MANSER

DECADES OF
EXPERTISE IN
WORKING WITH

MACOR®-
GLASS CERAMICS

www.manser-ag.com

What is Macor® glass ceramics?

Macor® is a white, odorless material with the appearance of porcelain that has no known toxic effects. Unlike ductile materials, it does not warp.

Composition:

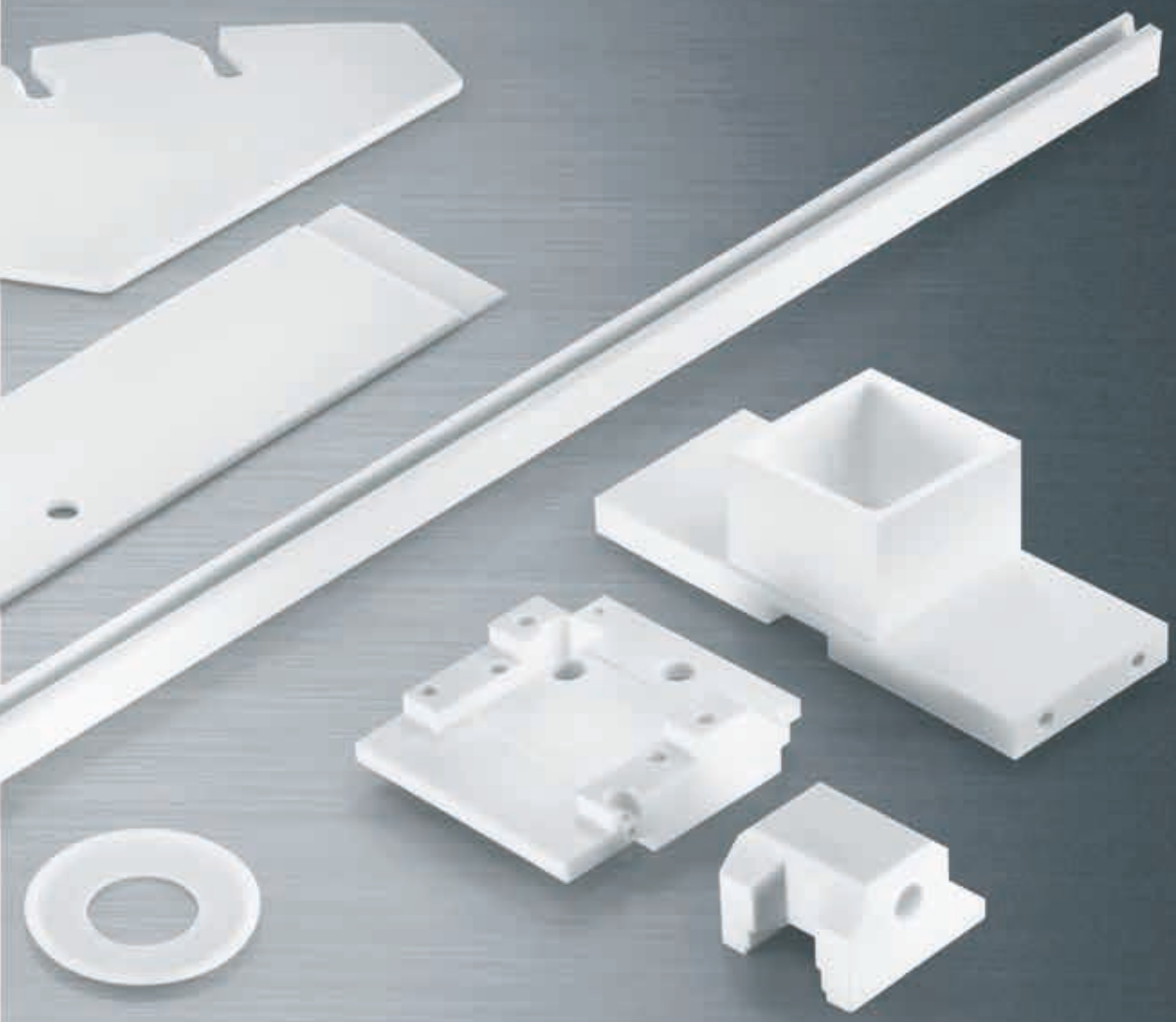
46% Silicon oxide (SiO_2)
17% Magnesium oxide (MgO)
16% Aluminum oxide (Al_2O_3)
10% Potassium oxide (K_2O)
7% Boric oxide (B_2O_3)
4% Fluorine (F)

Top customer benefits

- Cost-effective machining
- Complex design shapes
- Resistant to radiation
- Low thermal conductivity
- Very high working temperature
- Good electrical insulator
- Non-porous; no outgassing
- Short lead times
- No glost firing required

Macor® high-performance glass ceramics

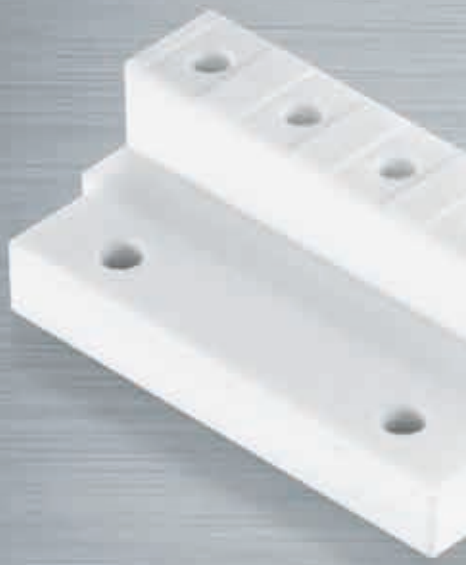
For decades, we have specialized in processing both standard materials and special, custom materials – most notably Macor® glass ceramics. This extraordinary materials is a combination of approx. 55% mica crystals and 45% borosilicate glass. This composition enables it to combine the performance of a technical ceramic material with the versatility of a high-performance polymer. It is also extremely efficient to machine, with tolerances of up to 0.01 mm. Complex shapes made to measure, short lead times, easy machining and the enormous technical advantages it offers in use make this material extremely useful for a wide range of products.



Did you know?

MACOR® in detail

- Its working temperature for continuous operation is 800°C, with peaks of 1000°C.
- It can achieve machining tolerances of up to 0.01 mm and a surface quality of less than Ra 0.1.
- The material has low thermal conductivity, and remains a good thermal insulator even at high temperatures.
- It is an excellent electrical insulator and has been used successfully in the electronics and semiconductor industry.
- It is non-porous and does not emit any gases when thoroughly heated in the furnace. This makes it the perfect material for ultra high volume applications.
- High strength and rigidity. Unlike high-temperature plastics, the material does not creep or warp.
- It is radiation-resistant, and is thus also used in nuclear and aerospace applications.
- It can be metallized in thin or thick layers, brazed and bonded with epoxy resin or frits.
- It is non-wetting, has zero porosity and, unlike ductile materials, does not warp.



Electrotechnical properties

• High dielectric strength
• High specific resistance
• Low dissipation factor

Thermal properties

• High working temperature
• Moderate heat conductivity
• High thermal expansion coefficient, can be bonded with ordinary glass

Chemical properties

• Zero water absorption
• Good chemical resistance
• Is not wetted by molten aluminum, magnesium or tin

Stability

• High stability
• High scratch resistance
• Dimensional stability
• Isotropic and uniform
• 50% higher impact resistance than Pyrex or Pyroceram

Vacuum impregnation

• Zero porosity
• No outgassing
• Low helium penetration
• Can be hermetically bonded with metals*[1], ceramic materials and glass using solder glass

Metallization properties

• Through vaporization of different metals
• Can be sealed and coated
• Hermetic sealing through the use of glass solder
• Soldered seals on metallized parts

*[1] e.g. silver, gold, platinum, nickel, titanium

Properties

I. THERMAL

	SI/METRIC	IMPERIAL
Coefficient of expansion		
CTE -100 °C → 25 °C	81 x 10^{-7}/°C	45 x 10^{-7}/°F
CTE 25 °C → 300 °C	90 x 10^{-7}/°C	50 x 10^{-7}/°F
CTE 25 °C → 600 °C	112 x 10^{-7}/°C	62 x 10^{-7}/°F
CTE 25 °C → 800 °C	123 x 10^{-7}/°C	68 x 10^{-7}/°F
Specific heat, 25 °C	0.79 kJ/kg·°C	0.19 Btu/lb·°F
Thermal conductivity, 25 °C	1.46 W/m·°C	10.16 Btu.in/hr.ft^2·°F
Thermal diffusivity, 25 °C	7.3 x 10^7 m^2/s	0.028 ft^2/hr
Continuous operating temperature	800 °C	1472 °F
Maximum no load temperature	1000 °C	1832 °F

II. MECHANICAL

	SI/METRIC	IMPERIAL
Density	2.52 g/cm^3	157 lbs/ft^3
Porosity	0 %	0 %
Young's modulus, 25 °C	66.9 GPa	9.7 x 10^6 PSI
Poisson's ratio	0.29	0.29
Shear modulus, 25 °C	25.5 GPa	3.7 x 10^6 PSI
Hardness, Knoop, 100 g	250 kg/mm^2	
Modulus of Rupture, 25 °C (flexural strength)	94 MPa (Minimum specified average value)	13 600 PSI
Pressure resistance (after polishing)	345 MPa up to 900 MPa	49 900 PSI 130 000 PSI

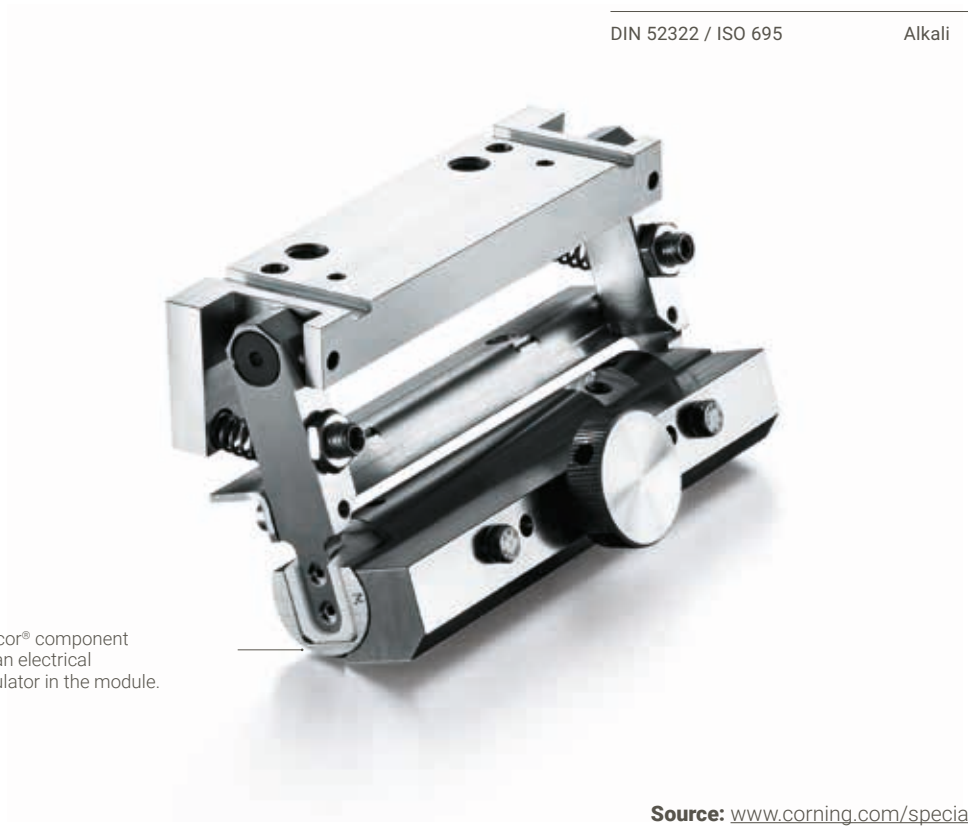
III. ELECTRICAL

	SI/METRIC	IMPERIAL
Dielectric constant, 25 °C		
1 kHz	6.01	6.01
8.5 GHz	5.64	5.64
Loss Tangent, 25 °C		
1 kHz	0.0040	0.0040
8.5 GHz	0.0025	0.0025
Dielectric strength (AC) average 25 °C, under 0.3mm thickness	45 kV/mm	1143 V/mil
Dielectric strength (DC), average 25 °C, under 0.3mm thickness	129 kV/mm	3277 V/mil
DC volume resistivity, 25 °C	10^{17} Ohm·cm	10^{17} Ohm·cm

IV. CHEMICAL

SOLUTION	pH	TIME	TEMP.	WEIGHT LOSS (mg/cm^2) GRAVIMETRIC
5 % HCl (hydrochloric acid)	0.1	24 h	95 °C	~100
0.002 N HNO_3 (nitric acid)	2.8	24 h	95 °C	~ 0,6
0.1 N $NaHCO_3$ (sodium bicarbonate)	8.4	24 h	95 °C	~ 0.3
0.02 N Na_2CO_3 (sodium carbonate)	10.9	6 h	95 °C	~ 0.1
5 % NaOH (sodium hydroxide)	13.2	6 h	95 °C	~ 10

CHEMICAL RESISTANCE		CLASS
DIN 12111 / NF ISO 719	Water	HGB2
DIN 12116	Acid	4
DIN 52322 / ISO 695	Alkali	A3



Macor® component as an electrical insulator in the module.

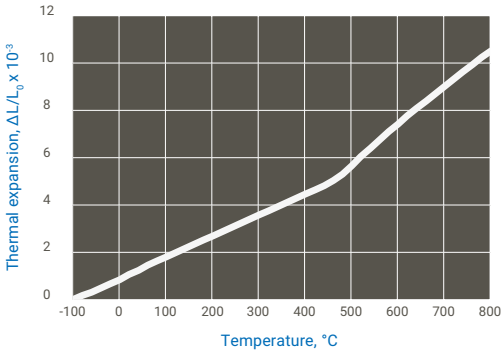
Source: www.corning.com/specialtymaterials/macor Date: May 18, 2018

Manufacturer's note: Actual properties of specific production batches may vary. The specified general properties reflect the results of regular tests on sample quantities in Corning's labs.

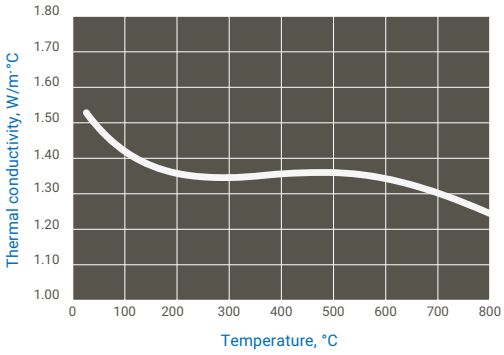
Technical information

The general properties of Macor® glass ceramic shown here have been measured during lab tests performed on material samples at Corning.

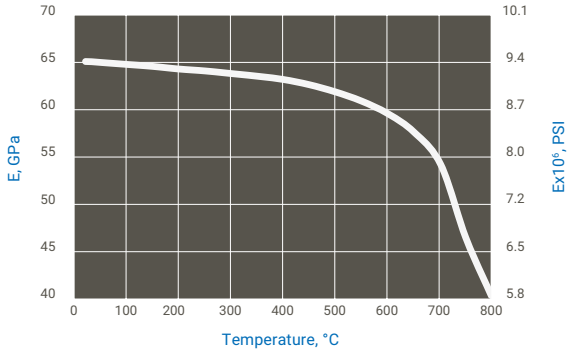
THERMAL EXPANSION



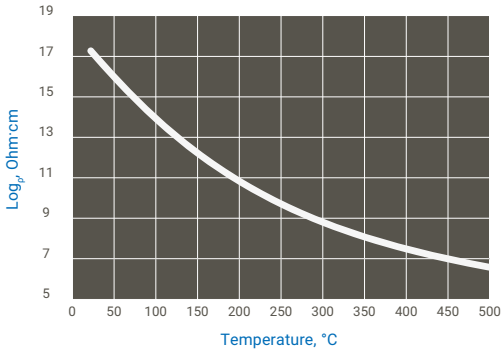
THERMAL CONDUCTIVITY



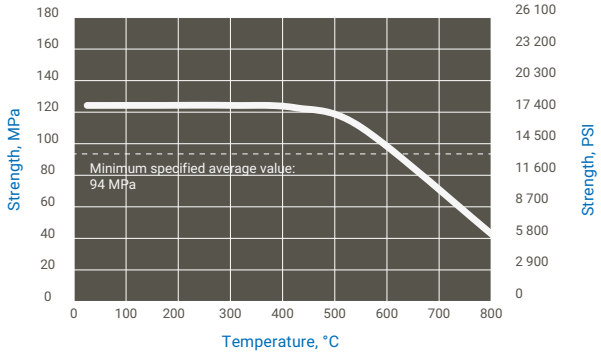
YOUNG'S MODULUS



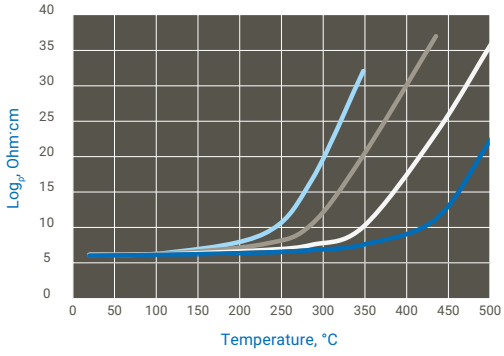
DC VOLUME RESISTIVITY



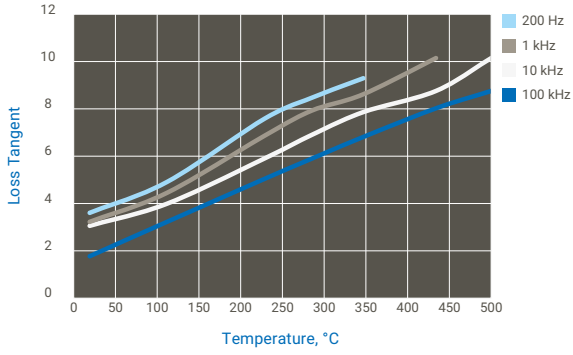
MODULUS OF RUPTURE



DIELECTRIC CONSTANT



LOSS TANGENT



MANSER

MANSER innovation

As a professional partner to our customers, it is our fundamental responsibility to look toward the future. We plan ahead, show initiative, and have the courage to embark on new challenges.

Our passion is combining ideas with knowledge to produce innovative products. It is this approach that ultimately leads to our success.

» manser-ag.com

August Manser AG

Unterfeld plant (head office)
Unterfeldstrasse 8
9450 Altstätten, Switzerland

Kesselbach plant
Kesselbachstrasse 50
9450 Altstätten, Switzerland

info@manser-ag.com • **Tel** +41 71 757 80 40 • **Fax** +41 71 757 80 45

Photos: Vision Studios, visionstudios.ch
Conception and design: WERBE&form, werbeundform.com