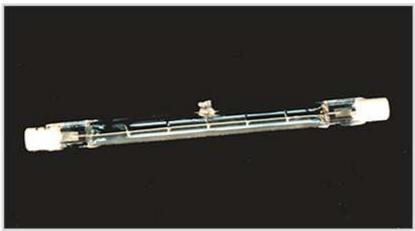


Description

Image





Caption

1. Halogen bulb. © Stefan Wernli, stef at en.wikipedia - (CC BY-SA 2.5) 2. Silica glass used for very high-power lamp envelopes. © Granta Design

The material

Fused silica, a glass of great transparency, is nearly pure SiO2, it has an exceptionally high melting point and is difficult to work, but, more than any other glass, it resists temperature and thermal shock.

Composition (summary)

SiO2

General properties

Density	2.17e3	-	2.22e3	kg/m^3
Price	* 6.21	-	10.4	USD/kg
Date first used	1905			

Mechanical properties

Young's modulus	68	-	74	GPa
Shear modulus	* 27.9	-	32.3	GPa
Bulk modulus	34	-	36	GPa
Poisson's ratio	0.15	-	0.19	
Yield strength (elastic limit)	* 45	-	155	MPa
Tensile strength	* 45	-	155	MPa
Compressive strength	1.1e3	-	1.6e3	MPa
Elongation	0			% strain
Hardness - Vickers	450	-	950	HV
Fatigue strength at 10^7 cycles	* 43	-	143	MPa
Fracture toughness	0.6	-	0.8	MPa.m^0.5



Mechanical loss coefficient (tan delta)	8e-6 - 2e-5			
Thermal properties				
Glass temperature	* 957 - 1.56e3 ℃			
Maximum service temperature	897 - 1.4e3 ℃			
Minimum service temperature	-273 °C			
Thermal conductor or insulator?	Poor insulator			
Thermal conductivity	1.4 - 1.5 W/m.℃			
Specific heat capacity	680 - 730 J/kg.℃			
Thermal expansion coefficient	0.55 - 0.75 μstrain/℃			
Thermal expansion coefficient	0.33 - 0.73 μετιαπή σ			
Electrical properties				
Electrical conductor or insulator?	Good insulator			
Electrical resistivity	1e23 - 1e27 µohm.cm			
Dielectric constant (relative permittivity)	3.7 - 3.9			
Dissipation factor (dielectric loss tangent)	2e-5 - 6e-5			
Dielectric strength (dielectric breakdown)	33 - 38 1000000 V/m			
Optical properties	Optical Quality			
Transparency	Optical Quality			
Refractive index	1.46			
Critical Materials Risk				
High critical material risk?	No			
Processability				
Castability	1 - 2			
Moldability	2 - 3			
Weldability	3 - 4			
Durability: water and aqueous solutions				
Water (fresh)	Excellent			
Water (salt)	Excellent			
Soils, acidic (peat)	Excellent			
Soils, alkaline (clay)	Excellent			
Wine	Excellent			
	EXOCION			
Durability: acids				
	Excellent			
Acetic acid (10%)	Excellent			
	Excellent			
Acetic acid (10%) Acetic acid (glacial) Citric acid (10%)	Excellent Excellent			



Hydrochloric acid (36%)	Excellent
Hydrofluoric acid (40%)	Unacceptable
Nitric acid (10%)	Excellent
Nitric acid (70%)	Excellent
Phosphoric acid (10%)	Excellent
Phosphoric acid (85%)	Excellent
Sulfuric acid (10%)	Excellent
Sulfuric acid (70%)	Excellent

Durability: alkalis

Sodium hydroxide (10%)	Acceptable
Sodium hydroxide (60%)	Limited use

Durability: fuels, oils and solvents

Amyl acetate	Excellent
Benzene	Excellent
Carbon tetrachloride	Excellent
Chloroform	Excellent
Crude oil	Excellent
Diesel oil	Excellent
Lubricating oil	Excellent
Paraffin oil (kerosene)	Excellent
Petrol (gasoline)	Excellent
Silicone fluids	Excellent
Toluene	Excellent
Turpentine	Excellent
Vegetable oils (general)	Excellent
White spirit	Excellent

Durability: alcohols, aldehydes, ketones

Acetaldehyde	Excellent
Acetone	Excellent
Ethyl alcohol (ethanol)	Excellent
Ethylene glycol	Excellent
Formaldehyde (40%)	Excellent
Glycerol	Excellent
Methyl alcohol (methanol)	Excellent

Durability: halogens and gases

Chlorine gas (dry)	Excellent
Fluorine (gas)	Limited use



Excellent			
Excellent			
cellent			
n-flammable			
aallant			
Excellent			
.4 - 41.4	MJ/kg		
- 2.43	kg/kg		
33 - 1.47	l/kg		
.7	millipoints/kg		
.3 - 17.3	MJ/kg		
9 - 153	MJ/kg		
A - 120	kg/kg		
	kg/kg		
.4	- 1.38 - 11.5		

Material recycling: energy, CO2 and recycle fraction

Recycle	✓			
Embodied energy, recycling	* 29	-	32	MJ/kg
CO2 footprint, recycling	* 2.28	-	2.52	kg/kg
Recycle fraction in current supply	23.8	-	26.3	%
Downcycle	✓			
Combust for energy recovery	×			
Landfill	✓			



Biodegrade	×
Toxicity rating	Non-toxic
A renewable resource?	×

Environmental notes

Silica, the prime ingredient of glass, is the commonest compound in the earths crust, though it is harder to find it in a form sufficiently pure to make glass. Nonetheless, the ingredients of glass are ubiquitous, and the material is readily recycled at the end of its life.

Supporting information

Design guidelines

Silica glass is exceptionally hard to shape, requiring either very high working temperatures or special process by which it is formed after working. This makes it much more expensive than soda lime or borosilicate glass.

Typical uses

Producers

Space vehicle windows, wind tunnel windows, lenses and mirrors, ultrasonic delay lines, crucibles for semiconductor crystal growing, spectrophotometric optical systems, high temperature glass applications, envelopes for high wattage lamps, thermal barrier coatings.

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