TECHNICAL CERAMICS FOR DEMANDING APPLICATIONS

Material overview

CONVINCING CERAMIC SOLUTIONS FOR YOUR INDUSTRY SECTORS

Kyocera offers precise and efficient technical ceramic solutions for a wide range of applications. Whether in mechanical and plant engineering, in the aerospace industry, in the semiconductor industry or in many other industries in which components need to withstand extreme demands: let the unique properties of our ceramic solutions convince you.

PRECISION, QUALITY AND RELIABILITY

Thanks to many years of experience in the development of high-performance ceramics, Kyocera covers a wide range of requirements in the field of non-oxide ceramics, oxide ceramics and other technical ceramic materials.

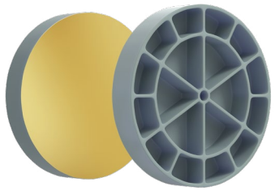
Flexible manufacturing processes make it possible to react to customer requirements regarding geometry or material properties. The versatile application possibilities of ceramic products are based on the specific properties with which they are superior to other materials in many respects. From the single piece to the finished series production we offer you highest flexibility and at the same time outstanding results.

Our engineers work daily on the development of innovative products for new applications and industries. Our technical ceramic products redefine standards with maximum safety and precision.

Our way of working is reflected in every single product. 100% maximum precision along the entire value chain, from powder preparation through the finished component to a careful final inspection in the company. This allows us to offer products of unmistakable quality. As a reliable partner, we therefore always work solution-oriented to enable the most valuable products offered to our customers: Trust and success.

Focussing unit for vacuum technology

Mirror with central metal connector and fusion bonding for internal cooling channels used for semiconductor applications



Cordierite mirror for aerospace

OUR MATERIALS FOR YOUR APPLICATION

SILICON NITRIDE

Sintered silicon nitride exhibits a combination of excellent material properties that make it suitable for a wide range of applications.

- Low density and very high specific strength
- High stiffness, strength and fracture toughness
- Low coefficient of thermal expansion with high thermal conductivity
- Extremely low wear

These properties make Kyocera's sintered silicon nitride the preferably selected material for complex structures and precise geometries in lightweight structures, optical systems or wear parts.

Guide rollers and bearings for milling applications

SILICON CARBIDE

Silicon-infiltrated silicon carbide is the only high-performance ceramic to offer 0% shrinkage during sintering. Therefore, large and complex components with undercuts, cooling channels and many other challenging design elements are possible. Structure sizes down to less than 1 mm are possible utilizing wire and sinking EDM.

In addition, there is a high stiffness and strength with extreme homogeneous material properties, which allows novel solutions with silicon-infiltrated silicon carbide, which cannot be realized with metals or other ceramics.

The excellent chemical resistance to most acids and alkalis makes sintered silicon carbide the most common material in the chemical industry, e.g. for sealing rings, bearings, bushings and shaft sleeves. Kyocera's sintered silicon carbide also features high wear resistance combined with high strength and hardness.

Good thermal shock resistance as well as high thermal conductivity and outstanding corrosion resistance, even in high temperature ranges, facilitates an application at high temperatures, e.g. for the dissipation of process heat.

Structural frame for measurement optic used for semiconductor applications

OUR MATERIALS FOR YOUR APPLICATION

ALUMINA

Alumina is a widely used technical ceramic owing to its exceptional properties such as high hardness, strength, and excellent resistance to wear, corrosion, and high temperatures. And yet there are differences in purity levels and manufacturing methods. By largely dispensing with the usual sintering aids, the corrosion resistance of the grain boundary chamfer could be developed to the best level. Due to the fine microstructure, brilliant surface qualities can be achieved by fine machining. The ceramic material has established itself as extremely versatile in numerous application areas, such as extruder screws, nozzles, and slide rings in mechanical and plant engineering, but also in high-temperature technology.

ZIRCONIA

Components made of zirconia can withstand the highest loads. The ceramic material is used in numerous applications due to its high mechanical strength, resistance to wear and corrosion as well as low thermal conductivity. It also has a high fracture toughness and can withstand considerable loads without breaking. Zirconia is also versatile in metal-ceramic composites. Coupled with our know-how in joining technology, components for special applications can be realised. Zirconia is, therefore, ideally suited for use in a wide range of industries, from mechanical and plant engineering to the oil and gas industry.

Tubes and capillaries

Containment shell for magnetic drive pumps

SAPPHIRE

Sapphire is a single-crystal alumina, a transparent material of excellent chemical stability that exhibits valuable mechanical, thermal and optical properties. Its material properties are far superior to glass, quartz, and other mass-produced transparent materials.
Single-crystal sapphire is increasingly important as a material for high-reliability electronics due to its excellent mechanical properties, chemical stability and light transmission.
Kyocera manufactures single-crystal sapphire in a vertically integrated mass-production process. From "pulling up" the raw material with EFG (Edge-Defined Film-Fed Growth) methods to processing, Kyocera produces and supplies various products with large diameters or specific shape requirements.

ALUMINIUM NITRIDE

Aluminium nitride is characterised by high thermal conductivity and excellent plasma resistance and is, therefore, particularly suitable for applications in semiconductor processing.

Thanks to its thermal properties, aluminium nitride is a popular choice for manufacturing components exposed to high temperatures. But the material is also used in other areas, for example, in the electronics and automotive industries as well as in aerospace technology.

Electrical insulator parts

Polishing plates

OUR MATERIALS FOR YOUR APPLICATION

ALUMINIUM TITANATE

The most important property of aluminium titanate is its very high thermal shock resistance. This means that major temperature changes are no problem for components made of this high-tech material. This property is only one of the advantages of our material. Thanks to its low wettability to liquid aluminium and very good thermal insulation properties, aluminium titanate is recommended for applications in foundry technology, for example, riser tubes or sprue nozzles. In addition, aluminium titanate has good electrical insulation properties and is resistant to corrosion and wear, making it suitable for various industrial applications.

CERMETS

Cermets are composite materials consisting of ceramics and metal components, such as cobalt, nickel or molybdenum, and thus have a unique combination of material properties. They are characterised by their high wear resistance and hardness, making them ideal for applications that require high abrasion resistance. In addition, cermets hardly adhere to metal, which makes them suitable for the manufacture of cutting tools and wear-resistant tools for the electrical industry, as well as for sliding parts.
Another advantage of cermets is their ability to be brazed to metal. This opens numerous application areas, for example, in the automotive industry or aerospace.

Riser tubes for foundry applications

Decorative ceramics

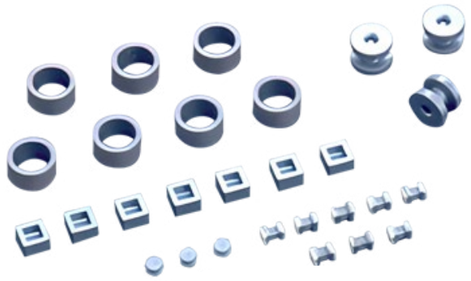
CORDIERITE

Cordierite is a high-performance ceramic material used in various industries due to its excellent properties. Cordierite is characterised by its extremely low thermal expansion and excellent mechanical properties. It is also very lightweight and has approximately 70% less mass than glass, which has a low coefficient of thermal expansion.

FERRITE

Ferrite is an extremely versatile material characterised by its magnetic properties. It is a porous ceramic material consisting of iron oxide, zinc oxide and other metal oxides. Ferrite is known for its high electrical insulation capacity and excellent corrosion resistance.

Vacuum chucks and integrated mirros for space applications



Product examples

OUR MATERIALS FOR YOUR APPLICATION

FORSTERITE

Forsterite is a mineral magnesium silicate used in technical ceramics due to its excellent properties. It is characterised by low microwave losses, excellent insulation at high temperatures, and a smooth surface, making it suitable for producing electron tube parts and circuit substrates. Because of its high coefficient of thermal expansion, forsterite bonds easily with metal and glass. The material is not only mechanically and thermally stable but also electrically insulating and chemically resistant. Therefore, products made of forsterite are often used in demanding applications where extreme conditions prevail, such as in the chemical industry, semiconductor manufacturing, aerospace, or medical technology.
Our forsterite products offer high quality and reliability to meet your requirements. You can choose from various shapes and sizes that can be customised to meet your needs.

MULLITE

Mullite is characterised by its excellent thermal and thermal shock resistance as well as particularly good creep resistance. Its coefficient of thermal expansion is roughly equivalent to that of a silicon semiconductor chip. Due to its low thermal expansion and excellent thermal stability, mullite retains its shape and strength even at high temperatures, making it ideal for applications in high-temperature technology. In addition, mullite offers good electrical insulation and low thermal conductivity, making it an outstanding material for electrical applications.
Applications of mullite are diverse, ranging from high-temperature technology and electrical insulation to the refractory industry.

Pressed and extruted parts

STEATITE

Steatite is a porous material consisting of a combination of magnesium silicate and talc. The material properties of steatite are diverse and offer numerous advantages for various applications. Steatite has a high insulating capacity, adequate mechanical strength, and high chemical resistance. It is an ideal material for applications requiring high temperatures and extreme conditions and is very easy to machine mechanically.
Steatite is often used in the electronics and automotive industries because it is an excellent insulator. It is also used in the medical industry to make intricate, precision parts. Steatite also has very good corrosion resistance, making it used in the chemical industry and the manufacture of medical equipment.

YTTRIA

Yttria is a ceramic with excellent material properties suitable for numerous applications. Particularly noteworthy is the plasma resistance, which makes the material very suitable for applications in semiconductor processing plants where particle contamination must be avoided.
But yttria is not only an important material in the semiconductor industry. Thanks to its high thermal conductivity and temperature resistance, it is also popular in applications such as high-temperature furnace construction or in the production of thermal barrier coatings. In addition, yttria offers good corrosion resistance and is therefore also suitable for use in chemical plants.

Anti-plasma components

MATERIAL OVERVIEW | OXIDE CERAMICS

Properties	Standard	Specification	Unit	F99.7	F99.7 hf	FZT	DEGUSSIT AL23	DEGUSSIT AL24	DEGUSSIT AL25	FZM Mg-PSZ	FZM+ Mg-PSZ	DEGUSSIT FZY	Star Ceram® AT 1203
Main component			-	α - Al_2O_3	α - Al_2O_3	Al_2O_3, ZrO_2				ZrO_2, MgO		ZrO_2, Y_2O_3, Al_2O_3	Al_2TiO_5
Colour			-	ivory	ivory	white	cream white	cream white	white	yellow	white	white	
Density	DIN EN ISO 18754		g/cm³	≥ 3.90	≥ 3.90	≥ 4.10	3.70 - 3.95	> 3.40	> 2.80	≥ 5.70	≥ 5.75	≥ 5.60	3.32
Open porosity	DIN EN ISO 18754		vol.-%	0	0	0	0	≥12	20-30	0	0	0	
Average crystal size	ISO 13383-1	A1	µm	10	20	5	10	40	70	50	25	30	
Mechanical characteristics													
Hardness HV10	DIN EN ISO 14705	Procedure A	GPa	17.3	16.1	18.4	17.1			12.0	11.8	13.7	5 (DPH)
Compressive strength	DIN ISO 17162		MPa	2,500	2,500	3,000	2,500	1,000	300	2,000	2,000	2,000	
Flexural strength σ_m	DIN EN 843-1	Four-Point-Bending	MPa	350	350	460	300 - 350	150	70	500	800	400	25
Young's modulus	EN 843-2	dynamic	GPa	380	380	360	380			207	215	200	10
Poisson's ratio	EN 843-2	resonance	-	0.24	0.22	0.24	0.22			0.31	0.32		
Fracture toughness	DIN EN ISO 23146	SEVNB	MPa*$m^{0.5}$	5	3.5	3.3				6.3	8.7		3-5
Weibull modulus	EN ISO 20501		-	>10	≥10	>15				>15	>20		60
Thermal characteristics													
Max. operating temperature		in air	°C	1,950	1,950	1,700	1,950	1,950	1,950	900	900	1,700	1,000
Thermal conductivity	DIN EN ISO 18755	20 °C	W/(m*K)	34.9	34.9	25	34.9	27.8		3	3.8	2.5 (100 °C)	1.4
Specific heat	DIN EN 821-3	20 °C	J/(g*K)	900	900	850	900	900		400	400	400	
Thermal expansion coefficient	DIN EN ISO 17562	20-1,000 °C	10^{-6}/K	8.2	8.2	8.3	8.2	8.2	8.2	10.6 (20 - 900 °C)	10.3 (20 - 500 °C)	10.9	1.25
Thermal shock resistance	DIN EN 820-3	R_1 , Type A, in water	°C	180									
Electrical characteristics													
Dielectric strength	DIN EN 60243-1		kV/mm	> 30	> 30		20-30						
Volume resistivity	DIN EN 62631-3	20 °C	Ω•cm	10^{15}		10^{13}-10^{14}				10^{10}	10^{10}	10^{10}	

MATERIAL OVERVIEW | NON-OXIDE CERAMICS

Properties	Unit	Star Ceram® S	Star Ceram® Si	Star Ceram® AM-Si	Star Ceram® N3000 P	Star Ceram® N7000	Star Ceram® N7015
Main component	-	SSiC	SiSiC	SiSiC	Si_3N_4	Si_3N_4 (incl. Al_2O_3; Y_2O_3)	Si_3N_4 (incl. Al_2O_3; Y_2O_3)
Colour	-	black / anthracite	grey	grey	black	Black / dark grey	Black / dark grey
Density	g/cm³	3.13	3.05	3,00 ± 0,03	3.24	3.22	3.23
Closed porosity	vol.-%	>2	< 2		0	0	0
Mechanical characteristics							
Hardness HV10	GPa	25	20		14.4	15	15
Compressive strength	MPa				4,275		
Flexural strength σ_m	MPa	375	300	190	1,150	800	950
Young's modulus	GPa	395	380	350	300		
Poisson's ratio	-		0.18	0.19	0.28	0.3	0.3
Fracture toughness	MPa*m$^{0.5}$	3.0	3.6		5.9	6.7	5.7
Weibull modulus		> 10	> 10	> 10	15	> 15	> 15
Thermal characteristics							
Max. operating temperature	°C	1,600	1,350		1,200	1,000	1,200
Thermal conductivity 20 °C	W/(m*K)	125	180	185	21	20	20
Thermal expansion coefficient 20-1,000 °C	10^{-6}/K	4.5	4.0	2.33[1)]	2.3	3.4	3.3
Thermal shock coefficient R1	K	180	190		670	450	505
Electrical characteristics							
Electrical conductivity 20 °C	10^{-3}MS*m		6 ± 1	10			
Specific electrical resistance 20 °C	Ω•cm	>10^4					

The values and information contained in this document are based on our current state of knowledge and are provided without any representation or warranty as to specific properties, completeness, accuracy, or suitability for a particular purpose. The stated values are derived from typical test samples under laboratory conditions and may vary depending on design, shape, manufacturing process, and application. Prior to any use, the suitability of the material for the intended purpose must be checked independently and if necessary, appropriate tests must be carried out. We reserve the right to modify this document and the values contained herein without prior notice. Liability claims are excluded, unless mandatory statutory provisions, particularly in cases of death, bodily injury, intent, or gross negligence, prohibit a more extensive limitation of liability.

[1)] 0-40 °C

Other materials and data are available online at www.kyocera-fineceramics.de/en/download

ABOUT KYOCERA

The global Kyocera corporation - a strong partner.

- **Headquarters:** Kyoto, Japan
- **Foundation:** 1959
- **Employees:** over 80,000 worldwide
- **European headquarters:** Esslingen, Germany
- **European production sites:** Mannheim, Germany
Selb, Germany
Erfurt, Germany
(further subsidiaries in Europe)

KYOCERA = KYOTO CERAMICS

KYOCERA – it all began with ceramics

KYOCERA Fineceramics Europe GmbH is a subsidiary of KYOCERA Europe GmbH, which has been successful in Europe for over 50 years. The Kyocera Group is one of the world's leading providers of high-performance ceramic components for the technology industry, offering over 200 different ceramic materials, as well as state-of-the-art technologies and services tailored to the specific needs of each market.

KYOCERA Fineceramics Europe GmbH has grown steadily in recent years – and is now one of the leading European suppliers of customised solutions made of technical ceramics. Working in partnership, we develop and manufacture products that offer our customers added value in their respective markets and secure their technological lead in the long term. We are committed to this every day.

We have also been active in the field of environmental technology for 30 years. Our solutions for treatment of exhaust air and waste water from chemical laboratories and industrial processes are known worldwide under the FRIDURIT brand.

Throughout Europe, we are represented by three production and development sites in Mannheim, Selb and Erfurt (Germany), as well as six sales offices – in Mannheim, Selb, Esslingen, Neuss (Germany), Rungis (France) and Frimley (United Kingdom).

Our business partners benefit from the fact that we think and work across divisions within the Kyocera Group. Because innovations and real milestones can only be achieved together – across industries and national borders.

This is what we believe.

About the KYOCERA Group

KYOCERA Europe GmbH is a company of the KYOCERA Corporation headquartered in Kyoto/Japan, a renowned supplier for semiconductor, industrial and automotive components as well as electronic components, printing and multifunction systems, and communications technology. Kyocera is one of the most experienced technology producers, with more than 65 years of industry expertise. The Kyocera Group comprises of around 300 subsidiaries.

Kyocera aims to create a better future for the world, using the power of technology to solve issues we face as a global society. This ambition is rooted in our Kyocera Management Rationale: to contribute to the advancement of society and humankind.

We will continue to work together with people around the world to solve issues critical to society leveraging all of the technologies and management capabilities we have accumulated during our 60-plus year history.

The company also takes an active interest in cultural affairs. The Kyoto Prize, a prominent international award, is presented each year by the Inamori Foundation established by Kyocera founder Dr Kazuo Inamori to individuals worldwide who have contributed significantly to the scientific, cultural, and spiritual betterment of humankind.

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