Laseri Optoelectronics Co., Ltd.
Futian Street, Yiwu City, Jinhua City, Zhejiang Province, China
Tel: +86 153 8174 0282 Email: sales@bj-laseri.com Website: https://www.bj-laseri.com

Material Properties of Fused Silica

Introduction

Quartz glass is a special industrial technical glass composed of a single component of silicon dioxide (SiO_2). Because it has a series of special properties that cannot be replaced by other materials, it has played a very important role in modern industry and high-tech fields. Ordinary quartz glass is made by high-temperature melting using natural crystal or silica as raw material, while high-purity high-quality quartz glass is made by flame hydrolysis synthesis process using inorganic or organic silicon-containing liquid compounds (such as silicon tetrachloride) as synthetic quartz glass.

In China, quartz glass is divided into the following 3 grades:
JGS1 far ultraviolet optical quartz glass, application spectral band 185-2500nm
JGS2 ultraviolet optical quartz glass, application spectral band 220-2500 nm
JGS3 infrared optical quartz glass, application spectrum band 260-3500nm

The performance of quartz glass is determined by its preparation method and its auxiliary processing technology. Although the chemical composition of quartz glass is almost the same (single component silica), the performance of quartz glass produced by each process has its own characteristics. The following are the main properties of quartz glass.

Mechanical Properties of Quartz Glass

Description	Standard Value
Density	2.2g/cm^3
Compressive Strength	1100Mpa
Bending Strength	67Mpa
Tensile Strength	48Mpa
Poisson's Ratio	0.14 ~ 0.17
Young's Modulus	72000Mpa
Rigid Modulus	31000Mpa
Moh's Hardness	5.5 ~ 6.5

Thermal Properties of Quartz Glass

Description	Standard Value
Deformation Point	1120℃
Softening Point	1680℃
Annealing Point	1210℃
Specific Heat (20 ~ 350℃)	670J/kg.℃
Thermal Conductivity (20℃)	1.4W/m.℃
Thermal Expansion Coefficient	5.5×10-7cm/cm.℃
Thermal Processing Temperature	1700 ~ 2000℃
Short-Term Use Temperature	1300℃
Long-Term Use Temperature	1100℃

Electrical Properties of Quartz Glass

Description	Standard Value
Resistivity	$7\times10^{7}\Omega.cm$
Dielectric strength	250 ~ 400Kv/cm
Dielectric constant ε	3.7 ~ 3.9
Dielectric Absorption Coefficient	$<4\times10^{4}$
Dielectric Loss Coefficient	$<1\times10^{4}$

Chemical Properties of Quartz Glass

Solution	Treatment Condition	Corrosion Capacity
H2O	95℃ 45 Hours	$1\sim2\times10^{-7}$ g/cm2
98%H2SO4	20℃ 2 Hours	1.4×10^{-8} g/cm2
60%HNO3	20℃ 2 Hours	5.0×10^{-8} g/cm2
36%HCl	20℃ 2 Hours	15×10^{-8} g/cm2
5%NaOH	100℃ 10 Hours	1.35×10^{-3} g/cm2
1%KOH	98℃ 2 Hours	68×10^{-6} g/cm2

Purity

Element	Impurities (ppm)			
	Synthetic (CVD)	Oxy-hyd melting JGS2		Electrical
	JGS1	JGS2-1	JGS2-2	Melting JGS3
Al	0.16	17.00	19.35	14.44
Fe	0.01	0.36	0.39	1.46
Ca	0.31	1.30	1.55	2.45
Mg	0.65	0.22	0.89	0.46
Ti	0.08	1.3	2.41	4.84
Cu	0.01	0.04	0.02	0.16
Ni	0.01	0.01	0.01	0.04
Co	0.04	0.01	0.01	0.02
Mn	0.01	0.03	0.02	0.08
K	0.34	0.63	0.93	2.16
Na	0.06	1.11	1.81	1.33
Li	0.01	0.63	0.62	0.81
B	/	0.08	0.09	0.05
OH	1100~1300	150~250	150~250	1~120
SiO2	>99.999%	99.99%	99.95%	99.92%

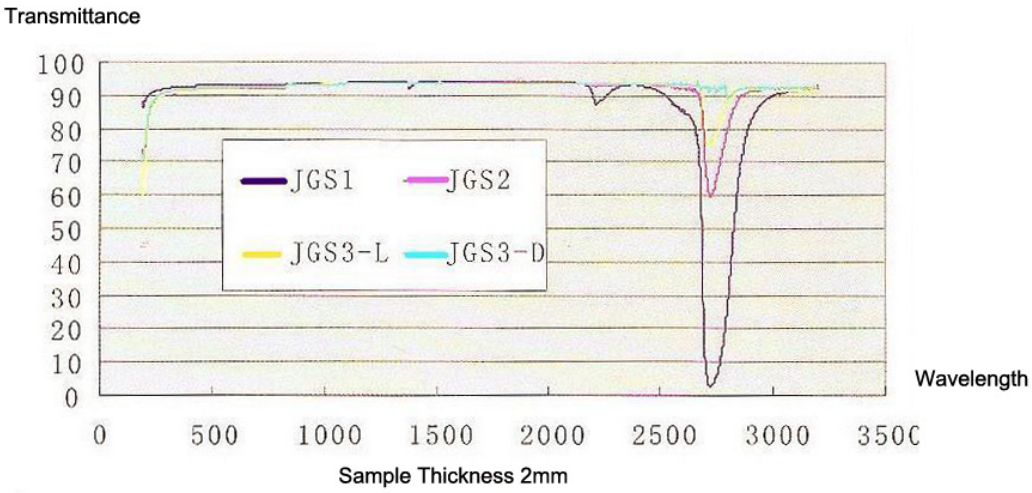
Laseri Optoelectronics Co., Ltd.
Futian Street, Yiwu City, Jinhua City, Zhejiang Province, China
Tel: +86 153 8174 0282 Email: sales@bj-laseri.com Website: https://www.bj-laseri.com

Optical Properties of Quartz Glass

Wavelength	Synthetic (CVD) JGS1	Oxy-hyd melting JGS2		Electrical Melting JGS3	
		JGS2-1	JGS2-2	JGS3-1	JGS3-2
190	86.42	73.84	71.02	75.73	68.35
200	86.88	75.16	74.81	77.16	73.94
210	88.51	79.90	78.89	81.59	79.92
220	89.09	85.69	85.24	85.79	85.53
230	89.58	87.57	87.61	86.61	87.58
240	89.90	87.58	87.75	85.51	88.15
250	90.12	88.64	88.77	87.04	88.93
260	90.46	90.11	89.97	89.42	89.92
280	90.89	90.82	90.79	90.45	90.74
300	91.14	91.15	91.02	90.84	91.11
350	91.49	91.45	91.33	91.12	91.49
400	91.72	91.75	91.63	91.44	91.70
500	92.08	91.99	91.89	91.68	92.04
750	92.26	92.32	92.13	91.91	92.26
1000	92.52	92.48	92.64	92.60	92.34
2000	93.25	93.48	93.51	93.52	93.26
2500	91.58	93.56	93.57	93.77	93.33
2600	87.06	92.45	92.38	95.59	94.91
2730	9.45	64.98	57.71	79.35	64.04
3000	89.70	91.04	92.10	92.94	92.36
3200	92.84	92.61	93.27	94.02	91.42

Remark: Sample thickness 1mm.

Spectrum



Far ultraviolet optical quartz glass JGS1

Transparent in the ultraviolet and visible spectrum; no absorption band in the 185-2500nm band; strong absorption band in the 2600-2800nm band; non-luminous, stable light radiation.

Ultraviolet optical quartz glass JGS2

Transparent in the ultraviolet and visible spectrum; no absorption band in the 220-2500nm band; strong absorption band in the 2600-2800nm band; non-luminous, stable light radiation. It is a good optical material in the 220-2500nm band. Its infrared transmission performance is the same as far ultraviolet quartz glass.

Infrared optical quartz glass JGS3

Transparent in the visible and infrared spectrum; no obvious absorption band in the 2600-2800nm band;

Compared with ordinary silicate glass, transparent quartz glass has excellent transmission performance over the entire wavelength. In the infrared region, the spectral transmittance is larger than that of ordinary glass; in the visible region, the transmittance of quartz glass is also relatively high. In the ultraviolet spectral region, especially in the short-wave ultraviolet region, the spectral transmission is much better than other glasses. The spectral transmittance is affected by three factors: reflection, scattering and absorption. The reflection of quartz glass is generally 8%, it is larger in ultraviolet region is larger, and smaller in infrared region. Therefore, the transmittance of quartz glass is generally not more than 92%. The scattering of quartz glass is relatively small and can generally be ignored. Spectral absorption is closely related to the impurity content of quartz glass and the production process; the transmittance in the band below 200 nanometers represents the amount of metal impurities; the absorption of 240 nanometers represents the amount of hypoxic structure; the absorption in the visible band is caused by the presence of transition metal ions. The absorption of 2730 nm is the absorption peak of the hydroxyl group, which can be used to calculate the hydroxyl content (OH).

Radiation Resistance

Compared with ordinary glass, quartz glass has excellent radiation resistance. Among them, synthetic quartz glass has the best radiation resistance and hardly produces color centers.

Instructions For Use Of Quartz Glass Products

1. Quartz glass is fragile, so please handle it with care during transportation and placement.
2. Quartz glass has extremely low thermal expansion. When in contact with materials with different coefficients of thermal expansion, being fixed or clamped, the rapid change in temperature will cause the quartz glass to break.
3. After the quartz glass is contaminated, it is easy to crystallize at high temperature. For non-cleaning-free quartz glass products that require high-temperature use, they should be cleaned before use. Cleaning should be done in this way: put the quartz product into de-ionized water or distilled water with degreasing agent to scrub, after scrubbing, quickly rinse the product with deionized water, and then use 5% (volume ratio) hydrogen soak in fluoric acid for 5 minutes or 5% ammonium fluoride for 10 minutes, then rinse with deionized water and quickly dry the product.
4. Intermittent use of quartz glass at high temperature is not recommended. This is mainly because the thermal expansion coefficient and specific gravity of quartz glass are similar to the crystallized product β-cristobalite. Therefore, in continuous use at high temperatures, although the crystallization zone continues to expand, the volume change is not obvious, and it can still be used satisfactorily. When the crystallization product is cooled to 800°C, a fine crack network appears. When cooling continues to 200~275°C, the structure of cristobalite changes from high temperature to low temperature (that is, β-cristobalite to α-cristobalite), and volume fusion occurs. If the crystalline layer is deep, the quartz glass will also crack.
5. Hydrofluoric acid and 200°C hot phosphoric acid will obviously corrode quartz glass.