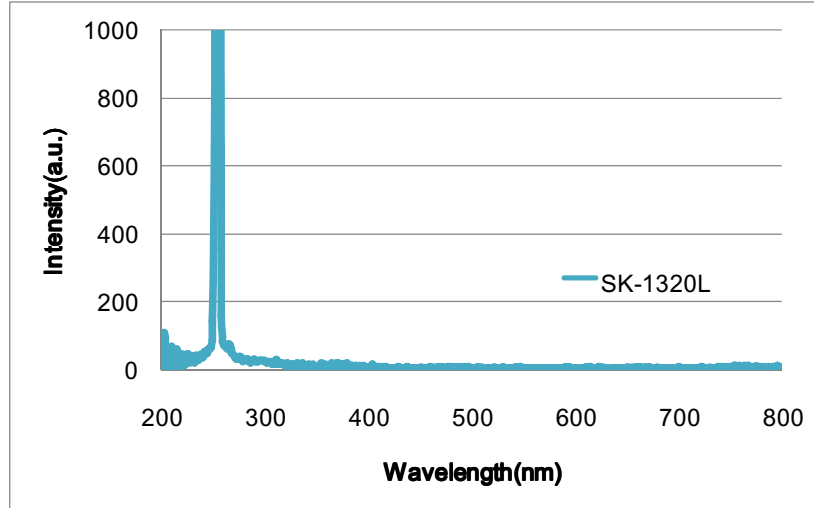
SK-1300 Series "L" for High-power Laser Fluorescence

Typical Characteristics 《SK-1320L, 1321L, 1322L》

The airlight strength ratio less than 1%

《Measurement condition》

Laser wavelength: 248nm
Energy density: 150mJ/cm²
Repetition rate: 10Hz

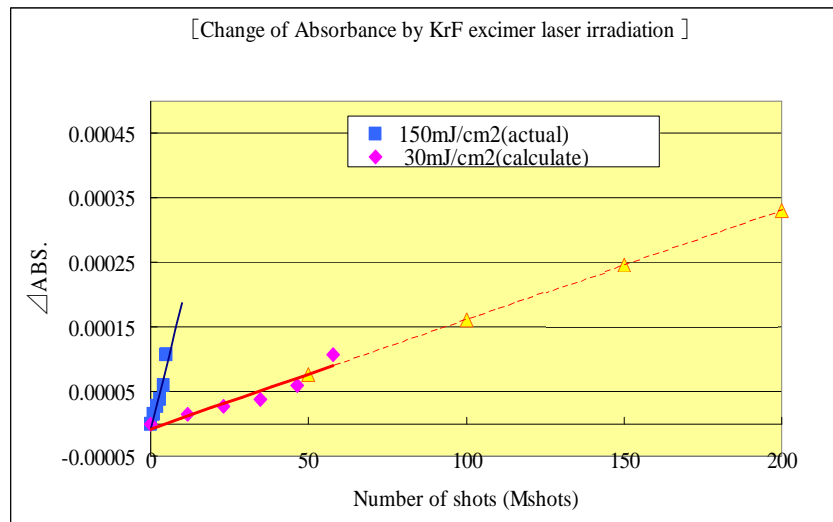


Laser Durability against KrF Excimer Laser

Typical Characteristics 《SK-1320L, 1321L, 1322L》

《Measurement condition》

Laser wavelength: 248nm
Energy density: 150mJ/cm²
Repetition rate: 100Hz
Number of shots: 5M



(30mJ/cm² 100Hz)

Number of shots (Mshots)	50	100	150	200
ΔAbsorbance	7.67E-05	1.61E-04	2.46E-04	3.30E-04
ΔTransmittance@cm	0.018%	0.037%	0.057%	0.076%

Laser Damage threshold by High-power Laser

Typical Characteristics 《SK-1321》

《Measurement condition》

N on 1

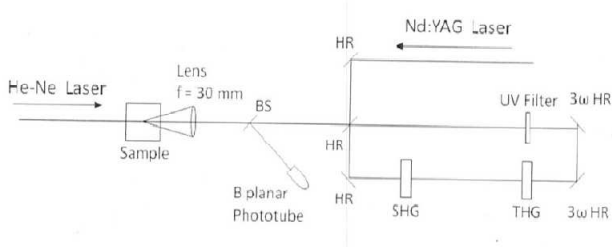
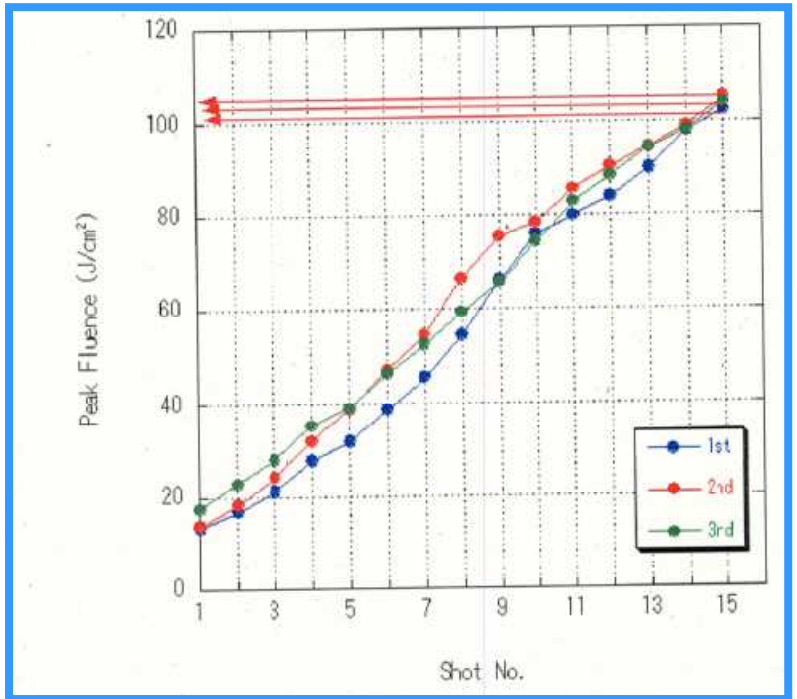
Laser wavelength: 1,064nm

Laser plus: 4ns

Spot size: 91x73μm

Shot angle: 0°

Linear polarization



		$DT_p(J/cm^2)$	$DT_A(J/cm^2)$
SK-1321	1st	102	51
	2nd	105	52
	3rd	104	52



SK-1300,1320L,1321,1321L,1322,1322L
Glass Data Sheet

Code(d) 459678

Code(e) 460677

Refractive Index n_d	1.45863 1.458630	Abbe Number v_d	67.8 67.84	Dispersion n_F-n_C	0.00676 0.006760
Refractive Index n_e	1.460244	Abbe Number v_e	67.69	Dispersion n_F-n_C	0.006799

Refractive Indices(at 25°C,Air,1013hPa)		
$\lambda(\mu m)$		
n_{2325}	2.32542	1.43315
n_{1970}	1.97009	1.43872
n_{1530}	1.52958	1.44445
n_{1129}	1.12864	1.44904
n_f	1.01398	1.45041
n_s	0.85211	1.45263
$n_{A'}$	0.76819	1.45406
n_r	0.70652	1.45531
n_C	0.65627	1.45653
$n_{C'}$	0.64385	1.45687
n_{He-Ne}	0.63280	1.45718
n_D	0.58929	1.45857
n_d	0.58756	1.45863
n_e	0.54607	1.46024
n_F	0.48613	1.46329
$n_{F'}$	0.47999	1.46367
n_{He-Cd}	0.44157	1.46639
n_g	0.435835	1.46686
n_h	0.404656	1.46979
n_i	0.365015	1.47471

Deviation of Relative Dispersions $\Delta\theta$ from "Normal"	
$\Delta\theta_{C,t}$	0.0403
$\Delta\theta_{C,A'}$	0.0083
$\Delta\theta_{g,d}$	-0.0063
$\Delta\theta_{g,F}$	-0.0040
$\Delta\theta_{i,g}$	0.0042

Constants of Dispersion Formula	
A_1	7.44386780E-01
A_2	3.60198890E-01
A_3	9.18623119E-01
B_1	4.95119834E-03
B_2	1.41130274E-02
B_3	1.00428510E+02

Other Properties	
Bubble Quality Group	1
Specific Gravity	2.20
Remarks	

Range of Temperature (°C)	Temperature Coefficients of Refractive Index dn/dt relative (10 ⁻⁶ /°C)						
	t	C'	He-Ne	D	e	F'	g
-40~20	-	-	-	-	-	-	-
-20~0	-	-	-	-	-	-	-
0~20	-	-	-	-	-	-	-
20~25	9.7	10.0	10.4	10.3	10.2	10.5	10.7
20~40	-	-	-	-	-	-	-
40~60	-	-	-	-	-	-	-
60~80	-	-	-	-	-	-	-

Partial Dispersions	
n_C-n_t	0.006120
$n_C-n_{A'}$	0.002477
n_d-n_C	0.002097
n_e-n_C	0.003711
n_g-n_d	0.008230
n_g-n_F	0.003567
n_h-n_g	0.002925
n_i-n_g	0.007850
n_C-n_t	0.006457
n_e-n_C	0.003374
n_F-n_e	0.003425
n_i-n_F	0.011041

Thermal Properties	
Strain Point STP (°C)	1060
Annealing Point AP (°C)	1160
Transformation Temperature Tg (°C)	-
Yield Point At (°C)	-
Softening Point SP (°C)	1700
Expansion Coefficients (+0~+200°C)	5.5
α (10 ⁻⁷ /°C) (+100~+300°C)	-
Thermal Conductivity k (W/m·K)	1.1 (26°C)

Mechanical Properties	
Young's Modulus E (10 ⁹ N/m ²)	714
Rigidity Modulus G (10 ⁹ N/m ²)	309
Poisson's Ratio σ	0.17
Knoop Hardness Hk[Class]	6400 7
Abrasion Aa	-
Photoelastic Constant β (nm/cm/10 ⁵ Pa)	3.5

Chemical Properties	
Water Resistance(Powder) Group RW(P)	
Acid Resistance(Powder) Group RA(P)	
Weathering Resistance(Surface) Group W(S)	
Acid Resistance(Surface) Group SR	1.0
Phosphate Resistance PR	

Impurities	
OH content (ppm)	<200
Cl content (ppm)	<1

Relative Partial Dispersions	
$\theta_{C,t}$	0.9053
$\theta_{C,A'}$	0.3664
$\theta_{d,C}$	0.3102
$\theta_{e,C}$	0.549
$\theta_{g,d}$	1.2175
$\theta_{g,F}$	0.5277
$\theta_{h,g}$	0.4327
$\theta_{i,g}$	1.1612
$\theta'_{C,t}$	0.9497
$\theta'_{e,C'}$	0.4962
$\theta'_{F,e}$	0.5038
$\theta'_{i,F}$	1.6239

Coloring			
λ_{90}	~180	λ_5	~180
λ_{70}	~180		
~180:Less than 180nm			

Internal Transmittance	
λ (nm)	τ 10mm
140	0.000
150	0.005
160	0.637
170	0.978
180	0.992
190	0.993
200	0.993
210	0.995
220	0.997
230	0.997
240	0.998
250	0.999~
260	0.999~
270	0.999~
280	0.999~
290	0.999~
300	0.999~
320	0.999~
340	0.999~
360	0.999~
380	0.999~
400	0.999~
450	0.999~
500	0.999~
550	0.999~
600	0.999~
650	0.999~
700	0.999~
800	0.999~
900	0.999~
1000	0.999~
1200	0.999~
1400	0.998
1600	0.999~
1800	0.999~
2000	0.999~
2200	0.982
2400	0.991
2500	0.982

0.999~:better than 0.999



SK-1310
Glass Data Sheet

Code(d) 459678
Code(e) 460677

Refractive Index n_d	1.45866 1.458663	Abbe Number v_d	67.8 67.85	Dispersion n_F-n_C	0.00676 0.006760
Refractive Index n_e	1.460277	Abbe Number v_e	67.71	Dispersion n_F-n_C'	0.006798

Refractive Indices(at 25°C,Air,1013hPa)		
$\lambda(\mu\text{m})$		
n_{2325}	2.32542	1.43320
n_{1970}	1.97009	1.43876
n_{1530}	1.52958	1.44449
n_{1129}	1.12864	1.44908
n_f	1.01398	1.45045
n_s	0.85211	1.45267
$n_{A'}$	0.76819	1.45409
n_r	0.70652	1.45535
n_C	0.65627	1.45657
$n_{C'}$	0.64385	1.45690
$n_{\text{He-Ne}}$	0.63280	1.45722
n_D	0.58929	1.45860
n_d	0.58756	1.45866
n_e	0.54607	1.46028
n_F	0.48613	1.46333
$n_{F'}$	0.47999	1.46370
$n_{\text{He-Cd}}$	0.44157	1.46642
n_g	0.435835	1.46689
n_h	0.404656	1.46982
n_i	0.365015	1.47475

Deviation of Relative Dispersions $\Delta\theta$ from "Normal"	
$\Delta\theta_{C,t}$	0.0400
$\Delta\theta_{C,A'}$	0.0082
$\Delta\theta_{g,d}$	-0.0063
$\Delta\theta_{g,F}$	-0.0040
$\Delta\theta_{i,g}$	0.0048

Constants of Dispersion Formula	
A_1	7.50110530E-01
A_2	3.54568578E-01
A_3	9.18389018E-01
B_1	4.97286260E-03
B_2	1.42109021E-02
B_3	1.00468940E+02

Other Properties	
Bubble Quality Group	1
Specific Gravity	2.20
Remarks	

Temperature Coefficients of Refractive Index							
Range of Temperature (°C)	dn/dt relative (10 ⁻⁶ /°C)						
	t	C'	He-Ne	D	e	F'	g
-40~20	-	-	-	-	-	-	-
-20~0	-	-	-	-	-	-	-
0~20	-	-	-	-	-	-	-
20~25	9.7	10.1	10.0	10.1	10.2	10.5	10.7
20~40	-	-	-	-	-	-	-
40~60	-	-	-	-	-	-	-
60~80	-	-	-	-	-	-	-

Partial Dispersions	
n_C-n_t	0.006118
$n_C-n_{A'}$	0.002476
n_d-n_C	0.002097
n_e-n_C	0.003711
n_g-n_d	0.008230
n_g-n_F	0.003567
n_h-n_g	0.002927
n_r-n_g	0.007853
n_C-n_t	0.006456
n_e-n_C'	0.003373
n_F-n_e	0.003425
n_r-n_F	0.011044

Thermal Properties	
Strain Point STP (°C)	1060
Annealing Point AP (°C)	1160
Transformation Temperature Tg (°C)	-
Yield Point At (°C)	-
Softening Point SP (°C)	1700
Expansion Coefficients (+0~+200°C)	5.5
α (10 ⁻⁷ /°C) (+100~+300°C)	-
Thermal Conductivity k (W/m·K)	

Mechanical Properties	
Young's Modulus E (10 ⁹ N/m ²)	716
Rigidity Modulus G (10 ⁹ N/m ²)	314
Poisson's Ratio σ	0.17
Knoop Hardness Hk[Class]	7
Abrasion Aa	-
Photoelastic Constant β (nm/cm/10 ⁵ Pa)	3.5

Chemical Properties	
Water Resistance(Powder) Group RW(P)	
Acid Resistance(Powder) Group RA(P)	
Weathering Resistance(Surface) Group W(S)	
Acid Resistance(Surface) Group SR	1.0
Phosphate Resistance PR	

Impurities	
OH content (ppm)	<1
Cl content (ppm)	<2000

Relative Partial Dispersions	
$\theta_{C,t}$	0.905
$\theta_{C,A'}$	0.3663
$\theta_{d,C}$	0.3102
$\theta_{e,C}$	0.549
$\theta_{g,d}$	1.2175
$\theta_{g,F}$	0.5277
$\theta_{h,g}$	0.433
$\theta_{i,g}$	1.1617
$\theta'_{C,t}$	0.9497
$\theta'_{e,C'}$	0.4962
$\theta'_{F,e}$	0.5038
$\theta'_{i,F}$	1.6246

Coloring			
λ_{90}	~180	λ_5	~180
λ_{70}	~180		
~180:Less than 180nm			

Internal Transmittance	
λ (nm)	τ 10mm
140	0.000
150	0.003
160	0.243
170	0.507
180	0.971
190	0.988
200	0.992
210	0.995
220	0.997
230	0.998
240	0.998
250	0.999~
260	0.999~
270	0.999~
280	0.999~
290	0.999~
300	0.999~
320	0.999~
340	0.999~
360	0.999~
380	0.999~
400	0.999~
450	0.999~
500	0.999~
550	0.999~
600	0.999~
650	0.999~
700	0.999~
800	0.999~
900	0.999~
1000	0.999~
1200	0.999~
1400	0.999~
1600	0.999~
1800	0.999~
2000	0.999~
2200	0.999~
2400	0.995
2500	0.992

0.999~:better than 0.999