

MACOR[®] MACHINABLE CERAMIC FOR ENGINEERING APPLICATIONS

Traditional ceramic materials can normally only be machined by diamond grinding once they have been fired, which can be costly. MACOR[®] machinable glass ceramic offers a potentially lower cost solution to this problem.

MACOR[®] is an extremely versatile engineering material, offering researchers, product designers and machinists the opportunity to quickly, accurately and economically make high precision components which are machinable with ordinary metalworking tools and do not require any post-firing after machining has been completed, removing a production process and potentially reducing costs.

MACOR[®] machinable glass ceramic exhibits good strength, electrical & thermal insulation, has zero porosity and can be machined to very high tolerances. This allows the performance of a technical ceramic to be achieved whilst reducing the time necessary between design and realization.

Goodfellow Ceramic and Glass Division is able to offer MACOR[®] machinable glass ceramic as rods, bars, sheets and finished components.

Characteristics of MACOR[®] machinable glass ceramic

> Excellent Machinability

High precision and complex shapes can be achieved, limited only by available equipment and the experience of the machinist.

> Excellent electrical properties

Good electrical insulation is achieved at high voltages, various frequencies and high temperatures. When properly baked out the material will not outgas in vacuum environments.

> Sealing, Joining & Metallizing

MACOR[®] machinable glass ceramic can be joined or sealed, both to itself and to other materials in a number of ways. It can also be thick film metallized using metal inks, or thin film metallized by sputtering.

- > Maximum use temperature of 1000°C
- > Strong and rigid
- > Radiation resistant
- > Low thermal conductivity
- > Can be highly polished



MACOR[®] machinable glass ceramic is a white, odorless material composed of approximately 55% fluorophlogopite mica and 45% borosilicate glass.

Manufacturing Applications of MACOR[®] machinable glass ceramic

- > Precision Coil Formers (Electronic / Semiconductor industry)
- > Spacers, cavities and reflectors (Laser industry)
- > Thermal breaks, coil supports, vacuum feedthroughs (High Vacuum industry)
- > Retaining rings, supports and components (Aerospace / Space industry)
- > Fixtures and reference blocks in power generation (Nuclear industry)

MACOR[®] is a registered trademark of Corning Incorporated

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Maximum available size

MACOR[®] machinable glass ceramic is manufactured in two standard sizes. The following should be referred to as the maximum possible dimensions when considering the use of MACOR[®] machinable glass ceramic:

Standard Block:	340 x 330 x 57mm
Standard Rods:	76mm diameter x 300mm long

Properties

Thermal

Coefficient of Expansion	
-200 to 25°C	$74 \times 10^{-7}/^{\circ}\text{C}$
25 to 300°C	$93 \times 10^{-7}/^{\circ}\text{C}$
25 to 600°C	$114 \times 10^{-7}/^{\circ}\text{C}$
25 to 800°C	$126 \times 10^{-7}/^{\circ}\text{C}$
Specific Heat, 25°C	.79KJ/kg°C
Thermal Conductivity, 25°C	1.46 W/m°C
Thermal Diffusivity, 25°C	$7.3 \times 10^{-7} \text{m}^2/\text{s}$
Continuous Operating Temperature	800°C
Maximum No Load Temperature	1000°C

Mechanical

Density	2.52 g/cm ³
Porosity	0%
Young's Modulus, 25°C (Modulus of Elasticity)	66.9 GPa
Poisson's Ratio	0.29
Shear Modulus, 25°C	25.5 GPa
Hardness, Knoop, 100g Rockwell A	250 48
Modulus of Rupture, 25°C (Flexural Strength)	94 MPa (minimum specified average value)
Compressive strength	345 MPa
Fracture Toughness	1.53 MPa m ^{0.5}

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Properties

Electrical

Dielectric Constant, 25°C

1 KHz	6.03
8.5 GHz	5.67

Loss Tangent, 25°C

1KHz	4.7×10^{-3}
8.5 GHz	7.1×10^{-3}

Dielectric Strength (AC) avg.
(at 0.3mm thickness and 25°C)

9.4 KV/mm

Dielectric Strength (DC) avg.
(at 0.3mm thickness and 25°C)

62.4 KV/mm

DC Volume Resistivity, 25°C

$>10^{16}$ ohm-cm

Chemical

Solution	Tests pH	Time	Temp.	Results
				Weight Loss (mg/cm ²) Gravimetric
5% HCl (Hydrochloric Acid)	0.1	24 hrs	95°C	~ 100
0.002 N HNO ₃ (Nitric Acid)	2.8	24 hrs	95°C	~ 0.6
0.1 N NaHCO ₃ (Sodium Bicarbonate)	8.4	24 hrs	95°C	~ 0.3
0.02 N Na ₂ CO ₃ (Sodium Carbonate)	10.9	6 hrs	95°C	~ 0.1
5% NaOH (Sodium Hydroxide)	13.2	6 hrs	95°C	~ 10
Resistance to water over time				
H ₂ O	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

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