



The Nilcra®
range of
Technical Ceramics

Innovative solutions for severe service wear and corrosion applications

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At **MACOR Machining China Inc.** we design and manufacture Advanced Ceramic Components from a portfolio of cutting edge materials.

We offer a wide range of technical ceramic materials, in-depth materials expertise and vast applications experience in diverse markets.



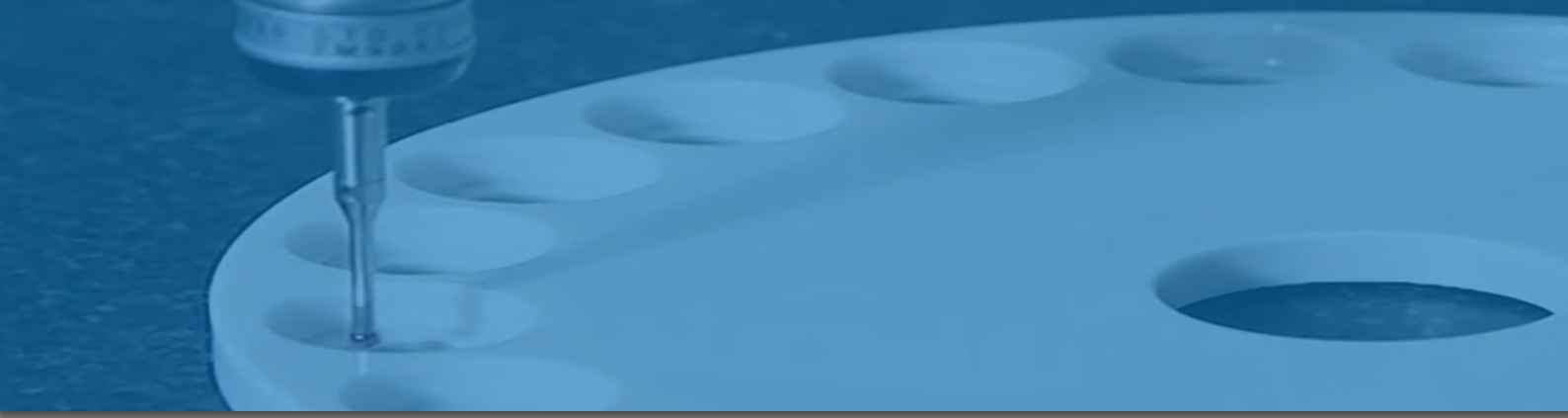
Our materials, coupled with our outstanding capability for the manufacturing of complex components, help our customers to extend the life of their equipment and reduce downtime even in the most demanding applications.

Our team of experienced technical specialists and design engineers will work with you to develop solutions that meet your specific requirements.

This is how we have consistently delivered innovation to industry, helping our customers to reduce costs and improve the performance of their products and processes.

We offer world-class design expertise and specialist manufacturing capabilities. We work in partnership with our customers to develop competitive tailored solutions to meet their needs.

Our team of experienced technical specialists and design engineers will work with you to develop solutions that meet your specific requirements.



Nilcra® Zirconia range

Originally referred to as “Ceramic Steel” Nilcra® Zirconia is a unique toughened ceramic material known as Mg-PSZ (Magnesia Partially Stabilized Zirconia).

It has exceptional strength and toughness that provides a reliable material that combined with high hardness and corrosion resistance provides a solution in severe service resistance to wear and corrosion environments.

Morgan's range of Nilcra® Zirconia's include both Mg-PSZ with our MS and TS grades and 3Y-TZP with HIP'ed options so we can select the right material for the application.

Our Nilcra® range of zirconia provides:

- High mechanical strength and fracture toughness to survive the application environment
- Exceedingly high resistance to corrosion
- Erosive and abrasive wear resistance
- Excellent resistance to cavitation



Nilcra® Zirconia's are frequently used to replace conventional metal alloys, hardened steels and tungsten carbides that suffer from wear and corrosion and are therefore used in a wide variety of severe service industries experiencing high maintenance costs, high downtime costs and poor product quality that is a consequence of lack of process control.

Nilcra® Zirconia's are used in industries as diverse as oil and gas, mining, food and battery production have enjoyed the benefits of long life, high production rates and low maintenance.

Morgan Technical Ceramics Australia were the first licensee of the original Mg-PSZ material patent and have been making this material for over thirty years still producing the strongest and most reliable version of this material in the world.



Our grades of Nilcra® Zirconia include:

Highest Fracture Toughness

These are the most mechanically reliable grades of ceramic in the world with a Weibull Modulus over >30, providing peace of mind that components will perform the same every time.

- Nilcra® Zirconia **MS** – “Maximum Strength” grade ideal for wear and corrosion solutions and used extensively in materials handling industries.
- Nilcra® Zirconia **TS** – “Thermal Shock” grade provides high resistance to thermal shock and is used in non-ferrous metal extrusion applications.
- Nilcra® Zirconia **3Y-TZP** – A fine grain grade extensively used in the Petrochemical Industry and for applications required to maintain a sharp edge.
- Nilcra® Zirconia **HIP’ed 3Y-TZP** – An ultrahigh density grade used widely in the manufacture of Food and Beverage Cans.

Nilcra®
ZIRCONIA **MS**

Nilcra®
ZIRCONIA **TS**

Nilcra®
ZIRCONIA **3Y-TZP**

Nilcra®
ZIRCONIA **HIP’ed-
3Y-TZP**

Industries served include:

- Severe Service Valves and Pumps
- Mineral Processing
- Food Processing
- Scientific Instrumentation
- Canneries
- Metal Forming
- Wire Drawing
- Materials Handling
- Power Stations

Morgan Technical Ceramics Australia were the first licensee of the original Mg-PSZ material patent and have been making this material for over thirty years.

Nilcra® SiAlON E 'Engineering Grade'

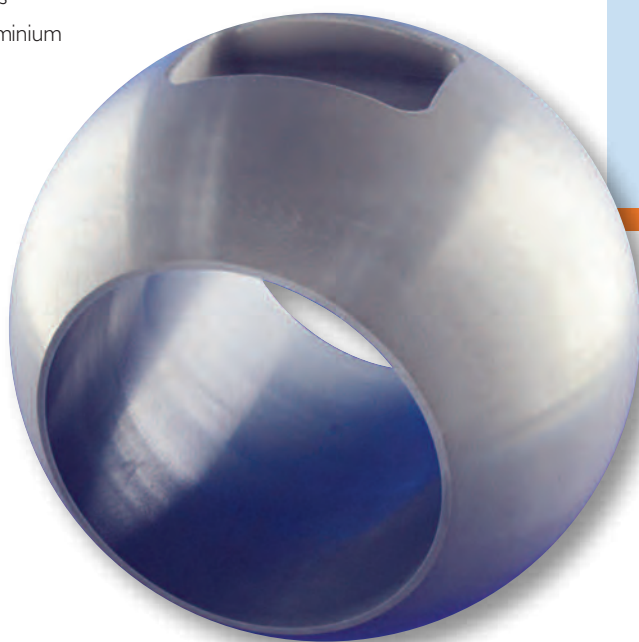
Nilcra® SiAlON E grade is an exceptionally reliable material designed for applications demanding high strength, toughness, corrosion and wear resistance even at very high temperatures of 1000°C (1832°F).

Key features of Nilcra® SiAlON E Engineering Grade:

- **Mechanical:** Nilcra® SiAlON E, a tough monolithic ceramic material that maintains strength and hardness even at high temperatures, making it highly resistant to wear, deformation, galling and corrosion. SiAlON E has a low coefficient of friction.
- **Engineering:** Due to its reliability and toughness Nilcra® SiAlON E can be used to manufacture highly engineered and reliable ceramic components. Additionally highly polished surface finishes can be achieved for applications such as tube metal forming, e.g. extrusion and tube welding.
- **Temperature:** Nilcra® SiAlON E Engineering Grade has better high temperature capabilities than most conventional metals combining retention of high strength and creep resistance with corrosion resistance. In addition, its low thermal expansion coefficient gives good thermal shock resistance compared with most other ceramic materials.

Typical Nilcra® SiAlON E applications include:

- Severe Duty Valves and Pumps
- HF Weld Rolls for Steel & Aluminium
Tube production
- Scientific Instrumentation
- Canneries
- Wire Drawing
- Molten Metals Handling



Nilcra® SiAlON E

Engineering grade offers:

- High temperature strength
- Superior thermal shock resistance
- Excellent wear resistance
- Good fracture toughness
- Excellent mechanical strength
- Good resistance to corrosion and erosion

Nilcra® Sintered Silicon Carbide

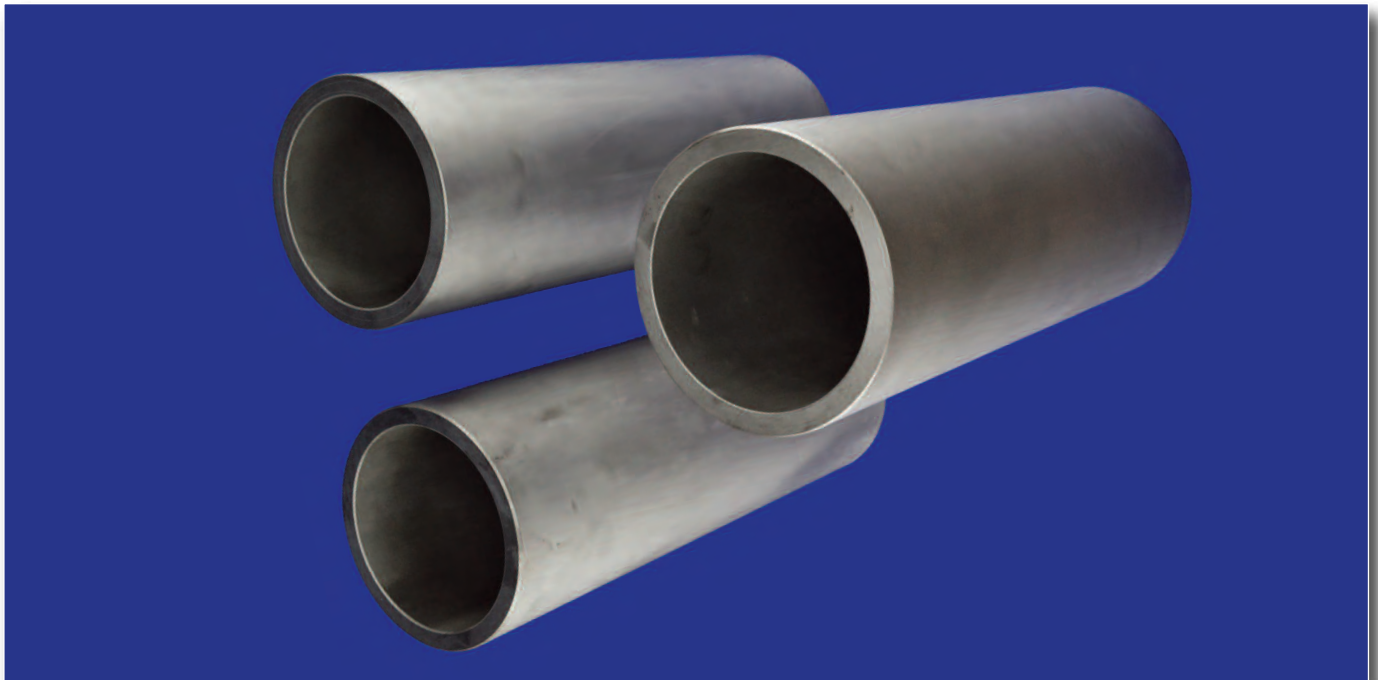
An Alpha sintered silicon carbide, Nilcra® Sintered Silicon Carbide has a combination of hardness, strength, and temperature resistance giving it excellent capabilities for service in a wide range of applications where chemical, erosion and abrasion resistance is demanded.

The high thermal conductivity allows it to be used where high surface speeds or high pressures demand the heat generated be safely conducted away. Nilcra® Sintered Silicon Carbide is an excellent counter face material when paired with premium mechanical carbon grades.

Due to its non-toxicity Nilcra® Sintered Silicon Carbide can be used for applications in the food industry.

Applications for Nilcra® Sintered Silicon Carbide include:

- Valve and Pump components
- Wear Resistant components
- Mechanical Seal Faces
- Nozzles
- Bearings and Bushings



Nilcra® SiAlON E grade is a super hard but robust material designed for applications demanding high strength, toughness, corrosion and wear resistance even at very high temperatures of 1000°C (1832°F).



Oil and Gas products

Oil and Gas providers are faced with increasing challenges for resilient, wear resistant materials and solutions to manage projects within harsh environments. Customers within these industries are looking for greater durability and more robust options to replace traditional materials.



Nilcra® Zirconia range provides:

- High mechanical strength and fracture toughness
- Chemical wear resistance to the vast majority of reagents and abrasive slurries
- Corrosion and abrasion wear resistance
- Excellent resistance to cavitation – the killer of process control valves

Nilcra® SiAlON range provides:

- High Strength at ambient & high temperatures up to 1000°C (1832°F)
- Excellent fracture toughness
- Extremely high hardness & wear resistance
- Low coefficient of thermal expansion
- Very high thermal shock resistance
- Excellent corrosion resistance in acids and alkaline



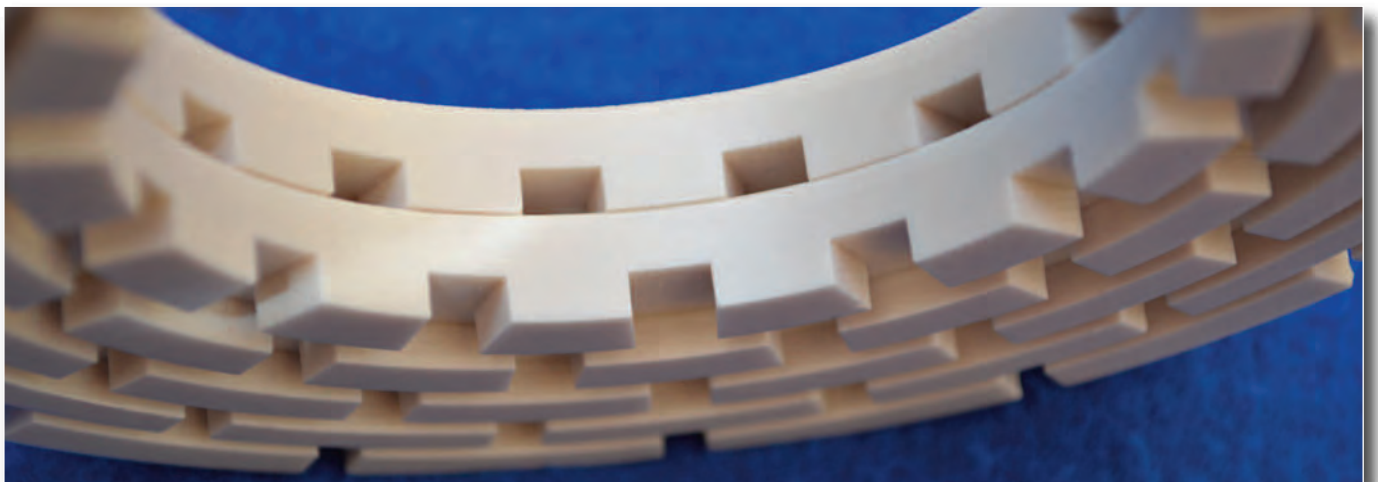
Our materials are found in products that are evident in a wide range of applications including:

- Directional Drilling Tool Components,
- Ball Valves
- Control Valves, (Plugs, Seats and Cages)
- Pump Plungers
- Dosing / Metering pumps
- Liners & Sleeves
- Pipeline Inspection

Valves

We use our advanced ceramic materials to make high performance valve components for corrosive and abrasive fluid flows in demanding processing environments such as chemical processing, paper and pulp manufacturing and in oil and gas extraction and refining. The range includes options for ball valves, butterfly valves and rotary and linear control valves.

Our valve components are made using Nilcra® Zirconia, an advanced ceramic material that is strong, tough and highly resistant to chemical reagents and abrasive slurries. It provides a reliable, high performance option where other materials tend to fail, even in the most challenging process applications, because it offers excellent resistance to cavitation, a major problem for process control valves. Used for critical duties in high value processing environments, Nilcra® Zirconia valve components offer processors the potential for substantial savings in downtime and valve repair costs. As a result, processors and their equipment suppliers are increasingly demanding it for use in applications that use difficult chemicals such as sour oil, bitumen, bleached wood pulp, concentrated sodium hydroxide, bauxite (alumina), lime slurries and sulphur dioxide (SO₂).



Nilcra® products provide a reliable, high performance option where other materials tend to fail, even in the most challenging process applications.

Nilcra® Properties and Materials

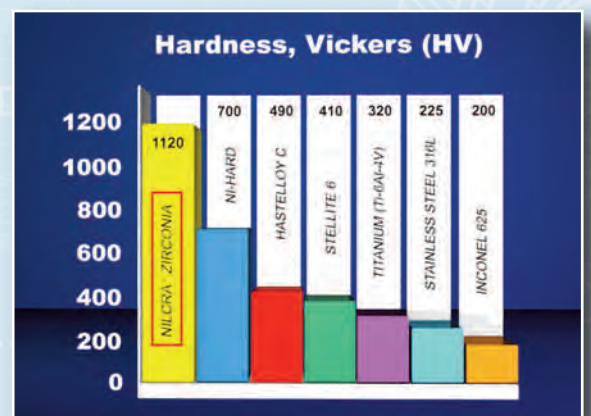
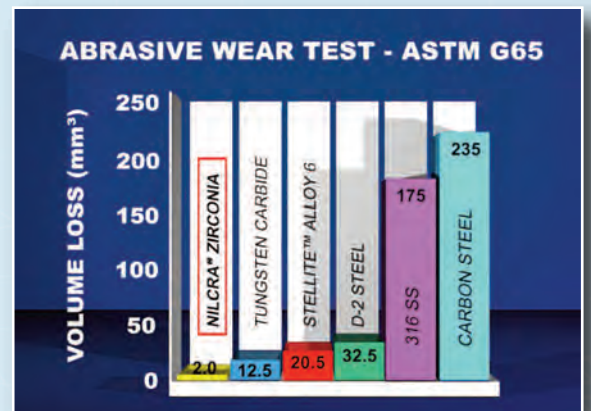
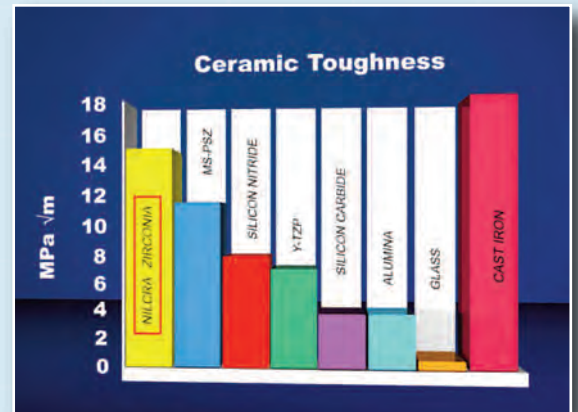
Properties ¹	Units	Magnesia Partially Stabilized Zirconia		Yttria Tetragonal
		Nilcra® Zirconia MS Grade	Nilcra® Zirconia TS Grade	Nilcra® Zirconia 3Y-TZP
Density	g/cm ³	5.74	5.74	6.05
Fracture Toughness	MPa√m	10 - 12	14 - 16	10
Flexural Strength ²	MPa (kpsi)	820 (118)	650 (94)	1000 (145)
Weibull Modulus ³		>30	>30	20
Compressive Strength	MPa (kpsi)	1990 (289)	1800 (273)	2300 (334)
Hardness, Vickers	HV _{0.3} kg/mm ²	1120	1020	1300
Modulus of Elasticity	GPa (x10 ⁶ psi)	205 (30)	205 (30)	205 (30)
Poisson's Ratio		0.31	0.31	0.3
Average Grain Size	μm	40	45	0.4
Electrical Resistivity	ohm.cm	>10 ¹¹	>10 ¹¹	>10 ¹¹
Thermal Conductivity	W/m.K (BTU/hr/ft.°F)	3.08 (1.8)	3.05 (1.8)	3.0 (1.7)
Coefficient Thermal Expansion	x 10 ⁻⁶ °C (°F)	10.2 (5.7)	9.9 (5.5)	9.0 (5.0)
Specific Heat	J/g.K	0.47	0.47	0.5
Thermal Shock Resistance, ΔT	°C (°F)	375 (705)	500 (930)	200 (390)
Colour		White	White	White

* All values quoted are based on test pieces and may vary according to component design.

These values are not guaranteed in anyway whatsoever and should be treated as indicative and for guidance only.

Notes: 1. Testing carried out at room temperature 20°C (70°F). 2. Four point bend test. 3. Calculated from production batch flexural strength data.

Polycrystal	Silicon Nitride	Silicon Carbide
Nilcra® Zirconia HIP'ed 3Y-TZP	Nilcra® Zirconia SiAlON E	Nilcra® Sintered Silicon Carbide
6.08	3.21	3.1
10	8	3
1400 (203)	650 (94)	450 (65)
20	15	12
2300 (334)	3000 (435)	3000 (435)
1350	1630	2650
205 (30)	320 (46)	400 (58)
0.3	0.28	0.16
0.4	1 - 10	1 - 5
> 10 ¹¹	> 10 ¹²	> 10 ⁴
3.0 (1.7)	25 (14)	125 (72)
9.0 (5.0)	3.2 (1.7)	3.2 (1.7)
0.5	0.65	0.67
200 (390)	600 (1110)	900 (1650)
Grey	Black	Black



Deal direct with the manufacturer.

MACOR Machining China Inc. is a global engineering company offering world-leading competencies in materials science, specialist manufacturing and applications engineering.

We focus on the delivery of products that help our customers to solve technically challenging problems, enabling them to address global trends such as energy demand, advances in healthcare and environmental sustainability.

What differentiates us?

- Advanced material science and processing capabilities.
- Extensive applications engineering experience.
- A strong history of innovation and reinvention.
- Consistent and reliable performance.
- A truly global footprint.
- We find and invest in the best people.