

Synthetic Silica Glass

ES grades

These are directly synthesized silica glass in Oxy-/Hydrogen flame from silicon tetra chloride and show the excellent properties for purity, UV transmittance, laser durability, and refractive index homogeneity. Five grades, ES, ESL-1, ESL-1000, ESL-2, and ESL-2000, will be available.

Impurity (Typical Data)

	Al	Ca	Cu	Fe	Na	K	Li	Mg	OH uni
ES	0.1	0.1	0.01	0.05	0.05	0.05	0.05	<0.01	600~1300

Optical Properties

Grade	Striae ¹⁾	OH Conc. (ppm)	Homogeneity ²⁾ $\Delta n(PV)/(ppm)$ within CA	Strain(nm /cm)	Fluores- cence ³⁾	Excimer Durability	Applicable Wavelength ⁵⁾ (nm)	Bubble Class ⁶⁾
ES	1D	600 ~ 1300	n.sp	20	NS	n.sp.	180 ~ 2000	Class 0
ESL-1	1D	600 ~ 1300	20(CA:φ 600) 10(CA:φ 350)	10	None	n.sp.	180 ~ 2000	Class 0
ESL-1000	1D	600 ~ 1300	20(CA:φ 600) 10(CA:φ 350)	10	None	sp.(4)	180 ~ 2000	Class 0
ESL-2	3D	600 ~ 1300	10(CA:φ 200xt70)	10	None	n.sp.	180 ~ 2000	Class 0
ESL-2000	3D	600 ~ 1300	10(CA:φ 200xt70)	10	None	sp.(4)	180 ~ 2000	Class 0

n.sp.= not specified

- Striae specification is defined as follows and whose level is class A, B, and C according to the interferometer pattern.
1D: 1 direction free 3D: 3 direction free
- means refractive index homogeneity and expressed as $\Delta n(PV)$ within effective area.
- Fluorescence shall be checked with excitation at 254 nm using a Hg-lamp.
- Specified with TOSOH own condition of KrF and ArF excimer laser damage tests.
- Applicable wavelength is defined as the wavelength range where external transmittance is more than 80% cm.
- As per DIN 58927



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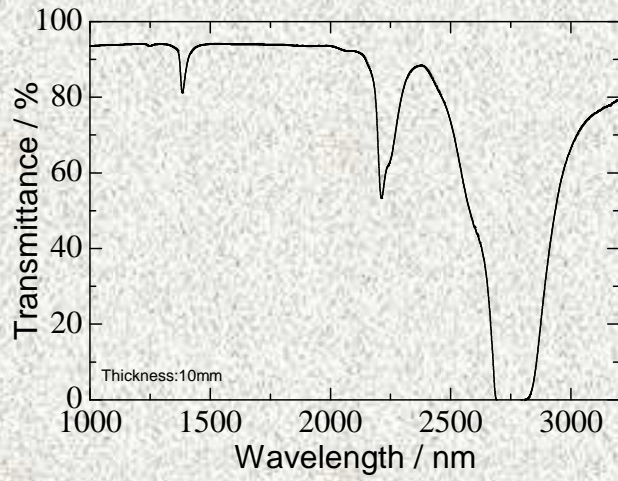
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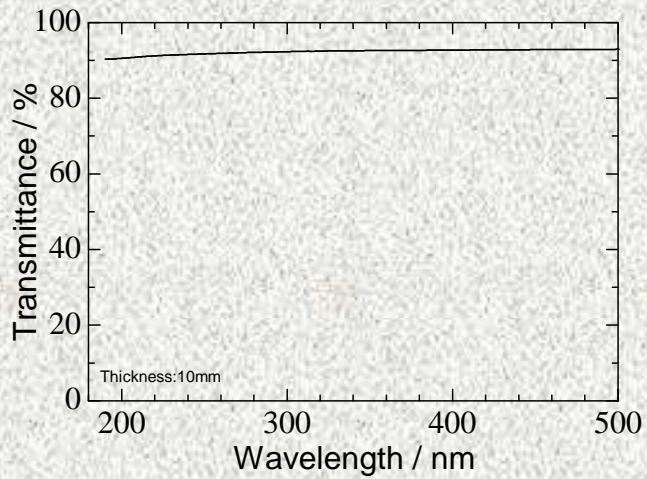


Spectra

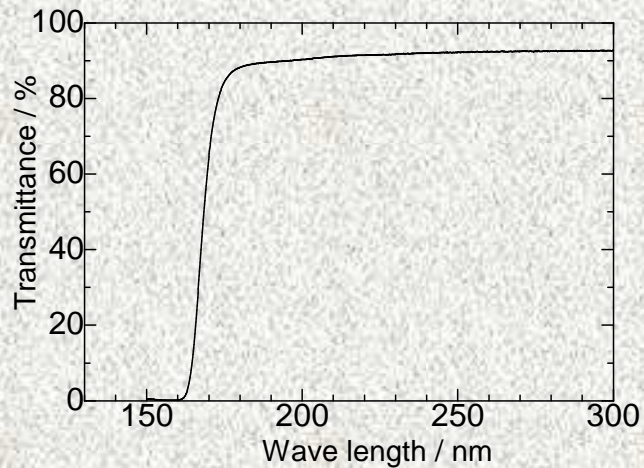
IR Transmittance



UV Transmittance



DUV Transmittance



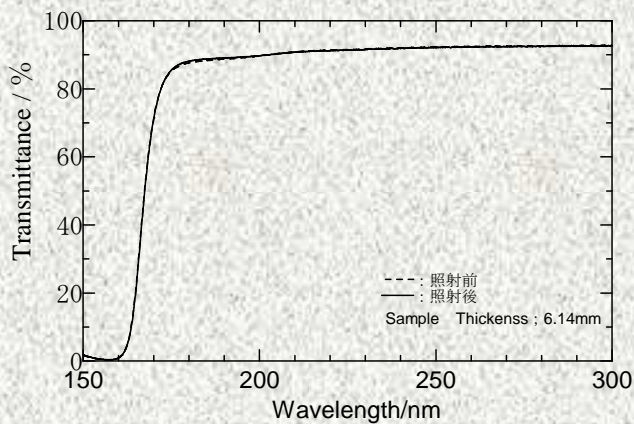
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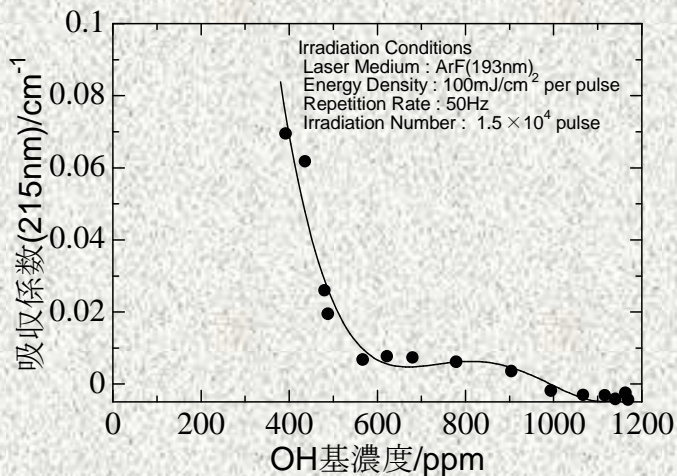


Excimer Laser Durability

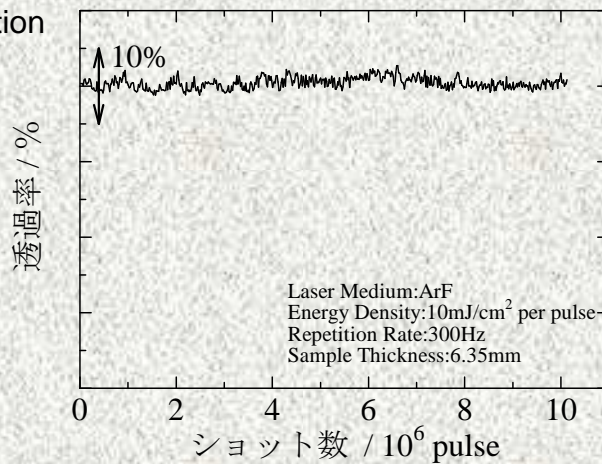
: Transmittance change in radiation



Absorption Coefficient vs
OH content



Transmittance Change during Radiation



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Mechanical properties

		Synthetic Fused Silica				
		ES	ED-A	ED-B	ED-C	ED-H
Vickers hardness	GPa	8.9	8.9	8.9	8.9	8.9
Young's modulus	GPa	74	74	74	74	74
Shea modulus	GPa	31	31	31	31	31
Poisson's Ratio		0.17	0.17	0.17	0.17	0.17
Bending Strength	MPa	94	94	94	94	94
Compressive Strength	MPa	1.1	1.1	1.1	1.1	1.1
Tensile Strength	MPa	49	49	49	49	49
Torsion Strength	MPa	29	29	29	29	29

Electrical properties

			Synthetic Fused Silica				
			ES	ED-A	ED-B	ED-C	ED-H
Dielectric Constant	1MHz		3.88	3.88	3.88	3.88	3.88
Dielectric Loss Factor(tan δ)	1MHz		0.005	0.005	0.005	0.005	0.005
Resistivity	100°C	Ω cm	10^{16}	10^{16}	10^{16}	10^{16}	10^{16}
	500°C	Ω cm	10^8	10^8	10^8	10^8	10^8
	1000°C	Ω cm	10^5	10^5	10^5	10^5	10^5
Dielectric Breakdown Voltage	20°C	kV/m m	32	32	32	32	32
	500°C	kV/m m	11	11	11	11	11



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Thermal properties

		Synthetic Fused Silica				
		ES	ED-A	ED-B	ED-C	ED-H
Strain point	°C	970	1,060	1,110	970	1,060
Annealing point	°C	1,080	1,170	1,200	1,080	1,170
Softening point	°C	1,720	1,720	1,720	1,720	1,720
Coefficient of Thermal Expansion	$\times 10^{-7} \text{ } ^\circ\text{C}^{-1}$	4.7	4.7	4.7	4.7	4.7
Specific Heat	20°C	$\text{J kg}^{-1} \text{K}^{-1}$	749	749	749	749
	500°C	$\text{J kg}^{-1} \text{K}^{-1}$	1,122	1,122	1,122	1,122
	700°C	$\text{J kg}^{-1} \text{K}^{-1}$	1,201	1,201	1,201	1,201
	900°C	$\text{J kg}^{-1} \text{K}^{-1}$	1,243	1,243	1,243	1,243
Thermal Diffusivity	19°C	$\times 10^{-7} \text{ m}^2 \text{ s}^{-1}$	8.5	8.5	8.5	8.5
	500°C	$\times 10^{-7} \text{ m}^2 \text{ s}^{-1}$	7.8	7.8	7.8	7.8
	700°C	$\times 10^{-7} \text{ m}^2 \text{ s}^{-1}$	8.2	8.2	8.2	8.2
	1000°C	$\times 10^{-7} \text{ m}^2 \text{ s}^{-1}$	9.6	9.6	9.6	9.6
Thermal Conductivity	19°C	$\text{W m}^{-1} \text{K}^{-1}$	1.38	1.38	1.38	1.38
	500°C	$\text{W m}^{-1} \text{K}^{-1}$	1.93	1.93	1.93	1.93
	700°C	$\text{W m}^{-1} \text{K}^{-1}$	2.17	2.17	2.17	2.17
	1000°C	$\text{W m}^{-1} \text{K}^{-1}$	2.55	2.55	2.55	2.55
Viscosity ($\log \eta$, 1200°C)	Pa s	10.6	11.61	12.00	10.6	11.37



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Electrical properties

			Synthetic Fused Silica				
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Dielectric Constant	1MHz		3.88	3.88	3.88	3.88	3.88
Dielectric Loss Factor(tan δ)	1MHz		0.005	0.005	0.005	0.005	0.005
Resistivity	100°C	Ω cm	10^{16}	10^{16}	10^{16}	10^{16}	10^{16}
	500°C	Ω cm	10^8	10^8	10^8	10^8	10^8
	1000°C	Ω cm	10^5	10^5	10^5	10^5	10^5
Dielectric Breakdown Voltage	20°C	kV/m m	32	32	32	32	32
	500°C	kV/m m	11	11	11	11	11



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