Macor®

A unique machinable glass ceramic, engineered to perfection

Corning Macor® machinable glass ceramic is recognized worldwide as a major technical innovation. It is the perfect technical solution for a wide range of applications in an equally wide field of industries. Opening a vast array of possibilities, Macor has the versatility of a high performance polymer, the machinability of a soft metal and the performance of an advanced technical ceramic.

Having excellent physical properties, high dielectric strength, and electrical resistivity, Macor is non-porous, non-shrinking and withstands high temperatures while providing tight tolerance capability. It can be easily machined into the most complex shapes with conventional metalworking tools enabling fast turnaround from design to delivery and has substantially lower costs when compared with other technical ceramics.

Macor machinable glass is the perfect material for both prototyping and large production runs.

As the UK's principal distributor for over 20 years, Precision Ceramics has wide experience in all aspects of Macor, its uses, applications and unique properties ...

- Can be machined with normal metalworking tools
- Strong and rigid; unlike high temperature plastics, Macor will not creep or deform
- Low thermal conductivity; useful high temperature insulator
- Electric insulator, especially at high temperatures
- Excellent with high voltages and a broad spectrum of frequencies
- Does not require firing after machining
- Continuous use temperature of 800°C; Peak temperature of 1000°C
- Zero porosity
- Won't outgas in vacuum environment
- Very tight machining tolerances of up to 0.0005in (0.013mm).
- Excellent dimensional stability in a variety of environments (heat, radiation, etc.)
- Radiation resistant
- Coefficient of thermal expansion readily matches most metals and sealing glasses.

Technical Properties

Macor machinable glass ceramic is a white, odourless, porcelain-like (in appearance) material composed of approximately 55% fluorophlogopite mica and 45% borosilicate glass.

The material contains the following compounds:

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Advanced Technical Ceramic Solutions

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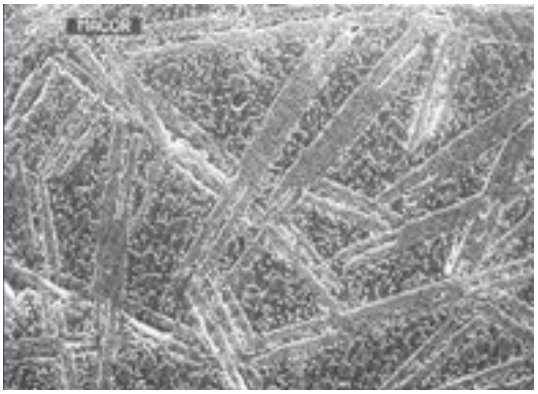
Compound	ID	Weight
Silicon Oxide	SiO_2	46%
Magnesium Oxide	MgO	17%
Aluminium Oxide	Al_2O_3	16%
Potassium Oxide	K_2O	10%
Boron Oxide	B_2O	7%
Fluorine	F	4%

The photograph (below) shows the microstructure of Macor machinable glass ceramic with 5000x magnification.



Randomly oriented mica flakes in the microstructure of Macor glass machinable ceramic are the key to its machinability.

Further technical information about Macor - properties (chemical, electrical, mechanical and thermal), technical data, graphs, information and studies (DC Volume Resistivity, Dielectric Constant, Loss Tangent, Modulus of Rupture, Thermal Conductivity, Thermal Expansion and Young's Modulus) and brazing can be found on our website – www.precision-ceramics.co.uk

By using this information, both potential and existing users will have quicker and more efficient access to technical information about Macor as well as being able to contact Precision Ceramics to discuss the best way forward for specific projects.

Typical applications for Macor include ...

Electronics/Semiconductors

- Precision coil formers (high precision and dimensionally stable)
- High voltage insulators (smooth surface finish and unaffected by arcing)

Laser Applications

- Spacers, cavities and reflectors in laser assemblies (precision finish and heat resistant)

High Vacuum Applications

- Thermal breaks in high temperature processing equipment.
- Coil supports and vacuum feed-throughs (vacuum stable and hermetically sealable)

Aerospace/Space Industry

- Retaining rings on hinges, windows and doors of NASA's Space Shuttle
- Supports and components in several satellite borne systems (thermally and electronically insulating)

Nuclear Industry

- Fixtures and reference blocks in power generation units (dimensionally unaffected by irradiation)

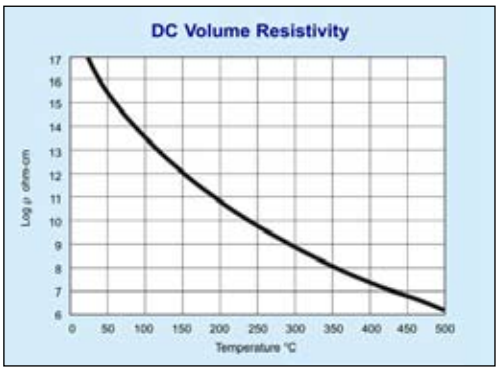
Typical Properties

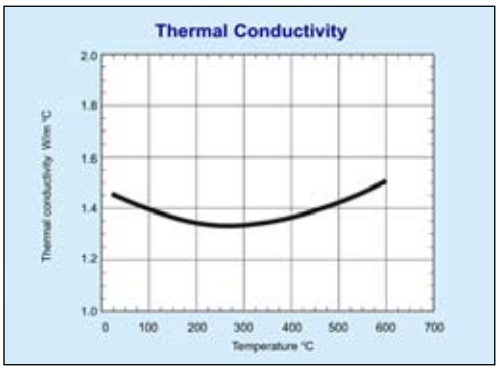
Chemical Properties				
Tests				**Results Weight Loss (mg/cm^2)**
Solution	pH	Time	Temp	Gravimetric
5% HCl (Hydrochloric Acid)	0.1	24hrs	95°C	~ 100
0.002 HNO_3 (Nitric Acid)	2.8	24hrs	95°C	~ 0.6
0.1 $NaHCO_3$ (Sodium Bicarbonate)	8.4	24hrs	95°C	~ 0.3
0.02 Na_2CO_3 (Sodium Carbonate)	10.9	6hrs	95°C	~ 0.1
5% NaOH (Sodium Hydroxide)	13.2	6hrs	95°C	~ 10
Resistance to water over time H_2O	7.6	1 day*	95°C	0.01
		3 days*	95°C	0.07
		7 days*	95°C	9.4
		3 days**	95°C	0.06
		6 days**	95°C	0.11
*Water not freshened daily ** Water freshened daily				

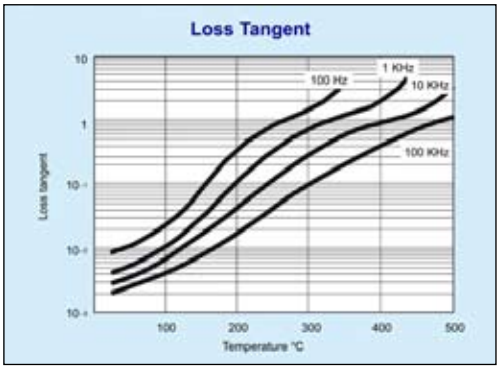
Electrical Properties		
	Metric	**Imperial**
Dielectric Constant, 25°C		
1 KHz	6.03	6.03
8.5 GHz	5.67	5.67
Loss Tangent, 25°C		
1 KHz	$4.7x10^{-3}$	$4.7x10^{-3}$
8.5 GHz	$7.1x10^{-3}$	$7.1x10^{-3}$
Dielectric Strength (AC) average (at 12 mil thickness and 25°C)	9.4 KV/mm	785 V/mil
Dielectric Strength (DC) average (at 12 mil thickness and 25°C)	62.4 KV/mm	5,206 V/mil
DC Volume Resistivity, 25°C	$>10^{16}$ ohm-cm	$>10^{16}$ ohm-cm

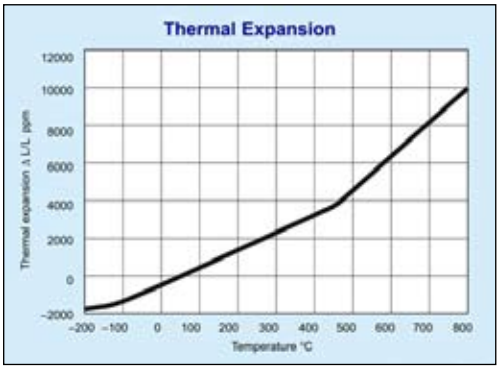
Mechanical Properties		
	Metric	**Imperial**
Density	2.52 g/cm^3	157 lbs/ft^3
Porosity	0%	0%
Young's Modulus, 25°C (Modulus of Elasticity)	66.9 GPa	$9.7x10^6$psi
Poisson's Ratio	0.29	0.29
Shear Modulus, 25°C	25.5 GPa	$3.7x10^6$psi
Hardness, Knopp, 100g	250	250
Hardness, Rockwell A	48	48
Modulus of Rupture, 25°C (Flexural Strength)	94 MPa	13,600 psi
Compressive Strength	345 MPa	50,000 psi
Fracture Toughness	1.53 MPa $m^{0.5}$	1,390 psi $in^{0.5}$

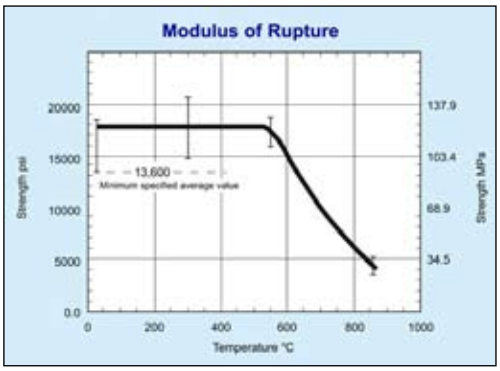
Thermal Properties		
	Metric	**Imperial**
Coefficient of Expansion		
-200 - 25°C	$74x10^{-7}$/°C	$41x10^{-7}$/°F
25 - 300°C	$93x10^{-7}$/°C	$52x10^{-7}$/°F
25 - 600°C	$114x10^{-7}$/°C	$63x10^{-7}$/°F
25 - 800°C	$126x10^{-7}$/°C	$70x10^{-7}$/°F
Specific Heat, 25°C	0.79 KJ/kg°C	0.19 Btu/lb°F
Thermal Conductivity, 25°C	1.46W/m°C	10.16 Btu in hr ft^2/°F
Thermal Diffusivity, 25°C	$7.3x10^{-7}m^{2/sup>/s}$	0.028 ft^2/hr
Continuous Operating Temperature	800°C	1,472°F
Maximum No Load Temperature	1,000°C	1,832°F

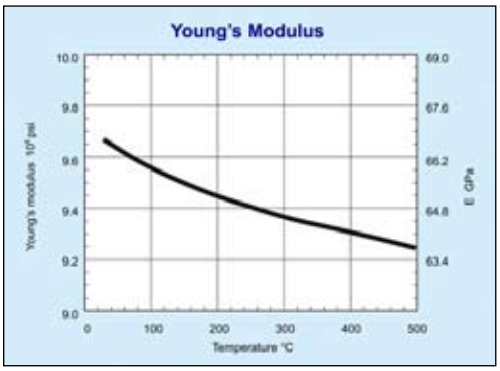












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