MACOR®
(Machinable Glass Ceramic)

•Is MACHINABLE with ordinary metal working tools
•Holds TIGHT TOLERANCES, up to .0005”
•Is CLEAN, no outgasing and zero porosity
•Allows FAST TURNAROUND, no post firing required
•Withstands HIGH TEMPERATURE, up to 1000ºC (no load)

Properties
MACOR® Machinable Glass Ceramic has a continuous use temperature of 800ºC and a peak temperature of 1000ºC. 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..

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. Straightforward mechanical joints are possible. It can be thick film metalized using metal inks, or thin film metalized by sputtering.

MACOR® Machinable Glass Ceramic (MGC), 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.

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.

Property	Units	MACOR®
Physical		
Density	lbs/ft^3	157
Specific Gravity	g/cc	2.52
Porosity	%	0
Mechanical		
Young's Modulus, 25ºC (Modulus of Elasticity)	psi	9.7×10^6
Poisson's Ratio		0.29
Shear Modulus, 25ºC	psi	3.7×10^6
Hardness, Knopp, 100g Rockwell A		 250 48
Modulus of Rupture, 25ºC (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 - 25ºC 25 - 300ºC 25 - 600ºC 25 - 800ºC	 ºF ºF ºF ºF	 41×10^{-7} 52×10^{-7} 63×10^{-7} 70×10^{-7}
Specific Heat, 25ºC	Btu/lb-ºF	0.19
Thermal Conductivity, 25ºC	$Btu\text{-}in/hr\text{-}ft^2\text{-}ºF$	10.16
Thermal Diffusivity, 25ºC	ft^2/hr	0.028
Continuous Operating Temperature	ºF	1,472
Maximum No Load Temperature	ºF	1832
Electrical		
Dielectric Constant, 25°C 1 KHz 8.5 GHz		 6.03 5.67
Loss Tangent, 25°C 1 KHz 8.5 GHz		 4.7×10^{-3} 7.1×10^{-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.