EuropTec
Glass and Polymer Technologies

MACOR®

machinable glass ceramic

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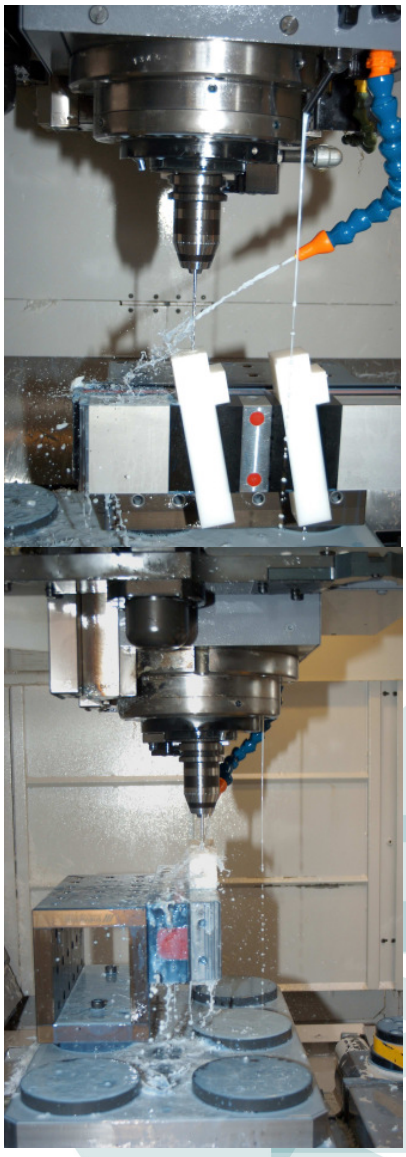
A unique material

MACOR is a versatile material. It combines the performance of a technical ceramic with the versatility of a high-performance polymer. MACOR glass ceramic is an excellent technical material that is suitable for machining with conventional tools.



- It has a continuous usable temperature of 800 °C, with a peak temperature of 1000 °C.
- MACOR has a low thermal conductivity and is a good thermal insulator even at high temperatures.
- It is also an excellent electrical insulator and is therefore used in the electronics and semiconductor industry.
- Macor is pore-free and does not outgas when properly baked out. This makes MACOR an ideal material for ultra-high vacuum applications.
- The material has high strength and rigidity. Unlike high-temperature polymers MACOR does not creep or deform.
- It is radiation-resistant and is therefore used in nuclear engineering.
- Macor can also be joined or sealed to itself and other materials in a number of ways through metallizing, brazing, fritting or using epoxy resin.
- It is white and can be bright-polished. MACOR is used in medical and optical devices.

Macor offers the following benefits:

- Precise machining is possible (tolerances +/-0.013 mm; surface quality <0.5 µm, polishing to 0.013 µm).
- Excellent design flexibility
  Design modifications are easy to implement, thereby reducing the time for product and process development.

Applications

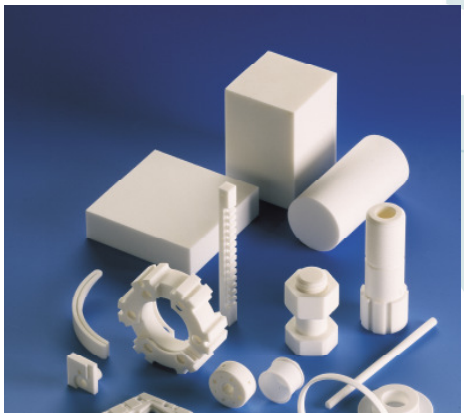
Production of unique components

MACOR glass ceramic enables rapid and cost-effective production of high-precision components.
The application of MACOR avoids mold costs and shrinkage during the firing process. Unlike in similar conventional processes no diamond tools are required.

Macor offers the following benefits...

Machinable MACOR glass ceramic is an ideal material for high-performance technical ceramics and complex shapes.

It keeps costs to minimum and significantly reduces the time between development and application.



The unique properties of MACOR are ideal for a wide range of applications:

- **Electronics and semiconductor industry**
  High-precision coil supports with high dimensional stability
  High-voltage insulators (smooth surface and high dielectric strength)
- **Laser industry**
  Spacers, resonators and reflectors in laser components (precision machining and heat resistance)
- **High vacuum industry**
  Thermal barriers for high-temperature manufacturing facilities. Coil carriers and vacuum feed-through (vacuum stability and hermetic connection)
- **Aerospace industry**
  Snap rings for joints, windows and doors of the NASA Space Shuttle.
  Supports and components for several satellite systems (thermal and electrical insulators)
- **Nuclear engineering**
  Assembly devices and reference cubes in nuclear power plants (dimensional stability under irradiation).

Plus a wide range of other applications in high-tech sectors.

Machining

The processing speed and the cooling medium are crucial for successful machining.

Machinable MACOR glass ceramic can be processed with tools made from high-speed steel. Carbide tools are recommended for longer service life and higher surface quality. Sufficient cooling is important.

No post fining is required after machining.

Special attention should be paid to microcracks. EuropTec is specialized in machining of Macor.

Properties

Density
2.52 g/cm^3

Thermal expansion coefficient (20-300°C)
74 x 10^{-7} / °C (-200 - 25 °C)
93 x 10^{-7} / °C (25 - 300 °C)
114 x 10^{-7} / °C (25 - 600 °C)
126 x 10^{-7} / °C (25 - 800 °C)

Thermal properties

Continuous use temperature:	800 °C
Maximum use temperature:	1,000 °C
Thermal diffusivity (25 °C):	7.3 x 10^{-7} m2/s
Thermal conductivity (25 °C):	1.46 W/m°C
Specific heat (25 °C):	0.79 KJ/kg°C

Mechanical properties

Porosity:	0%
Young's modulus (25 °C):	66.9 GPa
Poisson's ratio:	0.29
Shear modulus (25 °C):	25.5 GPa
Knoop hardness (100 g):	250
Flexural strength (25 °C):	94 MPa
Compressive strength:	345 MPa
Fracture toughness:	1.53 MPa m$^{0.5}$

Electrical properties

Dielectric constant (25 °C):	6.03 (1 kHz)
Loss factor (25 °C):	4.7 x 10^{-3} (1 kHz)
Dielectric strength (25 °C):	40 KV / mm (at 0.254 mm thickness)
Volume resistivity:	>10^{16} Ω-cm

Chemical properties

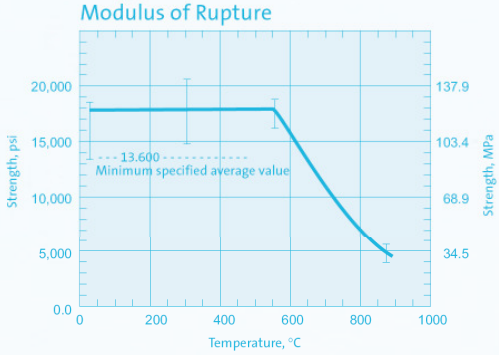
Solution	pH	Time (h)	Temp. (°C)	Weight loss (mg/cm2)
5% HCL	0,1	24 h	95 °C	approx. 100
0.002 N HNO_3	2.8	24 h	95 °C	approx. 0.6
0.1 N $NaHCO_3$	8.4	24 h	95 °C	approx. 0.3
0.02 N Na_2CO_3	10.9	6 h	95 °C	approx. 0.1
5% NaOH	13.2	6 h	95 °C	approx. 10
H_2O (water)	7.6 2	4 h	95 °C	approx. 0.01

Technical data

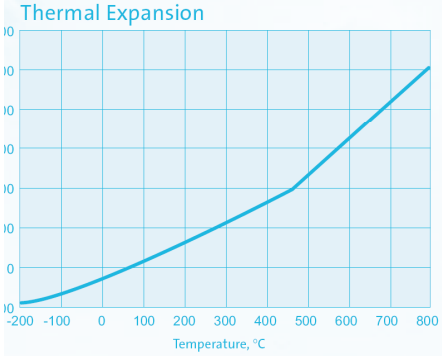
Technical Data

The general characteristics of this material described below were derived from laboratory tests performed by Corning from time to time on sample quantities. Actual characteristics of production lots may vary.

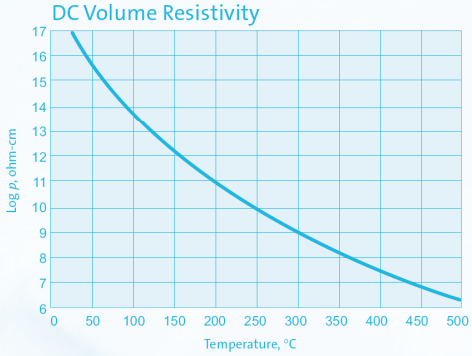
Modulus of Rupture



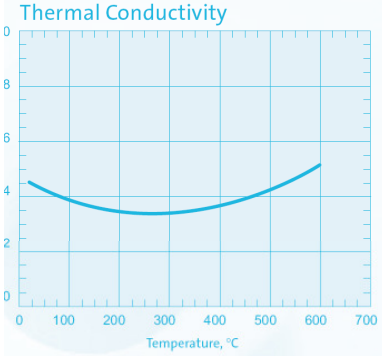
Thermal Expansion



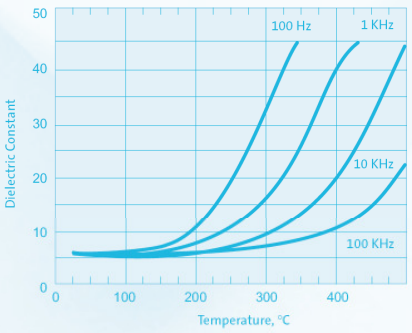
DC Volume Resistivity



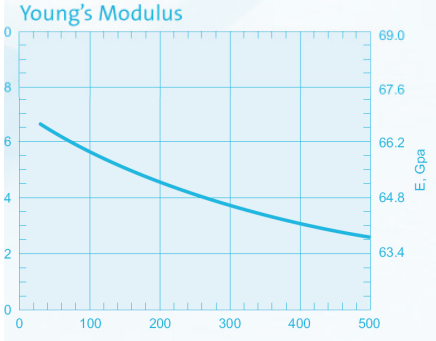
Thermal Conductivity



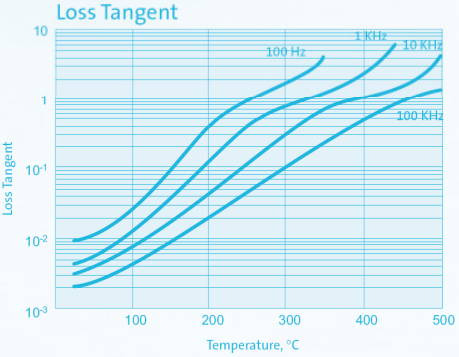
Dielectric Constant



Young's Modulus



Loss Tangent



Composition

Chemical composition

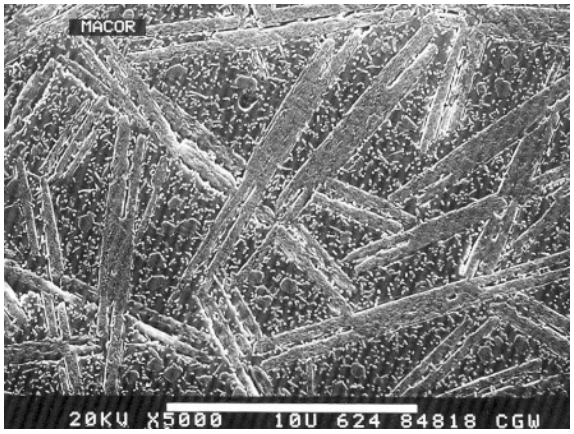
Machinable MACOR glass ceramic is a white, odorless material with porcelain-like appearance, consisting of approx 55% mica crystals and 45% borosilicate glass.

MACOR has no known toxic effect, although the dust generated during machining may cause irritations which can be avoided by suitable machining methods.

The material contains the following components:

	Percent by weight, approx.
Silicon oxide	- SiO_2 46%
Magnesium oxide	- MgO 17%
Aluminum oxide	- Al_2O_3 16%
Potassium oxide	- K_2O 10%
Boron oxide	- B_2O_3 7%
Fluorine	- F 4%

Microstructure



Microstructure of the machinable MACOR glass ceramic, magnification 5000 x

The mechanical machinability of MACOR is based on randomly oriented mica crystals in the microstructure.

Availability

EuropTec can supply pre-machined semifinished products or finished components.

Contact

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