

MACOR® (Machinable Glass Ceramic)

- is MACHINABLE with ordinary metal working tools
- allows FAST TURNAROUND, no post firing required
- holds TIGHT TOLERANCES, up to .0005"
- withstands HIGH TEMPERATURE, up to 1000°C (no load)
- is CLEAN, no outgasing and zero porosity

Properties

MACOR® Machinable Glass Ceramic has a continuous use temperature of 800°C and a peak temperature of 1000°C. Its coefficient of thermal expansion readily matches most metals and sealing glasses. It is non-wetting, exhibits zero porosity, and unlike ductile materials, won't deform. It is an excellent insulator at high voltages, various frequencies, and high temperatures. When properly baked out, it won't outgas in vacuum environments.

Machining

Machining tolerances are surprisingly tight, up to .0005". It can be machined to a surface finish of less than 20µin and polished to a smoothness of 0.5µin-AA. Configurations are limited only by available equipment and the experience of the machinist.

Sealing, Joining and Metalizing

MACOR MGC can also be joined or sealed - both to itself and to other materials - in a number of ways: metalized parts can be soldered together and brazing has proven an effective method of joining the material to various metals; epoxy produces a strong joint, and sealing glass creates a vacuum tight seal. Even a straightforward mechanical joint is possible. It can be thick film metalized using metal inks, or thin film metalized by sputtering.

With MACOR® Machinable Glass Ceramic (MGC), fabrication is fast because it can be machined into complicated shapes and precision parts with ordinary metal working tools, quickly and inexpensively, and it requires no post firing after machining. That means no frustrating delays, no expensive hardware, no post fabrication shrinkage, and no costly diamond tools to meet specifications.

Applications

Ultra-High Vacuum Environments

MACOR® Machinable Glass Ceramic is used as an insulator or coil support and for vacuum feed-throughs. In these applications, the conductive materials are supported by the MACOR MGC part and a compatible sealing glass is used to produce a vacuum-tight, hermetic seal.

Constant Vacuum Applications

MACOR MGC parts are found in spacers, headers and windows for microwave tube devices and as sample holders in field ion microscopes.

Aerospace Industry

Over 200 distinctly shaped MACOR MGC parts can be found on America's reusable Space Shuttle Orbiter. Retaining rings of MACOR MGC are used at all hinge points, windows and doors. Also, large pieces of MACOR glass ceramic are used in a NASA space borne gamma radiation detector. For this application, frame corners are joined by a combination of machined (butt-lap) mechanical joints and a sealing glass.

Nuclear-Related Experiments

Since MACOR MGC is not dimensionally affected by irradiation, small cubes of the material are machined to a tolerance of one micron and used as a reference piece to measure dimensional change in other materials.

Welding Nozzles

Welding equipment manufacturers are using MACOR MGC as a nozzle on the tips of oxyacetylene torches. The material's nonwetting characteristic means molten particles won't adhere to and decrease the effectiveness of the nozzle.

Fixtures

MACOR MGC is used as an electrode support and burner block in several industrial high heat, electrical cutting operations due to its low thermal conductivity and excellent electrical properties.

Medical Equipment

Producers of medical components are intrigued by MACOR MGC's inertness, precise machinability and dimensional stability.

Property	Units	MACOR®
Physical		
Density	lbs/ft ³	157
Specific Gravity	g/cc	2.52
Porosity	%	0
Mechanical		
Young's Modulus, 25°C (Modulus of Elasticity)	psi	9.7x10 ⁶
Poisson's Ratio		0.29
Shear Modulus, 25°C	psi	3.7x10 ⁶
Hardness, Knopp, 100g Rockwell A		250 48
Modulus of Rupture, 25°C (Flexural Strength)	psi	13,600 (minimum specified average value)
Compressive strength	psi	50,000
Fracture Toughness	psi in ^{0.5}	1,390
Thermal		
Coefficient of Expansion -200 - 25°C	°F	41x10 ⁻⁷
25 - 300°C	°F	52x10 ⁻⁷
25 - 600°C	°F	63x10 ⁻⁷
25 - 800°C	°F	70x10 ⁻⁷
Specific Heat, 25°C	Btu/lb-°F	0.19
Thermal Conductivity, 25°C	Btu-in/hr-ft ² -°F	10.16
Thermal Diffusivity, 25°C	ft ² /hr	0.028
Continuous Operating Temperature	°F	1,472
Maximum No Load Temperature	°F	1832
Electrical		
Dielectric Constant, 25°C 1 KHz		6.03
8.5 GHz		5.67
Loss Tangent, 25°C 1 KHz		4.7x10 ⁻³
8.5 GHz		7.1x10 ⁻³
Dielectric Strength (AC) avg. (at 12 mil thickness and 25°C)	V/mil	785
Dielectric Strength (DC) avg. (at 12 mil thickness and 25°C)	V/mil	5206
DC Volume Resistivity, 25°C	ohm-cm	>10 ¹⁶

NOTE: The information contained herein are typical values intended for reference and comparison purposes only. They should NOT be used as a basis for design specifications or quality control. Contact us for manufacturers' complete material property datasheets. All values at 73°F (23°C) unless otherwise noted.