Borosilicate glass

Description

Image

Caption

1. Borosilicate glass (Pyrex) is used for ovenware and chemical equipment. © iStockphoto 2. Teapot designed by Wilhelm Wagenfeldt in 1931. © Chris Lefteri

The material

Borosilicate glass is soda lime glass with most of the lime replaced by borax, B203. It has a higher melting point than soda lime glass and is harder to work; but it has a lower expansion coefficient and a high resistance to thermal shock, so it is used for glassware and laboratory equipment.

Composition (summary)

74% SiO2/1% Al2O3/15% B2O3/4% Na2O/6% PbO

General properties

Density	137	-	144	lb/ft^3
Price	* 2.04	-	3.39	USD/lb
Date first used	1893			

Mechanical properties

Young's modulus	8.85	-	9.28	10^6 psi
Shear modulus	* 3.71	-	3.9	10^6 psi
Bulk modulus	* 4.86	-	5.15	10^6 psi
Poisson's ratio	0.19	-	0.21	
Yield strength (elastic limit)	* 3.19	-	4.64	ksi
Tensile strength	3.19	-	4.64	ksi
Compressive strength	* 38.3	-	55.7	ksi
Elongation	0			% strain
Hardness - Vickers	* 83.7	-	92.5	HV
Fatigue strength at 10^7 cycles	* 3.84	-	4.25	ksi
Fracture toughness	* 0.455	-	0.637	ksi.in^0.5
Mechanical loss coefficient (tan delta)	4.6e-5	-	6.2e-5	

Thermal properties

Glass temperature	842	-	1.12e3	°F
Maximum service temperature	446	-	860	°F
Minimum service temperature	-460			°F
Thermal conductor or insulator?	Poor insulator			
Thermal conductivity	* 0.578	-	0.751	BTU.ft/h.ft^2.F
Specific heat capacity	* 0.182	-	0.191	BTU/lb.°F
Thermal expansion coefficient				

	1.78	-	2.22	µstrain/°F

Electrical properties

Electrical conductor or insulator?	Good insulator			
Electrical resistivity	3.16e21	-	3.16e22	µohm.cm
Dielectric constant (relative permittivity)	4.65	-	6	
Dissipation factor (dielectric loss tangent)	0.01	-	0.017	
Dielectric strength (dielectric breakdown)	* 305	-	356	V/mil

Optical properties

Transparency	Optical Quality			
Refractive index	1.47	-	1.48	

Processability

Castability	2	-	3	
Moldability	4	-	5	
Weldability	3	-	4	

Eco properties

Embodied energy, primary production	* 2.96e3	-	3.27e3	kcal/lb
CO2 footprint, primary production	* 1.65	-	1.83	lb/lb
Recycle	✓			

Supporting information

Design guidelines

Borosilicate glass is harder to work, and requires higher temperatures, than soda-lime glass, but its properties are better. It is particularly its resistance to thermal shock that is good, making it the right choice for applications in which the temperature changes suddenly.

Typical uses

Ovenware, laboratory ware, piping, lenses and mirrors, sealed beam headlights, tungsten sealing, bells

Tradenames

Pyrex

Links

Reference

ProcessUniverse

Producers