

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, B₂O₃. 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

| | | | | |
|-------------------------------------|---|---|---------|---------|
| Eco-costs (global trade mix) | 0.138 | - | 0.168 | USD/lb |
| Embodied energy, primary production | * 2.96e3 | - | 3.27e3 | kcal/lb |
| CO2 footprint, primary production | * 1.65 | - | 1.83 | lb/lb |
| Recycle |  | | | |
| Eco-costs, (credit) downcycling | 0 | | | USD/lb |
| Eco-costs, (credit) upcycling | -0.0973 | - | -0.0738 | USD/lb |
| Eco-costs, landfill | 0.0781 | | | USD/lb |

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