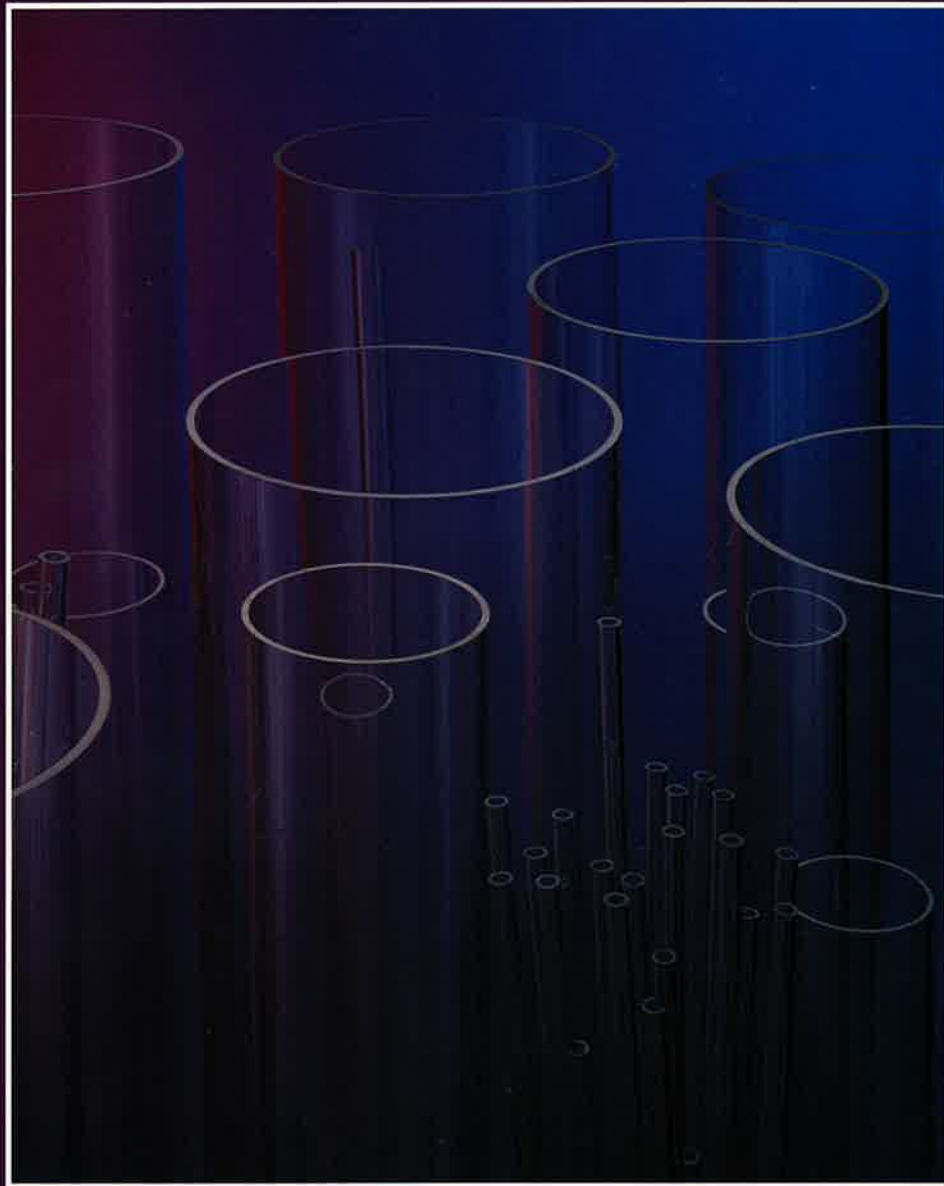


FUSED QUARTZ

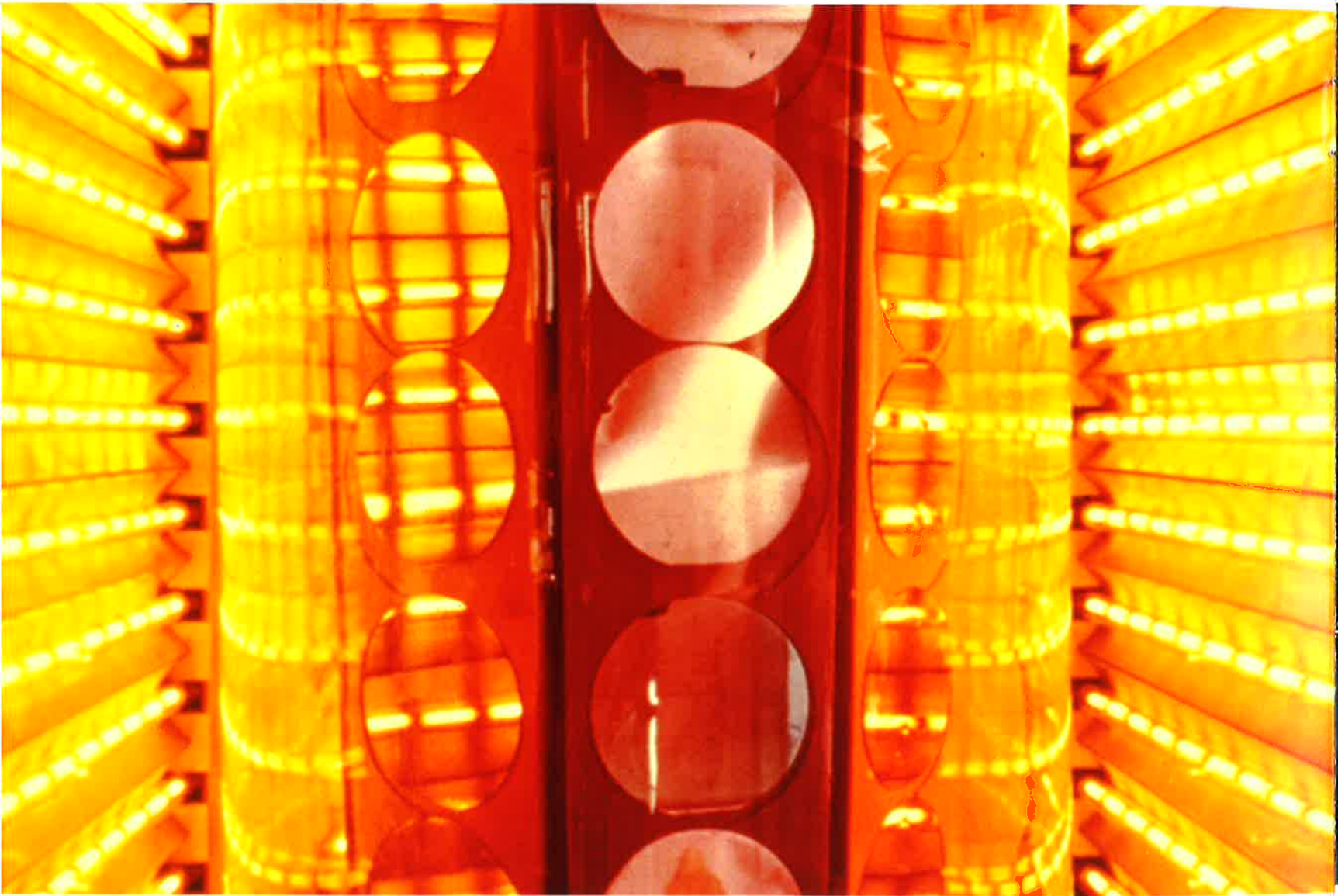


SYLVANIA Emissive
Products



THE POWER IS ON

QUALITY AND SERVICE BASED ON DECADES OF FUSED QUARTZ EXPERIENCE



The GTE Fused Quartz Operation is part of the Precision Materials Group of GTE Products Corporation which manufactures a broad range of engineered materials, parts, and components for virtually every basic industry.

Backed by extensive capabilities for research and development, divisions of the Group work closely with thousands of customers—including most "Fortune 500" firms—to solve problems and contribute strategically to the development and manufacture of a host of technologically advanced consumer and industrial end products.

GTE has been manufacturing fused quartz products for over 20 years. We control quality through every step of our unique, vertically integrated process. GTE tubing has proven to be performance effective for semiconductor and lighting manufacturers worldwide.

GTE'S CONCENTRATION ON SEMICONDUCTOR AND LAMP APPLICATIONS

Grade SG25 SCH, our heavy wall fused quartz tubing, is used for the processing of power devices and some bipolar devices at temperatures to 1250°C.

Wafers 5 inches in diameter and larger are processed in Grade SG25 SCR resized tubing which is available in sizes above 200 mm OD.

Lighting: A focus on the best and the brightest

GTE Grades SG25 A and AB are widely used in high-temperature arc and filament lamps requiring high purity to minimize devitrification and provide optimum sag resistance. These attributes contribute to the long life of these lamps at high operating temperatures.

Arc Lamp Life Expectancy

Lamp Type	Arc Tube Temp	Expected Life
Mercury	700° C	24,000 hrs.
Metal Halide	850° C	10,000 to 20,000 hrs.
Tungsten Halogen	350° C to 750° C	50 to 5,000 hrs.

The outgassing of hydrogen from fused quartz tubing reduces lamp life and results in hard starting for arc lamps. GTE Fused Quartz is vacuum baked to reduce the residual hydrogen content to very low levels.

The amount of residual hydrogen in fused quartz is related to the optical transmission at 2.73 microns which is the hydroxyl (OH) absorption wavelength in fused quartz.

GTE's Grade SG25 ABZ "ozone free" and ultra-violet absorbing fused quartz contains .01 to .02% titanium dioxide as an additive. The UV transmission below 200 nanometers (nm) is eliminated which prevents the formation of ozone generated when the 185 nm wavelength strikes oxygen.

Because ozone is a lung irritant, Grade SG25 ABZ is used in arc lamps for reproduction machines that are located in confined spaces.

$$\beta = \frac{1}{t} \log \frac{T_{2.6}}{T_{2.73}}$$

β = Beta factor, mm⁻¹

t = Wall thickness, mm

$T_{2.6}$ = Transmission at 2.6 Microns

$T_{2.73}$ = Transmission at 2.73 Microns

ppm (OH) \approx 1,000 \times β



Brooklyn Bridge

Semiconductors: The purest materials for the purest technology

GTE's SG25 SC grades of fused quartz tubing are recognized by major semiconductor manufacturers throughout the world for their consistent high chemical purity and high-temperature resistance.

Applications commonly are furnace tubes for oxidation and diffusion processes, end caps, transfer carriers, thermocouple tubes, wafer carriers, end plates, baffles, and bell-jars for epitaxial reactors.

HARNESSING THE POWER OF THE CRYSTAL



GTE Fused Quartz features low levels of metallic contaminants, low water content, and excellent resistance to high-temperature deformation.

Purified quartz crystal is melted in our high-temperature furnaces at 1900° to 2000°C. Tubing is formed and drawn continuously to outside diameters over 200 mm. To produce these larger sizes, GTE has designed and built the largest direct-draw quartz melting furnace in the world.

Grade SG25 SCR is available in sizes from 200 mm to 330 mm diameter. These larger tubing sizes are produced by a resizing process in which rigid dimensional specifications are met to serve the needs of IC manufacturers using the latest 6 in. and 8 in. wafer technology.

Mining the Quartz Ore



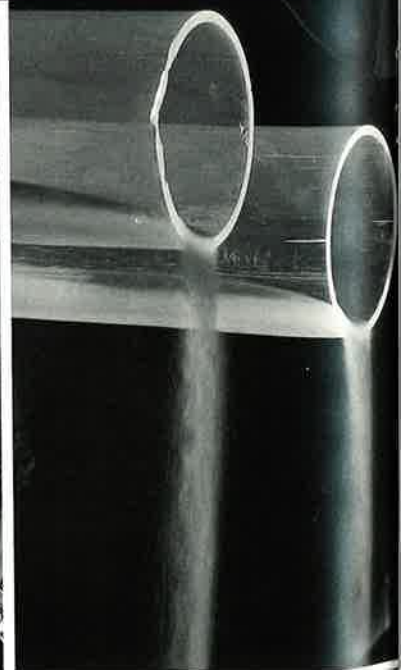
Magnetic Separating



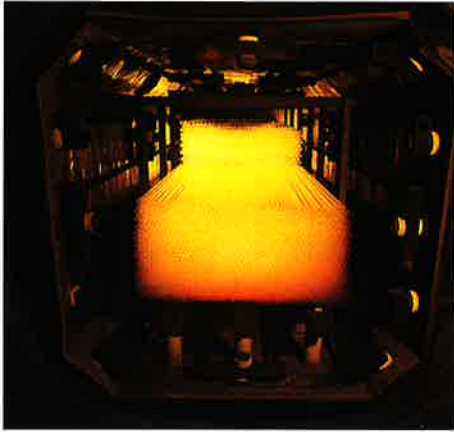
Acid Treating



Calcining



THE QUEST FOR PURITY



At GTE, we produce consistently pure fused quartz, starting with an in-house chemical and firing operation for purifying naturally occurring crystalline quartz.

Flame atomic absorption and inductively-coupled plasma analytical methods are routinely used to insure the quality of the starting, in-process, and finished quartz materials.

Although the crystalline quartz raw material as received contains 300–600 ppm of elemental contaminants, our process reduces total elemental contaminants to less than 30 ppm. This is accomplished by a series of steps that

include high intensity magnetic separation to remove iron and iron-bearing minerals, screening to remove contaminated fractions of the raw materials, a strong acid wash to dissolve non-quartz particles, and high-temperature calcining to remove residual organic materials that may exist on the surfaces of the individual quartz crystals.

GTE's rigid process controls assure consistency of processing and the quality of the treated quartz. Quality is monitored by a careful sampling and chemical analysis testing of the purified quartz before it is used in the melting and tube forming process.



Melter Sand Feeding



Tube Drawing



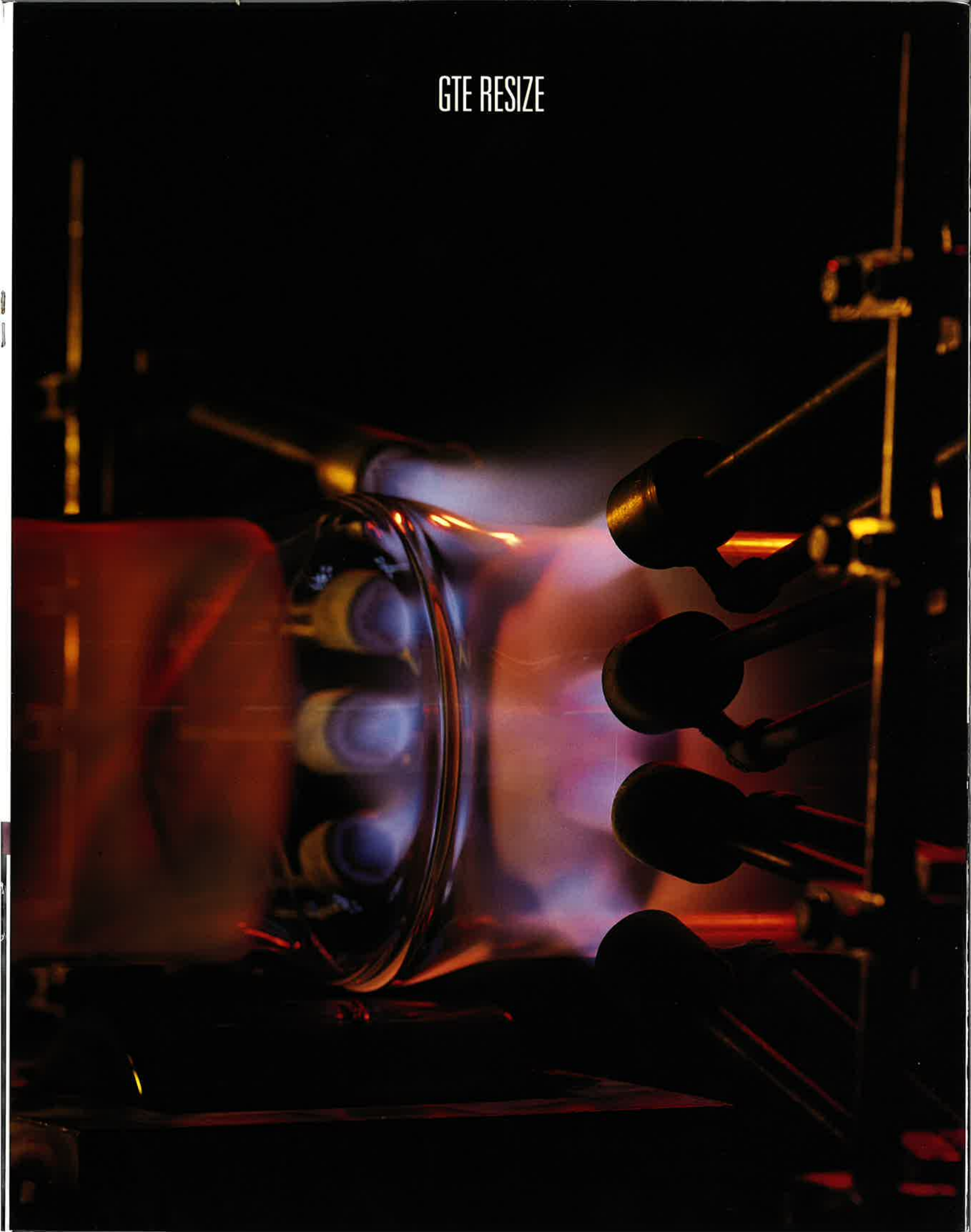
In-Process Quality



Tube Washing



GTE RESIZE

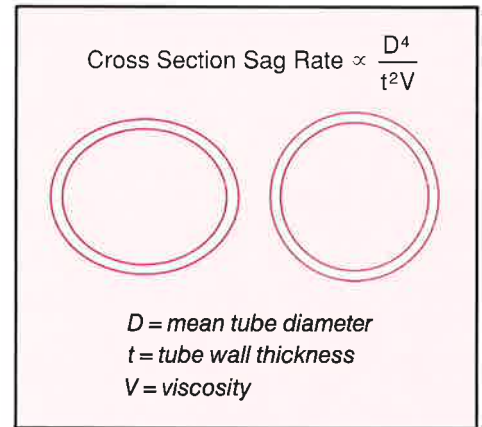
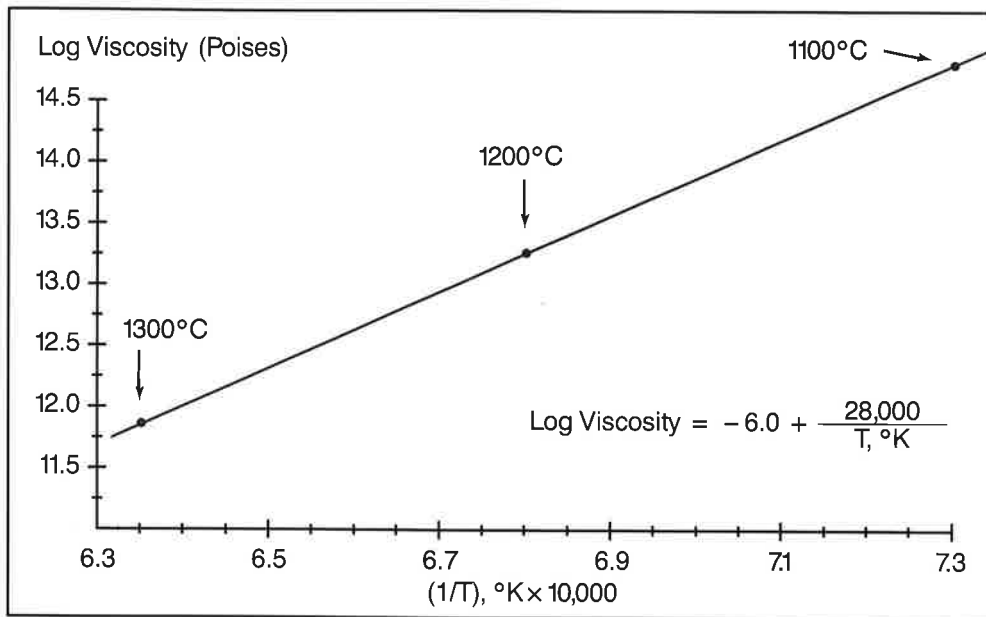


PRECISION TEMPERATURE CONTROL IS THE KEY TO QUALITY

GTE melts the crystalline quartz in furnaces that are designed and built with in-house resources. These furnaces utilize a unique combination of refractory metals and oxides that allow melting and forming temperatures of 1900° to 2000°C.

The high-temperature melting process converts the crystalline quartz to

an amorphous or glassy structure. Because it is a glass, fused quartz does not have a melting point. It does have a softening or flowability property that is called the viscosity. A linear relationship exists between the logarithm of viscosity (V) and the reciprocal of the absolute temperature (T) as shown.



This relationship is useful for evaluating the effect of temperature on the stability of fused quartz. For example, a 10°C temperature increase at 1100°C reduces viscosity and increases the sag rate by about 30%. Temperature sensitivity is important in assessing the performance of fused quartz at high temperatures.

We monitor the tubing continuously to maintain dimensional control well within specifications. For semiconductor furnace applications, each tube is identified with a lot number on the packing label to provide traceability back to the date of manufacture and the raw material.



GTE SYLVANIA QUARTZ TUBING GROW WITH THE POWER OF TECHNOLOGY

GTE Sylvania has grown in ways that address the specific needs of our semiconductor and lighting customers worldwide:

- Improved dimensional tolerance and enhanced purity to help you better control your processes.
- Statistical process control methods to ensure unrivaled product consistency.
- Electronic mail system (GTE Tele-mailSM) connecting GTE order entry and warehouse locations with major quartz fabricators to expedite the processing of your orders.

- An expanded regional warehousing network to ensure that GTE Sylvania Quartz Tubing is where you want it, when you want it.

We're committed to servicing your present and future quartz tubing requirements, to satisfying your growing demands for quality and reliability, and to supporting your developmental efforts.

GTE is uniquely positioned to meet your fused quartz needs and underlying it all is our guarantee of total satisfaction.

If you're not already buying GTE Sylvania Fused Quartz Tubing, you should be. Specify GTE.

CALL GTE PRODUCTS CORPORATION TODAY

GTE maintains extensive stocks of fused quartz tubing at regional warehouses in the USA. A phone call or fax to our customer service departments in Exeter, NH or San Jose, CA will provide you with availability, delivery, and price information. Additional customer service and technical assistance is available through our Exeter, NH location.

New Hampshire

(603) 772-4331 Telephone
(603) 772-1072 Fax
(800) 258-8290 Toll-Free Outside NH

California

(408) 971-0661 Telephone
(408) 287-0830 Fax
(800) 347-3435 Toll-Free



Additional photos, thanks to:

*Applied Materials, Inc.
BTU Engineering Corporation
W.R. Grace & Co.-Conn.
Weiss Scientific Glass Blowing Co.*

GRADES • SIZES • TOLERANCES • CHEMICAL ANALYSIS

GTE Fused Quartz Tubing Grades

SG25 A	Lighting—mercury and tungsten-halogen
SG25 AB	Lighting—metal-halide, specialty
SG25 ABZ	Lighting—ozone-free (UV absorbing)
SG25 SC	Semiconductor standard wall
SG25 SCH	Semiconductor heavy wall, 5 mm and larger
SG25 SCR	Semiconductor resized tubing (OD > 200 mm)

Dimensional Tolerances

Size Ranges Available, OD mm	Tolerance				SG25 Grades					
	OD ±	Oval Max	Wall ±	Siding Max	A	AB	ABZ	SC	SCH	SCR
4– 12	2.5%	2.0%	10%	10%	X	X		X		
12– 40	2.5%	2.0%	10%	10%	X	X	X	X		
100–150	2.0%	1.2%	10%	15%				X	X	
150–200	2.0%	1.2%	10%	15%				X	X	
200–350	3.0mm	1.0%	20%	20%						X
Max. Beta (OH Content), 1/mm					.005	.001	.001	.030	.040	.030

Chemical Analysis

Element	Typical Analysis Range, ppm	Element	Typical Analysis Range, ppm	Element	Typical Analysis Range, ppm
Al	15–20	Ca	0.7–1.0	Cu	<0.2
Fe	0.1–0.6	Mg	0.5–0.9	Mn	<0.1
Na	0.6–0.9	Ti	0.9–1.2	B	<2.0
K	0.5–0.8	Zr	2.0–3.2	P	<0.2
Li	0.5–0.8				

SYLVANIA

Emissive
Products

GTE
THE POWER IS ON

GTE SYLVANIA QUARTZ TUBING TOLERANCES

ID (mm)	OD (mm)	OD RANGE (mm)	WALL RANGE (mm)	Max. Siding (mm)	Max. Ovality (mm)	Pounds Per Foot	KG Per Meter
3.00	5.00	4.88- 5.13	0.90-1.10	0.100	0.10	0.02	0.03
4.00	6.00	5.85- 6.15	0.90-1.10	0.100	0.12	0.02	0.03
5.00	7.00	6.83- 7.18	0.90-1.10	0.100	0.14	0.03	0.04
6.00	8.00	7.80- 8.20	0.90-1.10	0.100	0.16	0.03	0.05
7.00	10.00	9.75- 10.25	1.35-1.65	0.150	0.20	0.06	0.09
8.00	10.00	9.75- 10.25	0.90-1.10	0.100	0.20	0.04	0.06
10.00	12.00	11.70- 12.30	0.90-1.10	0.100	0.23	0.05	0.08
12.00	14.00	13.65- 14.35	0.90-1.10	0.100	0.27	0.06	0.09
15.00	18.00	17.55- 18.45	1.35-1.65	0.150	0.35	0.11	0.17
18.00	20.00	19.50- 20.50	0.90-1.10	0.100	0.39	0.09	0.13
20.00	22.50	21.94- 23.06	1.13-1.38	0.125	0.44	0.12	0.18
22.00	24.50	23.89- 25.11	1.13-1.38	0.125	0.48	0.13	0.20
24.00	26.00	25.35- 26.65	0.90-1.10	0.100	0.51	0.12	0.17
25.00	28.00	27.30- 28.70	1.35-1.65	0.150	0.55	0.18	0.27
26.00	30.00	29.25- 30.75	1.80-2.20	0.200	0.59	0.26	0.39
28.00	31.00	30.23- 31.78	1.35-1.65	0.150	0.60	0.21	0.31
30.00	33.00	32.18- 33.83	1.35-1.65	0.150	0.64	0.22	0.33
32.00	35.00	34.13- 35.88	1.35-1.65	0.150	0.68	0.23	0.35
35.00	38.00	37.05- 38.95	1.35-1.65	0.150	0.74	0.25	0.38
37.00	40.00	39.00- 41.00	1.35-1.65	0.150	0.78	0.27	0.40
101.60	106.60	104.47-108.73	2.25-2.75	0.375	1.28	1.21	1.80
105.00	110.00	107.80-112.20	2.25-2.75	0.375	1.32	1.25	1.86
110.00	115.00	112.70-117.30	2.25-2.75	0.375	1.38	1.31	1.94
115.00	120.00	117.60-122.40	2.25-2.75	0.375	1.44	1.36	2.03
120.00	125.00	122.50-127.50	2.25-2.75	0.375	1.50	1.42	2.11
125.00	130.00	127.40-132.60	2.25-2.75	0.375	1.56	1.48	2.20
130.00	142.70	139.85-145.55	5.71-6.98	0.952	1.71	4.02	5.98
130.00	140.00	137.20-142.80	4.50-5.50	0.750	1.68	3.13	4.66
130.00	135.00	132.30-137.70	2.25-2.75	0.375	1.62	1.54	2.29
135.00	147.70	144.75-150.65	5.71-6.98	0.952	1.77	4.16	6.20
135.00	145.00	142.10-147.90	4.50-5.50	0.750	1.74	3.25	4.83
135.00	141.00	138.18-143.82	2.70-3.30	0.450	1.69	1.92	2.86
140.00	152.70	149.65-155.75	5.71-6.98	0.952	1.83	4.31	6.42
140.00	150.00	147.00-153.00	4.00-6.00	0.400	1.80	3.36	5.01
145.00	151.00	147.98-154.02	2.70-3.30	0.450	1.81	2.06	3.07
150.00	156.00	152.88-159.12	2.70-3.30	0.450	1.87	2.13	3.17
152.00	164.70	161.41-167.99	5.71-6.98	0.952	1.98	4.67	6.94
160.00	170.00	166.60-173.40	4.50-5.50	0.750	2.04	3.83	5.70
160.00	166.00	162.68-169.32	2.70-3.30	0.450	1.99	2.27	3.38
165.00	171.00	167.58-174.42	2.70-3.30	0.450	2.05	2.34	3.48
170.00	182.70	179.05-186.35	5.71-6.98	0.952	2.19	5.20	7.73
170.00	176.00	172.48-179.52	2.70-3.30	0.450	2.11	2.41	3.58
180.00	185.00	181.30-188.70	2.25-2.75	0.375	2.22	2.12	3.15
180.00	190.00	186.20-193.80	4.00-6.00	0.750	2.28	4.29	6.39
184.00	190.00	186.20-193.80	2.70-3.30	0.450	2.28	2.60	3.87
184.00	197.00	193.06-200.94	5.20-7.80	0.975	2.36	5.75	8.55
185.00	197.00	193.06-200.94	4.80-7.20	0.900	2.36	5.32	7.91
187.00	194.00	190.12-197.88	3.15-3.85	0.525	2.33	3.09	4.60
190.00	196.00	192.08-199.92	2.70-3.30	0.450	2.35	2.69	4.00
196.00	202.00	197.96-206.04	2.70-3.30	0.450	2.42	2.77	4.12
200.00	206.00	203.00-209.00	2.40-3.60	0.600	2.06	2.83	4.21
200.00	208.00	205.00-211.00	3.20-4.80	0.800	2.08	3.79	5.63
203.00	211.00	208.00-214.00	3.20-4.80	0.800	2.11	3.84	5.72
208.00	216.00	213.00-219.00	3.20-4.80	0.800	2.16	3.93	5.86
215.00	221.00	218.00-224.00	2.40-3.60	0.600	2.21	3.03	4.52
220.00	230.00	227.00-233.00	4.00-6.00	1.000	2.30	5.22	7.77
225.00	235.00	232.00-238.00	4.00-6.00	1.000	2.35	5.34	7.94
230.00	240.00	237.00-243.00	4.00-6.00	1.000	2.40	5.45	8.11
240.00	250.00	247.00-253.00	4.00-6.00	1.000	2.50	5.68	8.46
240.00	246.00	243.00-249.00	2.40-3.60	0.600	2.46	3.38	5.03
250.00	260.00	257.00-263.00	4.00-6.00	1.000	2.60	5.92	8.80
270.00	280.00	277.00-283.00	4.00-6.00	1.000	2.80	6.38	9.49
290.00	300.00	297.00-303.00	4.00-6.00	1.000	3.00	6.84	10.19
305.00	313.00	310.00-316.00	3.20-4.80	0.800	3.13	5.74	8.53
320.00	330.00	327.00-333.00	4.00-6.00	1.000	3.30	7.54	11.22
340.00	350.00	347.00-353.00	4.00-6.00	1.000	3.50	8.00	11.91

OPTICAL PROPERTIES

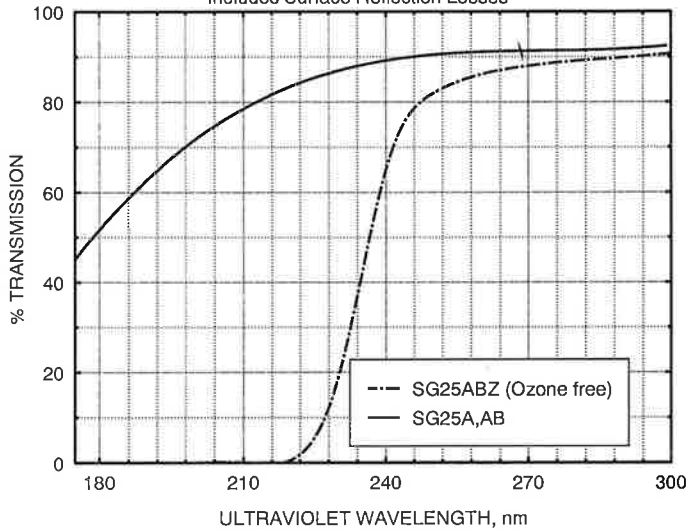
- For superior discharge lamp performance, the SG25 lighting grades have virtually no hydroxyl content, as shown by the transmission at 2730nm. The maximum hydroxyl contents are 1.0ppm for grades SG25AB and SG25ABZ, and 5.0ppm for grade SG25A. Hydroxy-containing quartz would show a measurable reduction of the transmission at 2730nm.
- Grade SG25ABZ prevents ozone generation by absorbing the 185nm wave length.

- For germicidal lamps, grades SG25A and AB provide excellent transmission at 254nm.
- For fused quartz, the transmission (T2) at other thicknesses (t2) is given by:

$$\ln(T2) = (t1/t2)\ln(T1/.92) + \ln(.92)$$
 Where T1 is the transmission at thickness t1
- Index of refraction 1.4585
- Optical dispersion 67.6

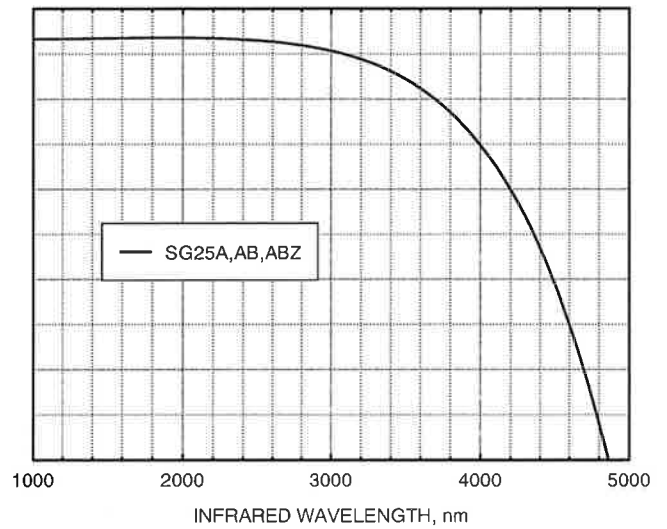
FUSED QUARTZ TRANSMISSION CURVES FOR SG25 LIGHTING GRADES

• Sample Thickness 1.5mm
 • Includes Surface Reflection Losses

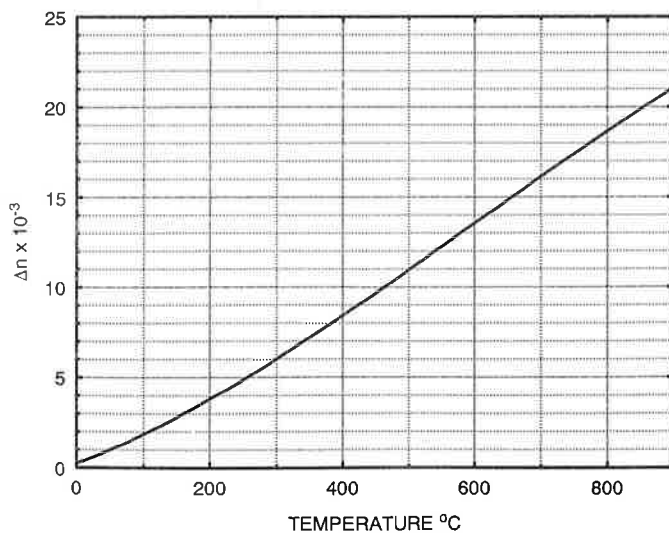


FUSED QUARTZ TRANSMISSION CURVES FOR SG25 LIGHTING GRADES

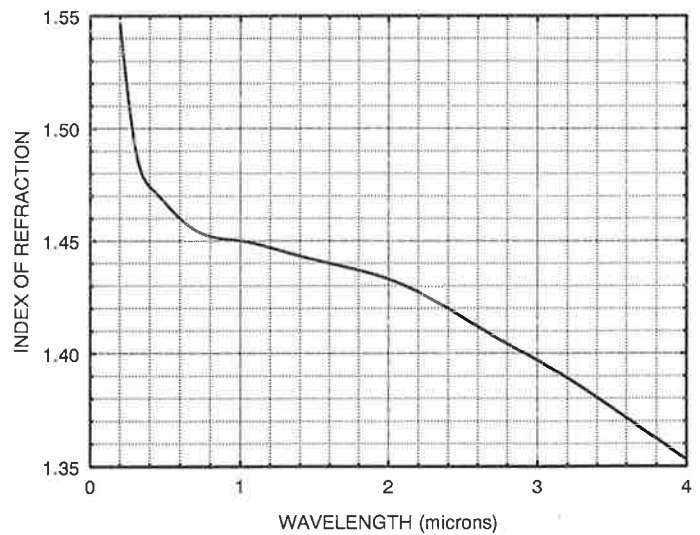
• Sample Thickness 1.5mm
 • Includes Surface Reflection Losses



REFRACTIVE INDEX vs TEMPERATURE



REFRACTIVE INDEX vs WAVELENGTH

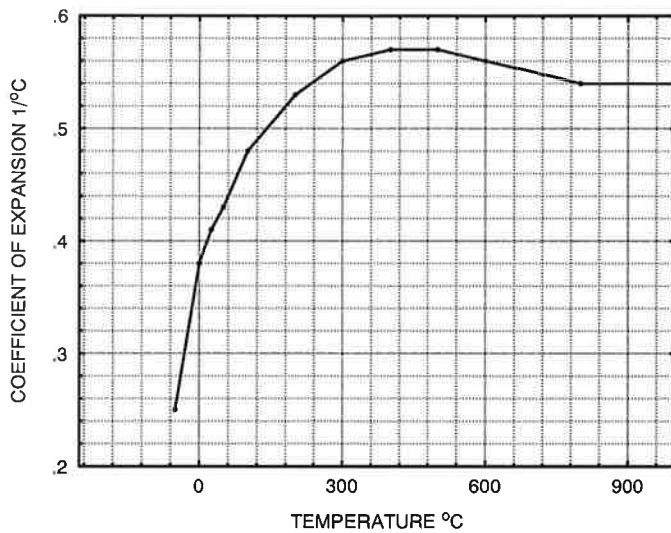


THERMODYNAMIC PROPERTIES

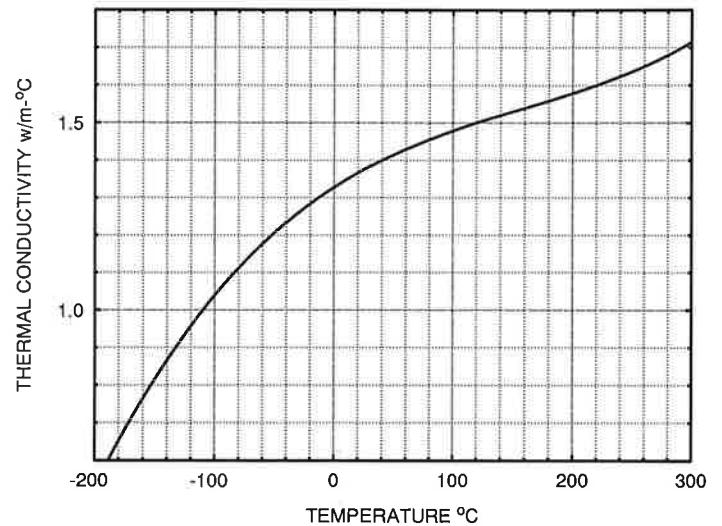
- Fused quartz has a thermal shock resistance that is superior to that of other glasses and most ceramics. This is due to the very low coefficient of thermal expansion. This property is beneficial to applications where rapid heating and cooling occurs, such as fabrication of quartzware for lighting and semiconductor processes.
- The thermal conductivity and heat capacity of fused quartz are temperature dependent, increasing with temperature.

- To optimize useful life at high temperatures, fused quartz should be cleaned just prior to use. Surface contaminants, especially the alkalis, will cause the surface to devitrify, or recrystallize, to cristobalite.
- Coefficient of thermal expansion, 20°C–320°C 5.5×10^{-6} cm/cm-°C
- Thermal conductivity, 25°C 0.00323 cal/cm-sec-°C
- Specific heat, 0°C–100°C 0.184 cal/g-°C

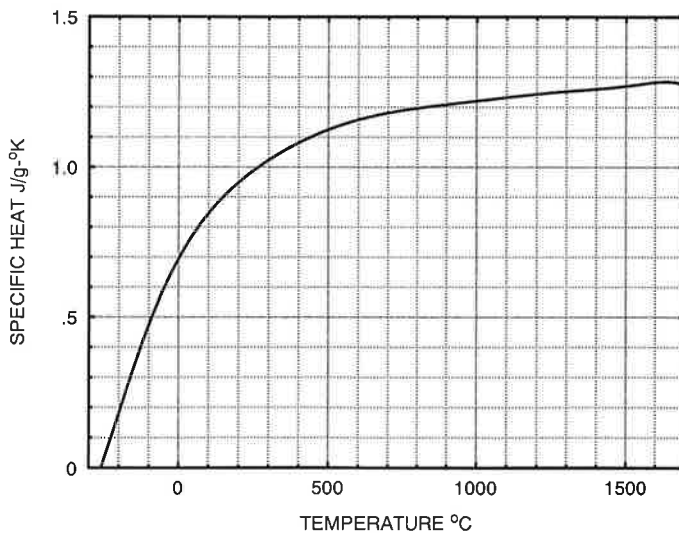
LINEAR COEFFICIENT OF EXPANSION OF FUSED QUARTZ



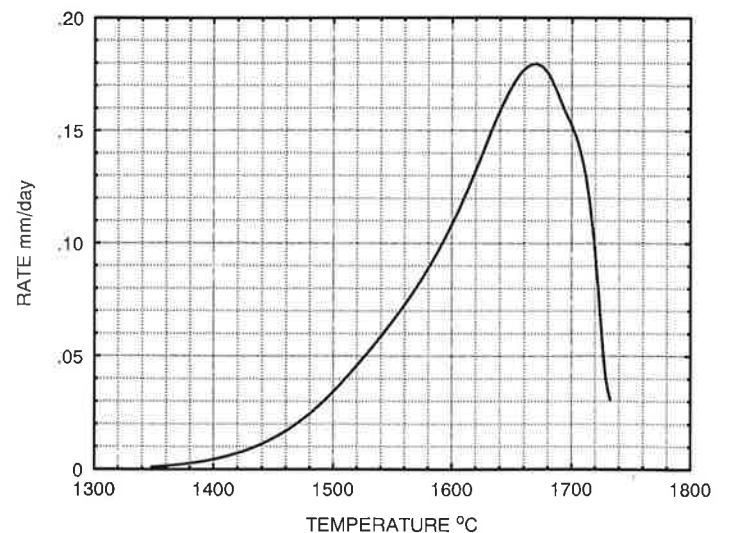
THERMAL CONDUCTIVITY OF FUSED QUARTZ



HEAT CAPACITY OF FUSED QUARTZ



RATE OF FUSED QUARTZ DEVITRIFICATION



MECHANICAL PROPERTIES

- The mechanical properties of fused quartz at low temperatures are similar to that of ordinary glasses.
- Surface flaws such as scuffs and scratches greatly reduce the tensile strength of all glasses, including fused quartz. For this reason, the design tensile strength is usually recommended to be 1000psi. The compressive design strength is 150,000psi.
- Viscosity is a measure of the rate at which a glass will deform or flow at a given temperature and stress. Fused quartz has the highest viscosity of all glasses. This is important to high temperature lighting and semiconductor uses.

- The annealing range for any glass is defined as the temperature range that has a viscosity range of $10^{14.5}$ poises (the strain point) to $10^{13.0}$ poises (the anneal point). For fused quartz, this range typically is 1100°C to 1210°C.

- Density 2.2 g/cc
- Hardness (KHN₅₀) 590 kg/sq.mm
- Modulus of elasticity 7.2×10^{10} Pa
- Modulus of rigidity 3.1×10^{10} Pa
- Poisson's ratio 0.17

Elastic Properties of Fused Quartz with Low Water Content

T (°C)	Young's modulus (GPa)	Shear modulus (GPa)	Poisson's ratio
25	72.9	31.3	0.165
100	74.0	31.6	0.171
200	75.1	32.0	0.173
400	77.2	32.8	0.177
600	78.7	33.3	0.182
800	80.0	33.7	0.187
1000	81.1	34.0	0.193
1100	(81.4)	(34.1)	(0.194)
1200	(81.5)	(34.1)	(0.195)
1250	(81.4)	(34.0)	(0.197)

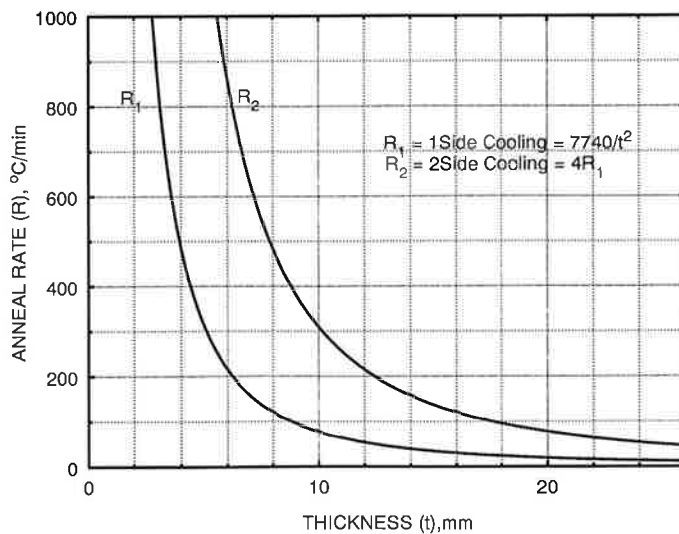
* Parenthesis indicate possible flow contributions to deformations.

Effect of Tube Size on Sag Rate

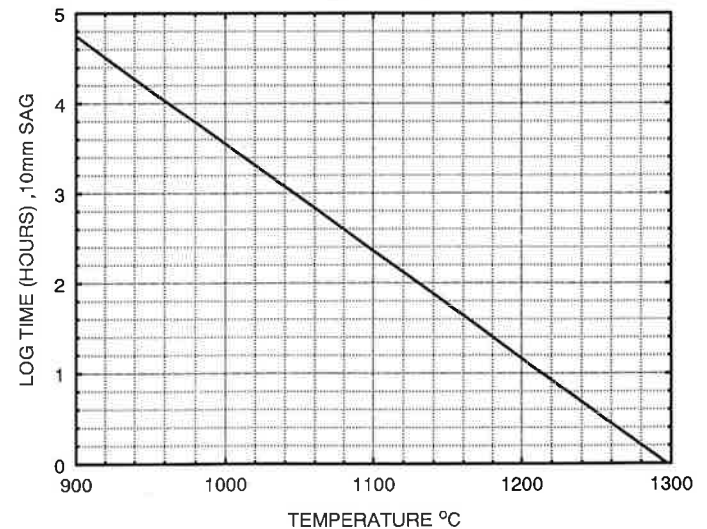
Tube Size mm	Approximate Time for 10mm OOR* Sag at 1100°C, hrs
320x330	32
190x196	133
225x235	153
184x197	575
135x141	599
160x170	680
101.6x106.6	1523

*OOR = Out-of-Round

ANNEALING RATES FOR FUSED QUARTZ



TUBE SAG RATE vs TEMPERATURE
Out of Round Sag for a 225 x 235 mm Tube

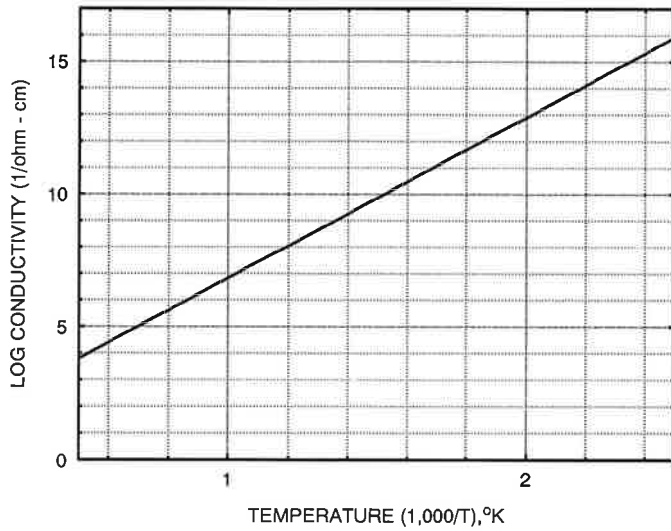


ELECTRICAL PROPERTIES

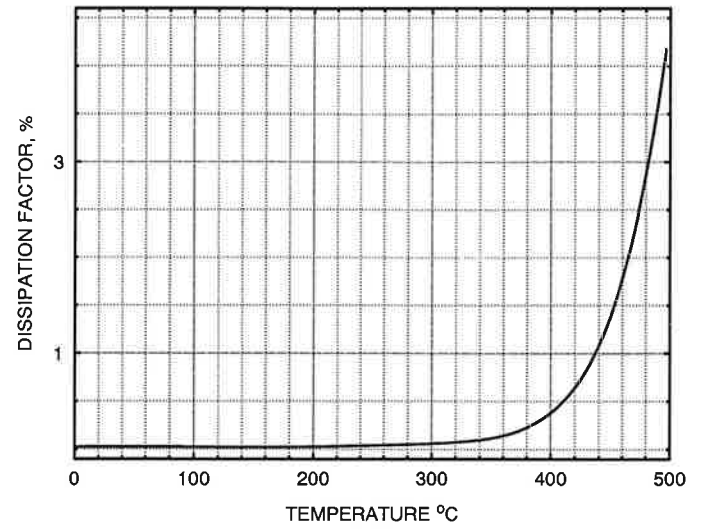
- Fused quartz has low electrical conductivity, low dielectric loss and a high dielectric strength, making it ideal for electrical insulation uses.

- Electrical Properties at 20°C, 1MHz
 - Electrical resistivity 10^{18} ohm-cm
 - Dielectric strength 50 k-volts/mm
 - Dielectric constant 3.75
 - Dissipation factor $< 1 \times 10^{-4}$
 - Dielectric loss factor $< 1 \times 10^{-4}$

ELECTRICAL CONDUCTIVITY vs TEMPERATURE



DISSIPATION FACTOR vs TEMPERATURE



PERMEABILITY, DIFFUSION

- Fused quartz is impermeable to most gases. Ionic and molecular diffusion rates are very low. However, at high temperatures, certain species travel through fused quartz at appreciable rates.
- In semiconductor processes at elevated temperatures, the diffusion of contaminants from the environment outside the quartz tube is an important consideration.
- In lamps, hydrogen diffusion into the lamp atmosphere can cause disruption of the tungsten-halogen cycle, or hard starting and short life in electric discharge lamps.
- Diffusion coefficients at 1000°C, cm.²/sec, x10⁶
 - Helium 55.
 - Hydrogen 73
 - Sodium 79
 - Lithium 1.0

Diffusion Coefficients of Sodium in Vitreous Silica

t, °C	D(cm ² /s)	t, °C	D(cm ² /s)
1000	7.9×10 ⁶	400	1.6×10 ⁹
900	3.8×10 ⁶	300	5.4×10 ⁻¹¹
800	1.6×10 ⁶	250	3.5×10 ⁻¹²
700	5.7×10 ⁻⁷	200	2.0×10 ⁻¹³
600	1.3×10 ⁻⁷	170	2.6×10 ⁻¹⁴
500	1.9×10 ⁸		

Diffusion Coefficients of Various Ions in Vitreous Silica at 1000°C

Ion	D(cm ² /s)
Sodium	7.9×10 ⁻⁶
Lithium	1×10 ⁻⁶
Silver	7×10 ⁻⁷
Potassium	1×10 ⁻⁸
Calcium	2×10 ⁻⁸
Aluminum	1×10 ⁻¹³
Phosphorus	8×10 ⁻¹⁴
Nickel	1×10 ⁻¹⁵
Arsenic	1×10 ⁻¹⁶
Boron	1×10 ⁻¹⁷

Diffusion Coefficients of Helium in Vitreous Silica as a Function of Temperature

t (°C)	D (10 ⁶ × cm ² /s)	t (°C)	D (10 ⁶ × cm ² /s)
24	0.024	490	9
78	0.11	605	16
112	0.22	700	24
148	0.37	814	36
191	0.73	860	40
284	2.0	1034	61
380	4.8		

Molecular Diffusion in Fused Silica

Molecule	Diameter (Å)	Diffusion Coefficient (cm ² /s)		Activation energy Q ¹ (kJ/mole)
		25°C	1000°C	
Helium	2.0	2.4×10 ⁻⁸	5.5×10 ⁻⁵	20
Neon	2.4	5×10 ⁻¹²	2.5×10 ⁻⁶	37
Hydrogen (deuterium)	2.5	2.2×10 ⁻¹¹	7.3×10 ⁻⁶	36
Argon	3.2		1.4×10 ⁻⁹	111
Oxygen	3.2		6.6×10 ⁻⁹	105
Water	3.3		3×10 ⁻⁷	71
Nitrogen	3.4			110
Krypton	4.2			190
Xenon	4.9			300

CHEMICAL PROPERTIES

- Fused quartz has the highest chemical stability of all the glasses. It does not react with most materials, even at temperatures as high as 1000°C. This is important to both lighting and semiconductor applications where many exotic materials are

coming in contact with fused quartz. It is reactive with hydrofluoric acid, phosphoric acid, and sodium compounds such as sodium hydroxide and sodium chloride.

Hydrofluoric Acid Dissolving Rates of Silica Phases @ 20°C

Silica Phase*	Silica dissolved %	
	In HF, 5%, 1/2h	In HF, 1%, 1h
Quartz	30.1	5.2
Tridymite	76.3	20.3
Cristobalite	74.3	25.8
Vitreous Silica	96.6	52.9

*Samples of uniform particle size, ca 40 um in dia

Corrosion of Quartz Glass by Phosphoric Acid

Temp (°C)	Loss After		Temp (°C)	Loss After	
	15 Hrs	15 Hrs		15 Hrs	15 Hrs
	(mg/cm ²)	(mg/cm ²)		(mg/cm ²)	(mg/cm ²)
0	0.0		400	7.3	
100	0.0		500	7.9	
200	0.0		600	11.3	
300	5.8		700	23.0	

Corrosion of Quartz Glass by Alkalis

Alkalis (Concentration)	Time (Hr)	Temp (°C)	Loss (mg/cm ²)	
Ammonium hydroxide	(10%)	100	20	0.019
		100	20	0.031
		100	20	0.0095
Sodium hydroxide	(5%)	10	100	1.5
		100	20	0.019
		100	20	0.027
Potassium hydroxide	(10%)	10	100	1.13
		100	20	0.015
		100	20	0.37

Durability Vitreous Silica at 95°C

Test solution	Duration of test, h	Wt Loss, mg/cm ²	Depth of Attack um
5% HCL	24	0.01	0.05
5% NAOH	6	0.7	3.2
0.02N Na ₂ CO ₃	6	0.02	0.09
5% H ₂ SO ₄	24	0.01	0.05
H ₂ O	24	0.01	0.05

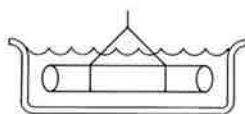
SYLVANIA

Emissive
Products

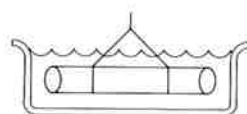
GTE

THE POWER IS ON

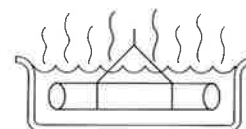
CLEANING



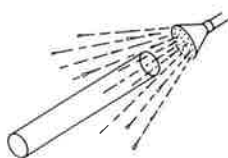
1. DI Water



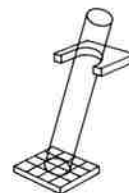
2. Acid Wash



3. Hot DI Water Rinse



4. Hot DI Water Spray



5. Drip Dry



6. Handling

Good cleaning procedures will maximize the life of fused quartz. Clean surfaces will minimize the recrystallization or devitrification of fused quartz caused by non-silica contaminants. A cleaning sequence is shown that is satisfactory for both lighting and semiconductor tubing. The initial water rinse before the acid wash serves to minimize the preferential etching of any scratches or scuffs.

The acid wash can be:

A: 5% by wt. HF for 2–3 minutes;

or

B: 5% by wt. NH_4F for 10–15 minutes.

Other acid strengths and times may be appropriate for special situations. Rinsing is best accomplished using

hot deionized or distilled water. Drying is best accomplished in a natural manner such as drip drying in a still, clean atmosphere. Methods commonly used to hasten drying such as wiping and/or forced air blowing around the tubes can re-contaminate the surfaces. If compressed air is used, make sure it is both oil- and water-free.

After drying, the clean tube should be:

A.) handled with gloves or other equipment that is clean;

B.) used in the manufacturing process as soon as possible; or

C.) wrapped in clean polyethylene film for storage.

If these precautions are not taken, the maximum performance of the fused quartz will not be accomplished.

SYLVANIA

Emissive
Products

GTE

THE POWER IS ON

CUSTOMER SERVICE AND SALES OFFICES

CUSTOMER SERVICE LOCATIONS

GTE Products Corporation
Portsmouth Avenue
Exeter, NH 03833
(603) 772-4331 Telephone
(603) 772-1072 FAX
(800) 258-8290 Toll Free
(800) 829-7990 Toll Free

GTE Products Corporation
1090 E. Williams Street
San Jose, CA 95116
(408) 971-0661 Telephone
(408) 287-0830 FAX
(800) 347-3435 Toll Free

SALES OFFICES (USA)

Portsmouth Avenue
Exeter, NH 03833
(603) 772-4331 Telephone
(603) 772-1072 FAX
(800) 258-8290 Toll Free
(800) 829-7990 Toll Free

2040 McKenzie Drive
Carrollton, TX 75011
(214) 247-7800 Telephone
(214) 247-4364 FAX

INTERNATIONAL SALES OFFICES

Japan

GTE Far East Services, Ltd.
Ohdai Building 8F
9-5, Shinjuku 1-Chome
Shinjuku-Ku, Tokyo 160
(03) 225-1517 Telephone
(03) 226-9107 FAX

France

GTE Precision Materials
Branche Matériaux Et Composants
BP 61
76360 Barentin
(35) 913505 Telephone
(35) 922706 FAX

Italy

GTE Sylvania, S.p.A.
Precision Materials
Via P.L. da Palestrina, 12
20124 Milano Mi
(02) 669 81037 Telephone
(02) 669-81053 FAX

Belgium

GTE Precision Materials
Avenue de Tervuren 34
1040 Brussels
(02) 735 4035 Telephone
(02) 736-0784 FAX

United Kingdom

GTE Products Corporation
Otley Road, Charlestown
W. Yorkshire BD17 7SN
England
274-595921 Telephone
274-597683 FAX

Hong Kong

GTE Precision Materials
414 Tsim Sha Tsui Centre
East Wing, 66 Mody Rd.
Kowloon
(03) 695531 Telephone
(03) 7218621 FAX

West Germany

GTE Light GmbH
Precision Materials
Postfach 1740 (Graf-Zeppelin-Str.)
8520 Erlangen
(09) 1319960 Telephone
(09) 131996230 FAX

SYLVANIA

Emissive
Products

GTE

THE POWER IS ON

SYLVANIA

Special Materials

PHIL HARRISON, PhD, BSc
Northern Europe
Sales Engineer

GTE

GTE Sylvania Ltd
Otley Road
Charlestown
Shipley, West Yorkshire
BD17 7SN
Tel. 0274 595921
Telex 51251
Fax 0274 580632

SYLVANIA

Emissive
Products

GTE

THE POWER IS ON

The information given is based on data considered to be true and accurate. It is offered for the user's consideration, but we do not warrant the results to be obtained. Please read all statements in conjunction with our conditions of sale which apply to all goods supplied by us. No statement is intended for any use which would infringe any patent or copyright.

GTE Products Corporation
Portsmouth Avenue
Exeter, NH 03833

© 1990 GTE Products Corporation
Printed in USA
RW/JSM 5/90

SYLVANIA

Emissive
Products

GTE

THE POWER IS ON