

## Description

### Image



### Caption

Glass ceramic can tolerate extreme thermal shock. © Kuppersbusch USA Inc.

### The material

Glass ceramics are glasses that, to a greater or lesser extent, have crystallized. They are shaped while in the glassy state, using ordinary molding methods and then cooled in such a way that the additives they contain nucleate small crystals. It is sold for cooking as pyroceram and is used for high performance heat resisting applications.

### Composition (summary)

SiO<sub>2</sub>/Al<sub>2</sub>O<sub>3</sub>/B<sub>2</sub>O<sub>3</sub>

## General properties

Density	150	-	181	lb/ft <sup>3</sup>
Price	* 0.939	-	5.64	USD/lb
Date first used	1957			

## Mechanical properties

Young's modulus	10.9	-	13.8	10 <sup>6</sup> psi
Shear modulus	* 4.38	-	7.09	10 <sup>6</sup> psi
Bulk modulus	* 7.25	-	8.7	10 <sup>6</sup> psi
Poisson's ratio	0.24	-	0.29	
Yield strength (elastic limit)	9.06	-	25.7	ksi
Tensile strength	9.06	-	25.7	ksi
Compressive strength	49.3	-	174	ksi
Elongation	0			% strain
Hardness - Vickers	230	-	720	HV
Fatigue strength at 10 <sup>7</sup> cycles	8.71	-	24.4	ksi
Fracture toughness	1.37	-	1.55	ksi.in <sup>0.5</sup>
Mechanical loss coefficient (tan delta)	5e-5	-	2e-4	

## Thermal properties

Glass temperature	1.05e3	-	3e3	°F
Maximum service temperature	1.47e3	-	2.14e3	°F
Minimum service temperature	-460			°F
Thermal conductor or insulator?	Poor insulator			
Thermal conductivity	0.768	-	1.45	BTU.ft/h.ft <sup>2</sup> .F
Specific heat capacity	0.143	-	0.215	BTU/lb.°F
Thermal expansion coefficient				

1.67 - 4.11  $\mu\text{strain}/^{\circ}\text{F}$

## Electrical properties

Electrical conductor or insulator?

Good insulator

Electrical resistivity

2e19 - 1e21  $\mu\text{ohm.cm}$

Dielectric constant (relative permittivity)

5.3 - 6.2

Dissipation factor (dielectric loss tangent)

0.0035 - 0.0047

Dielectric strength (dielectric breakdown)

965 - 1.02e3 V/mil

## Optical properties

Transparency

Translucent

Refractive index

1.5 - 1.55

## Processability

Castability

1

Moldability

3 - 4

Machinability

1 - 3

Weldability

1

## Eco properties

Embodied energy, primary production

\* 4.06e3 - 4.5e3 kcal/lb

CO2 footprint, primary production

\* 2.2 - 2.43 lb/lb

Recycle

✗

## Supporting information

### Design guidelines

Glass ceramic is shaped in a two-stage process. The molding is done while the material is still a true glass, using standard glass-forming methods. The shaped product is then heat treated, causing "phase-separation" : the formation of crystalline phases. These have a very low thermal expansion coefficient, with the result that the material can withstand very sudden changes of temperature without cracking. Some grades of glass ceramic are machinable.

### Typical uses

Photosensitive applications, Cookware, Lasers, Stove window glass, Telescope mirror banks, Exterior and interior cladding, Laboratory bench tops, Missile Radomes

### Tradenames

Pyroceram, Macor, Shapal M-soft.

## Links

Reference

ProcessUniverse

Producers