

# *Industrial Ceramics & High End Plastics*

## *precision machine shop*



Manufacturer « Fabrication « Prototype « Production « Distributor

## **HAVE A CERAMIC CHALLENGE?**

*MAKE OUR COMPLETE CAPABILITIES YOURS*

- Fabricator of hard and soft ceramics
- Isostatic pressing
- Full forth axis machining
- Green machining threads down to 000 -120
- Glazing
- State of the art packaging
- 3D CAM and programming
- Prototype to production
- On-site sintering up to 1800°C
- Lapping
- Clean firing of semi-conductor
- Laser cutting of substrates

*Forty blessed years of an on-growing business and experienced staff.*

## High Purity (AL<sub>2</sub>O<sub>3</sub>) Alumina Material Specifications

Alumina Oxide (AL<sub>2</sub>O<sub>3</sub>) is a readily available material with reasonable processing cost, possessing excellent mechanical, electrical, and wear properties. Our fabricated Alumina is used in a wide range of applications not limited to aerospace, automotive, medical and military.

Technical Products processes include cold isotactic pressing of green billets, pre-fired machining, sintering, and post sintered grinding operations.

Physical Properties	Units	AL <sub>2</sub> O <sub>3</sub> -96%	AL <sub>2</sub> O <sub>3</sub> -99.8%	AL <sub>2</sub> O <sub>3</sub> -99.9%
Bulk Density	g/cm <sup>3</sup>	3.72	3.9	3.93
Color	-	white	ivory	ivory
Water Absorption	%	0	0	0
Hardness (Rockwell 45 N)	-	78	83	86
Grain Size	Microns	6	6	3

Mechanical Properties	Units	AL <sub>2</sub> O <sub>3</sub> -96%	AL <sub>2</sub> O <sub>3</sub> -99.8%	AL <sub>2</sub> O <sub>3</sub> -99.9%
Compressive Strength	MPa	2100	2300	2600
Modulus of Elasticity	GPa / psi • 10 <sup>6</sup>	303 / 44	370 / 54	393 / 57
Flexural Strength	MPa /psi • 10 <sup>3</sup>	358 / 52	375 / 54	400 / 58
Poisson's Ratio	-	0.21	0.22	0.22
Fracture Toughness	MPa m <sup>1/2</sup>	4 – 5	4 - 5	5
Gas Permeation	%	0	0	0

Thermal Properties	Units	AL <sub>2</sub> O <sub>3</sub> -96%	AL <sub>2</sub> O <sub>3</sub> -99.8%	AL <sub>2</sub> O <sub>3</sub> -99.9%
Max. Use Temperature (no load)	°C / °F	1600 / 2912	1700 / 3092	1700 / 3092
Thermal Conductivity	W/mK	24.7	30	35
Thermal Expansion 20°C – 1000°C	10 <sup>-6</sup> /°C	8.2	8.2	8.2
Specific Heat	J/kg*K	880	880	870

Electrical Properties	Units	AL <sub>2</sub> O <sub>3</sub> -96%	AL <sub>2</sub> O <sub>3</sub> -99.8%	AL <sub>2</sub> O <sub>3</sub> -99.9%
Dielectric Constant	-	9	9.8	9.7
Dielectric Strength	ac V/mils	210	220	230

\*\*The information provided in this table is a compilation of publicly available data. This information is provided for comparison purposes only, and is not intended to be warrantable. Further, *Technical Products, Inc.* disclaims any and all liability from errors, in accuracies, or omissions.

## Zirconia (ZrO<sub>2</sub>) Material Specifications

Zirconia (ZrO<sub>2</sub>) is a readily available material with reasonable processing cost, possessing excellent mechanical, electrical, and wear properties. Our fabricated Zirconia is used in a wide range of applications not limited to aerospace, automotive, medical and military.

Technical Products processes include cold isotactic pressing of green billets, pre-fired machining, sintering, and post sintered grinding operations.

Physical Properties	Units	ZrO <sub>2</sub> -YTZP	ZrO <sub>2</sub> -TTZ-C	ZrO <sub>2</sub> -TTZ-T
Sintered	-	Yttria	Magnesium (MgO)	Magnesium (MgO)
Density	g/cc	6.04	5.72	5.70
Color	-	White	White/Ivory	Yellow
Water Absorption	%	0	0	0
Gas Permeability	-	0	0	0
Hardness (Rockwell 45 N)	-	81	77	77

Mechanical Properties	Units	ZrO <sub>2</sub> -YTZP	ZrO <sub>2</sub> -TTZ-C	ZrO <sub>2</sub> -TTZ-T
Compressive Strength	MPa / psi x 10 <sup>3</sup>	2500 / 363	1750 / 254	1750 / 254
Tensile Strength	MPa	500	483	483
Flexural Strength	MPa	1240	900	900
Modulus of Elasticity (Young's Mod.)	GPa	210	200	200
Fracture Toughness, K(I c)	MPa m <sup>1/2</sup>	13	11	11
Poisson's Ratio, 20°C	-	0.23	0.28	0.30

Thermal Properties	Units	ZrO <sub>2</sub> -YTZP	ZrO <sub>2</sub> -TTZ-C	ZrO <sub>2</sub> -TTZ-T
Max. Use Temperature (no-load cond.)	°C	500	1500	1500
Thermal Shock Resistance Δ Tc	°C	350	350	350
Thermal Conductivity, 20°C	W/m-K	2.2	2.2	2.2
Thermal Expansion Coefficient, 25-1000°C	1 x 10 <sup>-6</sup> /°C	10.3	10.2	10.2
Specific Heat, 100°C	J/kg*K	400	400	400

Electrical Properties	Units	ZrO <sub>2</sub> -YTZP	ZrO <sub>2</sub> -TTZ-C	ZrO <sub>2</sub> -TTZ-T
Dielectric Strength	ac V/mil	228	240	240
Dielectric Constant, 25°C	1 MHz	29.0	28.0	28.0
Dielectric Loss (tan delta) , 25°C	1 MHz	0.001	0.001	0.001
Volume Resistivity, 25°C	ohm-cm	>10 <sup>13</sup>	>10 <sup>13</sup>	>10 <sup>13</sup>
500°C		2 x 10 <sup>4</sup>	2 x 10 <sup>6</sup>	2 x 10 <sup>6</sup>
1000°C		<10 <sup>3</sup>	<10 <sup>3</sup>	<10 <sup>3</sup>

# Macor® (MGC) Material Specifications

Technical Products, Inc. is an authorized distributor of Macor® machinable glass ceramic. We inventory large quantities of stock both [in-house](#) and [online](#) ready to ship in 1-3 business days.

Macor® glass ceramic offers an outstanding combination of thermal, mechanical, electrical and chemical properties. Macor® material withstands high temps. up to 1000°C (no load) and demonstrates high electrical resistivity and dielectric strength. It can also be machined (using ordinary metal working tools) in intricate shapes and precision parts.

Mechanical Properties	SI/Metric	Imperial
Density	2.52 g/cm <sup>3</sup>	157 lbs/ft <sup>3</sup>
Porosity	0%	0%
Young's Modulus, 25°C (Modulus of Elasticity)	66.9 GPa	9.7 x 10 <sup>6</sup> psi
Poisson's Ratio	0.29	0.29
Shear Modulus, 25°C	25.5 GPa	3.7 x 10 <sup>6</sup> psi
Knoop Hardness, 100g	250 kg/mm <sup>2</sup>	-
Modulus of Rupture, 25°C (Flexural Strength)	94 MPa (Minimum specified average value)	13,600 psi
Compressive Strength (After Polishing)	345 MPa up to 900 MPa	49,900 psi 130,000 psi

Thermal Properties	SI/Metric	Imperial
Coefficient of Expansion		
CTE -100°C → 25°C	81 x 10 <sup>-7</sup> /°C	45 x 10 <sup>-7</sup> /°F
CTE 25°C → 300°C	90 x 10 <sup>-7</sup> /°C	50 x 10 <sup>-7</sup> /°F
CTE 25°C → 600°C	112 x 10 <sup>-7</sup> /°C	62 x 10 <sup>-7</sup> /°F
CTE 25°C → 800°C	123 x 10 <sup>-7</sup> /°C	68 x 10 <sup>-7</sup> /°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 <sup>2</sup> °F
Thermal Diffusivity, 25°C	7.3 x 10 <sup>-7</sup> m <sup>2</sup> /s	0.028 ft <sup>2</sup> /hr
Continuous Operating Temperature	800°C	1472°F
Maximum No Load Temperature	1000°C	1832°F

Electrical Properties	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) avg. 25°C, under 0.03mm thickness	45 kV/mm	1143 V/mil
Dielectric Strength (DC) avg. 25°C, under 0.03mm thickness	129 kV/mm	3277 V/mil
DC Volume Resistivity, 25°C	10 <sup>17</sup> Ohm.cm	10 <sup>17</sup> Ohm.cm

Chemical Properties	pH	Time	Temp.	Gravimetric
5% HCl (Hydrochloric Acid)	0.1	24 hrs.	95°C	~ 100
0.002 N HNO (Nitric Acid)	2.8	24 hrs.	95°C	~ 0.6
0.01 N NaHCO <sub>3</sub> (Sodium Bicarbonate)	8.4	24 hrs.	95°C	~ 0.3
0.02 N Na <sub>2</sub> CO <sub>3</sub> (Sodium Carbonate)	10.9	6 hrs.	95°C	~ 0.1
5% NaOH (Sodium Hydroxide)	13.2	6 hrs.	95°C	~ 10
Chemical Durability				Class
DIN 12111 / NF ISO 719		Water		HGB2
DIN 12116		Acid		4
DIN 52322 / ISO 695		Alkali		A3

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## Alumina Silicate Grade "A" Lava Material Specifications

We have tons of the finest quality Lava in stock and ready to deliver. Grade "A" Lava is a natural ceramic material. In chemical terms it is a hydrous alumina silicate. Lava is a machinable ceramic material that is easy to machine in an unfired state and can be used unfired in applications up to 1000°F. After simple firing, parts are as hard as carbide and usable up to 2100°F.

Physical Properties	Units	Test	Unfired Lava	Fired Lava
Chemical Formula	-	-	$Al_2(Si_4O_{10})(OH)_2$	$Al_2(Si_4O_{10})(OH)_2$
Density	g/cc	C 20-97	2.60	2.30
Color	-	-	gray	pink
Water Absorption	%	C 20-97	2.5	3
Gas Permeability	atms-cc/sec	-	porous	porous
Hardness	Moh's Scale	-	2	6

Mechanical Properties	Units	Test	Unfired Lava	Fired Lava
Compressive Strength	psi	-	12,000	25,000
Tensile Strength	psi	-	1,000	3,000
Flexural Strength	psi	F 417-87	4,000	10,000

Thermal Properties	Units	Test	Unfired Lava	Fired Lava
Max Use Temperature (Non-Loading)	°F	-	1200	2000
Max Use Temperature (Non-Loading)	°C	-	650	1100
Thermal Conductivity 25°C	W/m-K	C408	-	2
Coefficient of Linear Thermal Expansion	$\mu\text{m}/\text{m}\cdot\text{°C}$ (~25°C though +/- 1000°C)	-	-	3.6

Electrical Properties	Units	Test	Unfired Lava	Fired Lava
Dielectric Constant	@1MHz	D150-98	5.8	5.3
Dielectric Strength (.125" Thick)	V/mil	D149-97A	80	100

## Mykroy/Mycalex® (Mica) Material Specifications

The low thermal conductivity and electrical properties of Mykroy/Mycalex® make it an excellent material. Mycalex® is dimensionally stable at temperatures ranging from -240°C to 600°C and does not burn or outgas. It is a good alternative to Macor when high temperature and price are a factor.

Physical Properties	Units	M400	M500	M600
Density	g/cm <sup>3</sup>	2.5	2.7	2.8
Color		Dark Gray	Light Gray	Cream
Water Absorption	%	Nil	Nil	Nil
Mica Filler		Natural	Synthetic	Synthetic
Flammability		Does Not Burn		

Mechanical Properties	Units	M400	M500	M600
Compressive Strength	psi / MPa	45,000 / 310	40,000 / 276	32,000 / 221
Tensile Strength	psi / MPa	6000 / 41.4	6000 / 41.4	5000 / 34.5
Modulus of Elasticity	psi x 10 <sup>6</sup>	11.0	12.0	10.6
	GPa	75	82.7	73.1
Impact Strength Izod (notched)	ft-lbs/in	1.8	1.7	1.3
	J/cm	0.961	0.908	0.694
Flexural Strength	psi / MPa	13,000 / 89.6	12,500 / 86.2	11,000 / 75.9
Hardness Rockwell	H / A	90 / 46	90 / 46	91 / 47

Thermal Properties	Units	M400	M500	M600
Max. Use Temperature	°F / °C	750 / 400	930 / 500	1100 / 600
Thermal Conductivity	W/m.K	.87	1.15	1.32
Specific Heat	cal/g/ °C	0.12	0.12	0.11
Coefficient of Thermal Expansion (x10 <sup>-6</sup> )	/° C @ 25 ° C	12.5	11.57	10.48
	@ 350 °C	11.0	10.53	9.74
	@ 500 °C	-	-	9.39
	@ 750 °C	-	-	-

Electrical Properties (Tested @ 25°C)	Units	M400	M500	M600
Dielectric Strength	V/mil	730	530	420
	kV/mm	28.7	20.9	16.5
Arc Resistance	Seconds	245	260	345
Dissipation Factor	1 MHz	0.0018	0.0013	0.0017
Loss Index	1 MHz	0.012	0.009	0.012
Surface Resistivity	Ω/sq (25° C)	10 <sup>9</sup>	10 <sup>12</sup>	10 <sup>11</sup>
Volume Resistivity	Ω-cm (25° C)	10 <sup>10</sup>	10 <sup>14</sup>	10 <sup>12</sup>
Dielectric Constant	1 MHz	6.7	6.9	6.8

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