Precision Ceramics has extensive in-house machining facilities including 4th and 5th axis machining centers to enable us to manufacture ceramics components to the highest specifications.

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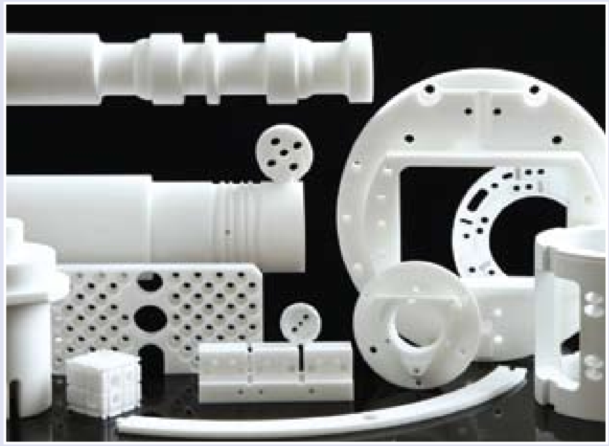
PRECISION CERAMICS USA

total ceramic solutions
for the 21st century

Precision Ceramics is a company dedicated to the engineering of technical ceramics and offers a complete service from procurement and supply through to technical design and specialist machining.



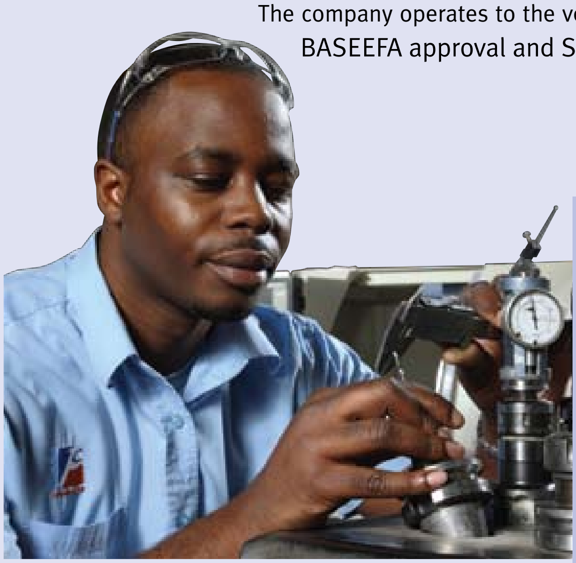
Since its UK formation in 1992, Precision Ceramics, a division of McGeoch Technology, has gained a truly international reputation for quality and service with specialist ceramic components engineered by the company finding their way into an ever-widening array of worldwide applications in industries as diverse as aerospace, electronics and opto-electronics, power generation and offshore oil and gas production.

Precision Ceramics opened its US office in late 2009 in response to the increasing volume of requests from US clients for us to address their varied needs in our industry. Our presence at international trade shows including OTC 2007 (Houston, Texas), Hannover Industry Fair 2008, (Hannover, Germany) and Ceramitec 2009 (Munich, Germany) has further highlighted our expertise and led to a wider global understanding of our ability to solve technical problems and provide a total ceramics solution.

In both new applications and in areas where technical ceramics are already being used, Precision Ceramics has the necessary expertise and in-depth knowledge to quickly find the best way forward for any potential application from prototypes through to full-scale production of components. And once fully up and running, we can easily take the process one stage further by offering expert advice in the engineering of more demanding materials.

With the opening of our new Florida Office, US clients now have rapid access to this advice and expertise and we are also now able to develop fast delivery solutions for our products into US markets.

The company operates to the very highest quality standards and holds BS EN ISO 9001:2008, BASEEFA approval and SC21.



Key Services

- ***Rapid Response***
- ***Extensive range of materials available from stock***
- ***Prototype through to production quantities***
- ***Wide experience of vacuum applications***
- ***Total solution provision***
- ***Complete design service***
- ***Full in-house machining and grinding capability***

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Design Solutions

Precision Ceramics has a wealth of 'hands-on' experience working with technical ceramics and since its formation has developed a wealth of knowledge in component design, all computer based for speed and accuracy.

Experience gained in actual applications enables us to offer the best possible advice in choice of material. And once made, that choice provides the basis for our technical design team to take a basic idea and turn it into the engineering reality of a finished component.

Machinables & Non-Machinables

Our ceramics fall into two basic categories:

Machinables - ceramics that are fully dense, require no post heat treatment and can be machined with ordinary metal-working tools.

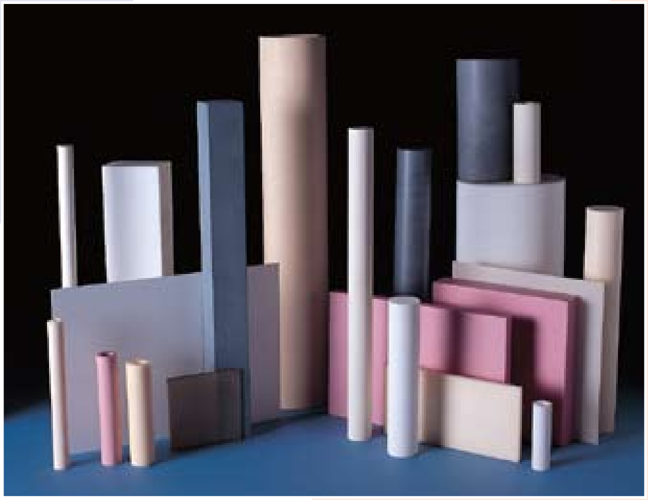
Non-Machinables - ceramics that once fired can only be machined using diamond grinding methods or other specialist machining practices.

Machinables are the perfect choice if rapid turn-round is required. They also provide the ideal basis for prototyping before moving up to harder materials.

Non-machinables offer a more extensive range of properties but require specialist tooling and longer lead times. This said, they are often more cost effective in the longer term.

Procurement & Supply

When McGeoch first introduced technical ceramics into their product range, they quickly became a principal distributor for Macor®, a unique machinable glass ceramic manufactured exclusively by Corning Incorporated. Other major distributorships quickly followed.



Nowadays, Precision Ceramics offers many other specialist materials to complement its operation. These include Macor® Shapal™ Machinable Aluminium Nitride, Boron Nitride, Alumina, Zirconia and Pyrophyllite (see centre pages for a full list of the materials we stock)

All these materials are available in plates, rod and bars as well as finished components, designed and machined to precise customer specifications.

Manufacturing

Precision Ceramics has extensive in-house machining facilities including 4th and 5th axis machining centers to enable us to manufacture ceramic components to the highest specifications. A fully controlled inspection facility with co-ordinated measurement system accurate to 0.002mm is also in operation to ensure that our rigorous quality standards are maintained at all times.

Precision Ceramics specialises in small batches between 1 and 2,000 pieces but also has the capability to tender for larger quantities.

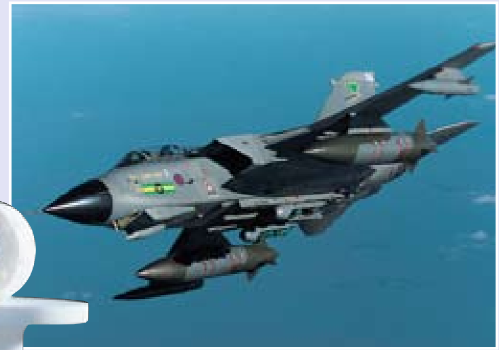
The Industries We Serve

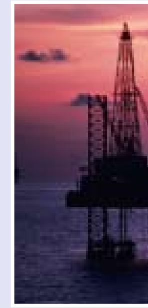
- ***Aerospace (Military & Civil)***
- ***Automotive***
- ***Defence***
- ***Dentistry***
- ***Domestic Household***
- ***Electronics & Opto-Electronics***
- ***Foundry***
- ***Medical***
- ***Nuclear Power***
- ***Offshore Oil & Gas***
- ***Power Generation***

Macor

Machinable Glass Ceramic

Macor® is an outstanding engineering material and is machinable with ordinary metalworking tools. Macor is also a problem solving material combining the performance of a technical ceramic with the versatility of a high performance plastic.

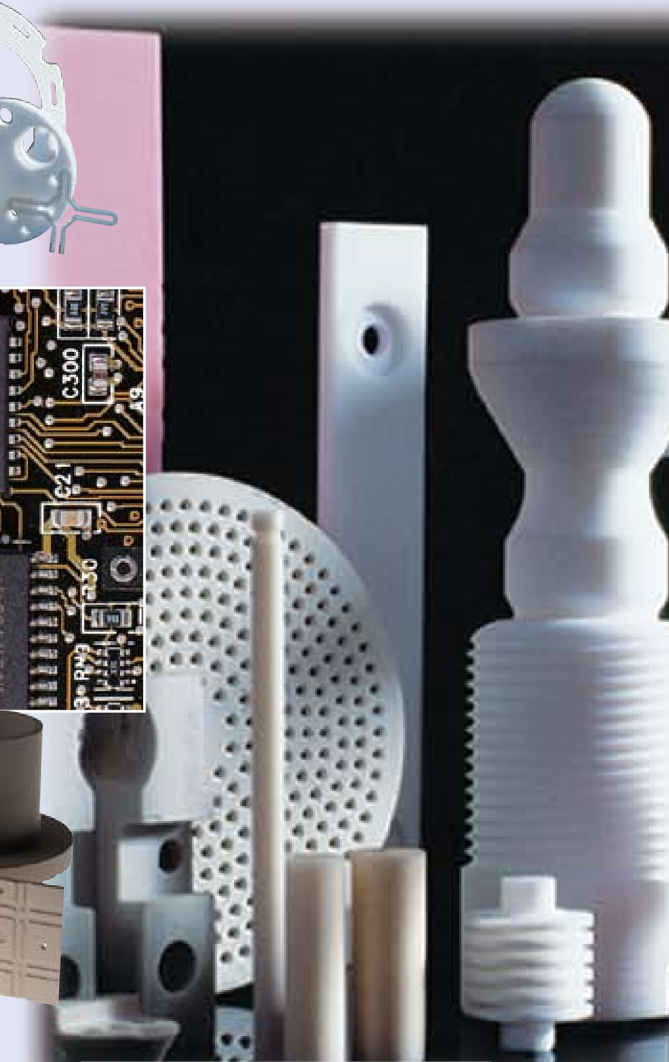




Macor has a high use temperature (800°C continuous – 1,000°C peak). It has a low thermal conductivity and is a useful high temperature insulator as well as an excellent electrical insulator. Macor has no porosity and when properly baked out, will not outgas. It is strong and rigid and, unlike high temperature plastics, will not creep or deform. Macor is also radiation resistant.

Macor is pure white and can be highly polished. It can be thick film metallised, brazed and epoxy bonded. Another major advantage of this unique material is that, even in small quantities, components are economical to manufacture.

Typical applications: Electronic and semiconductors; nuclear applications; medical and optical devices.



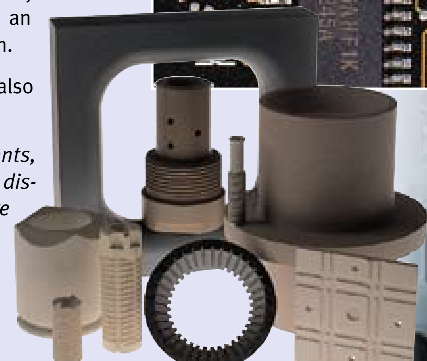
Shapal

Machinable Ceramic

Shapal™ is a new type of machinable ceramic and combines a high thermal conductivity with a high mechanical strength with bending strengths of 30 kg/mm^2. Shapal-M soft, in particular, has an excellent sealing ability to vacuum. It also has good heat resistance and an extremely low coefficient of thermal expansion.

Shapal-M maintains a low dielectric loss and also has an ultra high purity level.

Typical applications: Electronic components, especially where electrical insulation and heat dissipation are required. Also components where low dielectric constant and dissipation factor are required; fixturing parts where a low coefficient of thermal expansion is required.



Boron Nitride

Boron Nitride is an advanced synthetic ceramic material available in powder, solid, liquid and aerosol spray forms. Its unique properties – from high heat capacity and outstanding thermal conductivity to easy machinability and superior dielectric strength – making Boron Nitride a truly outstanding material.

In its solid form, Boron Nitride can easily be machined to close tolerances in virtually any shape. After machining, it is ready for use without additional heat treating or firing operations.

In inert and reducing atmospheres, Boron Nitride will withstand temperatures over 2,000°C. It is not wet by most molten metals and slags and can therefore be used as a container for most molten metals including aluminium, cryolite, sodium, iron, steel, silicon, boron, tin, germanium and copper.

Typical applications: Metals manufacturing, containment and processing; foundry applications.

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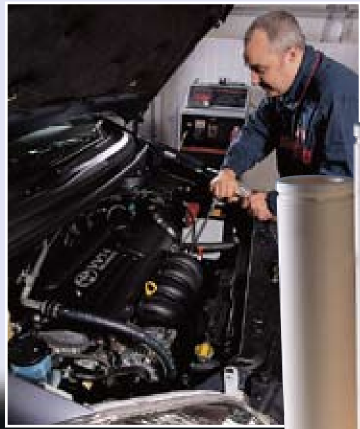

Oxides

Aluminia, Zirconia

Alumina and zirconia are hard wearing materials used for many applications. Once fired and sintered, they can only be machined using diamond-grinding methods.

Alumina's combination of hardness, high temperature operation and good electrical insulation makes it useful for a wide range of applications. Alumina is the most commonly used type of ceramic and is available in purities up to 99.9%.

Zirconia is similar to alumina in many of its properties but offers significant improvement in fracture toughness. It is particularly useful in applications where the mechanical strength of alumina is not sufficient.

Typical applications: electrical insulators; seal faces; valve seats.

Nitrides

Aluminium Nitride and Silicon Nitride

Aluminium nitride is an interesting material and is one of the best materials to use if high thermal conductivity is required. When combined with its excellent electrical insulation properties, aluminium nitride is an ideal heat sink material for many electrical and electronic applications.

Silicon nitride is an extremely hard material and is very useful for applications in which physical wear is of great importance. Silicon nitride also has very good thermal shock characteristics.

Typical applications: electronic components; heat sinks; turbine blades.

Carbides

Silicon Carbide

Like oxides and nitrides, silicon carbide is a very hard wearing material, again requiring diamond-grinding methods to process once fired.

Although not exclusively, carbides are used mainly for applications in which physical wear is a major consideration. They are amongst the hardest materials available.

Typical applications: valve seats; bearings.

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	COLOUR	DENSITY	POROSITY	POISSONS RATIO	THERMAL CONDUCTIVITY	COEFFICIENT OF THERMAL EXPANSION	DIELECTRIC STRENGTH	DIELECT CONSTA
MACHINABLES								
MACOR	White	2.52 g/cm3	0%	0.29	1.46 Wm/°C	$9.3x10^{-6}$/°C 25-300°C	40 KV/mm	6.03 1 K
SHAPAL - M	Fawn	2.9 g/cm3	0%	0.31	90 Wm/°C	$4.4x10^{-6}$/°C	40 KV/mm	7.1 1 MH
FIRED LAVA	Brown/pink		2.6%		1.25 Wm/°C	$29x10^{-6}$/°C	100 V/mm	5.3
ZSBN	Grey	2.9 g/cm3	2.4-3.4%		para 22.62 perp 40.21 Wm/°C	para 6.4 perp 1.98 x 10^{-6}/°C		
BORON NITRIDE grade A	Off-white	1.92 g/cc	2.84%		para 30.13 perp 33.17 Wm/°C	para 11.85 perp 3.12 x 10^{-6}/°C	2400 V/mm	4.15-4.5
BORON NITRIDE HP grade	White	1.9 g/cc	15.26%		para 27.37 perp 30.97 Wm/°C	para 2.95 perp 0.87 x 10^{-6}/°C	1700 V/mm	4.02-4.3
BORON NITRIDE AX05	White	1.91 g/cc	14.2%		para 71.3 perp 121.2 Wm/°C	para 0.57 perp 0.46 RT -1500°C x 10^{-6}/°C	2000 V/mm	4.0
NON-MACHINABLES								
ALN	Fawn/grey	3.3 g/cm3	0%		180 Wm/°C	$3.8x10^{-6}$/°C	20 KV/mm	9 1 MHZ
BeO	White	2.9 g/cm3			260 Wm/°C	10^{-6}/°K	10 KV/mm	7 1 MHZ
BORON CARBIDE (B_4C)		2.48 ± 0.02/ g/cm3	0%	0.19 ± 0.02				
SILICON NITRIDE	Grey	2.5 g/cm3		0.2	10-15 Wm/°C	$3.2x10^{-6}$/°C 20-800°C		10
PORCELAIN	White	2.4 g/cm3	0%		2.06 Wm/°C	$6.5x10^{-6}$ 20-800°C	25 KV/mm	
SILICON NITRIDE sintered	Grey	3.3 g/cm3	0%	0.24	25 Wm/°C	$3x10^{-6}$/°C		
SILICON CARBIDE sintered	Black	3.1 g/cm3	0%	0.17	150 Wm/°C	$3x10^{-6}$/°C		
ZIRCONIA YTTRIA stabilised	White	6.05 g/cm3	0%	0.3	2 Wm/°C	$10x10^{-6}$/°C		
ZIRCONIA Mgo stabilised	Cream	5.6 g/cm3	0%	0.31	2.5 Wm/°C	$10x10^{-6}$/°C		
ULE	Clear	2.2 g/cm3	0%	0.17	1.31 Wm/°C	$0x10^{-9}$/°C		
ALUMINA 96% substrate	White	3.8 g/cm3	0%		24 Wm/°C	$7.8x10^{-6}$/°C	10 KV/mm	9.8
ALUMINA high-purity re-crystalised	Off-white	3.8 g/cm3	0%		30 Wm/°C		17 KV/mm	9.9
ALUMINA high purity	Off-white	3.5 g/cm3	0%	0.22	20-28 Wm/°C	$84x10^{-6}$/°C	10-25 KV/mm	9-10
QUARTZ	Clear	2.2 g/cm3	0%	0.17	1.4 Wm/°C	$0.55x10^{-6}$/°C	25-40 KV/mm	3.8
SAPPHIRE	Clear	3.97 g/cm3	0%	0.27-0.30	40 Wm/°C	$8.8x10^{-6}$/°C	15-50 KV/mm	7.5-11.5

* *Inert atmosphere*

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TRIC ANT	FRACTURE TOUGHNESS	FLEXUAL STRENGTH	HARDNESS	DC VOLUME RESISTANCY	MAX USE TEMPERATURE	THERMAL EXPANSIVITY	SPECIFIC HEAT	COMPRESSIVE STRENGTH
HZ 25°C		94 MPa	400 Vickers	>10^{16} ohm/cm	1000°C	13x10/K	0.79 KJ/kg°C	345 MPa
HZ 25°C			560 Vickers	>10^{12} ohm/cm	1000°C/1900°C*	5.2x10/K		1200 MPa
		10,000 psi	6 Mohs		1100°C/1600C*			105 MPa
		para 10,460 perp 20,790	95-105 kg/mm Knoop		850°C/1600°C*	1100/1200°C	para 0.722 perp 0.705 (@100°C)	31.74 psi 23°C
8		para 11,000 perp 16,400	15.51-24.19 kg/mm Knoop	>10^{14} ohm/cm	850°C/1100°C*	1100/1200°C	1.61 @700°C (J/g°C)	para 20,780 perp 27,060 psi 25°C
3		para 6,340 perp 8,730	13.79-18.95 kg/mm Knoop	>10^{14} ohm/cm	850°C/1100°C*	1100/1200°C	1.468@700°C (J/g°C)	para 4,370 perp 6,460 psi 25°C
		para 2,025 perp 3,125	3.42-491 kg/mm	>10^{14} ohm/cm	850°C/2000°C*		1.5@700°C (J/g°C)	para 2,600 perp 3,400 psi 25°C
Z	3.0 KIC	360 MPa	1100 Vickers	>10^{14} ohm/cm	1800°C		800 J/kgK	
Z		200 MPa	1200 Vickers	>10^{14} ohm/cm	1700°C		1000-1320 J/kgK	1750 MPa
			3330 Vickers	– 0.85^{10}	680°C		1.2 J/kgK	390 MPa
		200 MPa	1100 Vickers	>10^{10} ohm/cm	1150°C	3.1 500-1300	1100 J/kgK	550 MPa
			7-8 Mohs					480 MPa
		650 MPa 20°C	1500 Hvo.3	>10^{10} ohm/cm	1150°C	3.3 500-1300K	800 J/kgK	2000 MPa
		400 MPa 20°C	2800 Hvo.3		1400°C	3x10^{-6}°C	1100 J/kgK	2000 MPa
	10 KIC	1000 MPa (e20°C)	1300 Hvo.3	10_9 ohm/cm 25°C	1000°C	10x10°C	400 J/kgK	2000 MPa
	6.0 KIC	545 MPa (e20°C)	1120 Hvo.3	>10_{10} ohm/cm 25°C	1000°C		400 J/kgK	1700 MPa
				>10^{11} ohm/cm	800°C		766 J/kgK	
		360 MPa	1500 Vickers	10^{13} ohm/cm	1600°C	64x10^{-6}	800 J/kgK	
			9 Mohs scale	10^{14} ohm/cm	1900°C	8.5x10^{-6}	900 J/kgK	3500 MPa
		330 MPa	1650 Vickers	10^{14} ohm/cm	1650°C	7.5-8.2x10^{-6}	880 J/kgK	3700 MPa
		80 MPa	1000 Vickers	10^{18} ohm/cm	1100/1400°C*	54x10^{-6}	700 J/kgK	1100
		1000 MPa	1700 Vickers	10^{14} ohm/cm	2000°C	5.8x10_{-6}	750 J/kgK	2100

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This table is intended as a guide only. Although every effort is made to ensure the accuracy, in some cases properties can vary.

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