Product information

Fused Quartz

Properties of Fused Quartz

While vitreous silica is the generic term used to describe all types of silica glass, some producers refer to this material as fused quartz or fused silica. Originally, there was a commerical distinction between transparent and opaque vitreous silica, with **fused quartz** products being produced from quartz crystal into transparent ware and **fused silica** being manufactured from sand into opaque ware.

Today, however, advances in raw material beneficiation permit transparent fusions from sand as well. Consequently, if **naturally occurring** crystalline silica (sand or rock) is melted, the material is called fused quartz. If the silicon dioxide is **synthetically** derived, the material is often referred to as synthetic fused silica.

General Electric fused quartz products provide a wide range of useful properties. Individually or in combination, these properties are making important contributions in a number of specialized applications.

The performance of most fused quartz products is closely related to the purity of the material. Contaminants, even in parts per million, are controlled very closely in the manufacture of the product.

GE fused quartz typically contains less than 50 ppm by weight as the element total impurities. The clear varieties have a nominal purity of 99.995 W% SiO_2. Alumina (Al_2O_3) is the major impurity. The remaining impurity content is composed of Na_2O, Fe_2O_3, CaO, TiO_2, K_2O and Li_2O.

Mechanical Properties

Mechanical properties of fused quartz are much the same as those of other glasses. The material is extremely strong in compression, with design compressive strength of better than 160,000 psi.

Surface flaws can drastically reduce the inherent strength of any glass, so tensile properties are greatly influenced by these defects. The design tensile strength for fused quartz with good surface quality is in excess of 7,000 psi. In practice, a design stress of 1,000 psi is generally recommended. Typical mechanical data are shown in Table XI.

Table XI – Typical Physical Properties, Clear Fused Quartz

PROPERTY	ENGLISH & METRIC SYSTEM VALUE	INTERNATIONAL SYSTEM OF UNITS (SI) VALUE
Density	2.2 gm/cm^3	2.2 × 10^3 kg/m^3
Hardness	5.5–6.5 Mohs' Scale 570 KHN_{100}	
Design Tensile Strength	7,000 psi	4.8 × 10^7 Pa (N m^2)
Design Compressive Strength	Greater than 160,000 psi	Greater than 1.1 × 10^9 Pa
Bulk Modulus	5.3 × 10^6 psi	3.7 × 10^{10} Pa
Rigidity Modulus	4.5 × 10^6 psi	3.1 × 10^{10} Pa
Young's Modulus	10.5 × 10^6 psi	7.2 × 10^{10} Pa
Poisson's Ratio	.17	17
Coefficient of Thermal Expansion	5.5 × 10^{-7} cm/cm•°C (20°C - 320°C)	5.5 × 10^{-7} m/m•°K (293°K - 593°K)
Thermal Conductivity (20°C)	3.3 × 10^{-3} gm cal•cm/cm^2•sec•°C	1.4 W/m•°K
Specific Heat (20°C)	.16gm cal/gm	670 J/kg•°K
Softening Point	1683°C	1956°K
Annealing Point	1215°C	1488°K
Strain Point	1120°C	1393°K
Electrical Resistivity	7(10^9) ohm•cm (350°C)	7(10^7) ohm-m
Dielectric Properties	(20°C and 1 Mc)	(293°K and 1 MHz)
Constant	3.75	3.75
Strength	1270 volts/mil	5 × 10^7 V m
Loss Factor	Less than 4 × 10^{-4}	Less than 4 × 10^{-4}
Dissipation Factor	Less than 1 × 10^{-4}	Less than 1 × 10^{-4}
Index of Refraction	1.4585	1.4585
Constringence (Nu value)		
Fused Quartz	67.56	67.56
Velocity of Sound-Shear Wave	3.75 × 10^5 cm/sec	3.75 × 10^3 m/s
Velocity of Sound/ Compressional Wave	5.90 × 10^5 cm/sec	5.90 × 10^3 m/s
Sonic Attentuation	Less than .033 db/ft•Mc	Less than .11 db/m•MHz
Permeability Constants	(cm^3•mm/cm^2•sec•cm of Hg—700°C/973°K)	
Helium	210 × 10^{-10}	
Hydrogen	21 × 10^{-10}	
Deutrium	17 × 10^{-10}	
Neon	9.5 × 10^{-10}	

Thermal Properties

One of the most important properties of fused quartz is its extremely low coefficient of expansion - 0.55 X 10^{-6} cm/cm°C (0-300°C). Its coefficient is 1/34 that of copper and only 1/7 of borosilicate glass. This makes the material particularly useful for optical flats, mirrors, furnace windows and critical optical applications which require minimum sensitivity to thermal changes. A related property is its unusually high thermal shock resistance. For example, thin sections can be heated rapidly to above 1500°C and then plunged into water without cracking.

REACTIVITY

Most acids, metals, chlorine and bromine are unreactive with fused quartz at ordinary temperatures. It is slightly attacked by alkaline solutions, the reaction rate increasing with temperature and concentration of solution. Phosphoric acid will attack fused quartz at temperatures above about 150°C. Hydrofluoric acid alone will attack at all temperatures. Carbon and some metals will reduce fused quartz; basic oxides, carbonates, sulfates, etc., will react with it at elevated temperatures. For general use it can be concluded that fused quartz is quite unreactive.

Fused Quartz Average Transmittance Curves