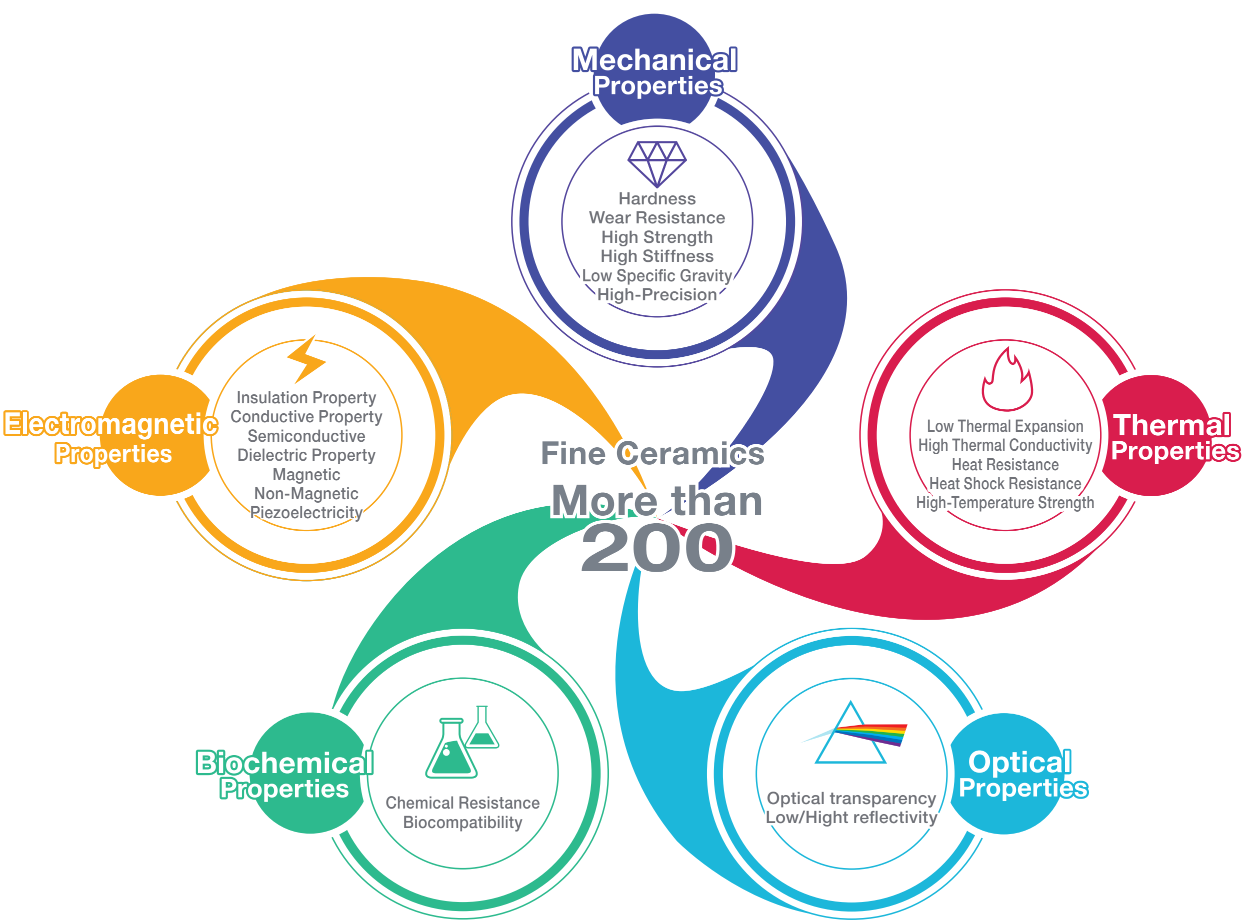
KYOCERA

Fine Ceramics

for Technical and Engineering Applications

We Want All Engineers to Know the Advantages of "engineering ceramics."

Fine Ceramics are the engineered materials that combine mechanical, electromagnetic, thermal, optical, and biochemical characteristics in a highly complex manner.
Selecting the ideal material according to applications and purposes and refining it to a high degree allows for maximized performance.
These unique characteristics are broadly applied in a wide range of fields, including industrial machinery, electronic devices, automobiles, aerospace, and the environment.
For example, the Fine Ceramics outstanding electrical characteristics are used for components of various substrates and electronic devices; high wear and corrosion resistance are used for pumps, nozzles, and valve parts; and high thermal and mechanical characteristics are used in the automotive and aerospace industries.
As a leader in Fine Ceramics, Kyocera helps customers improve their new product development and increase productivity in various industries to open up a new future for society and humankind.



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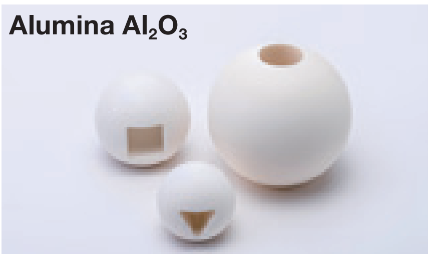
Types of Fine Ceramics

Many materials have been developed as Fine Ceramics, such as alumina sintered bodies.

Kyocera has developed many new materials carving out a name for ourselves as a pioneer in Fine Ceramics. We have already developed more than 200 new materials. These include polycrystalline oxide materials manufactured by a general firing process, such as alumina; non-oxide materials, such as silicon nitride and silicon carbide; and single crystal materials created by crystal control growth technology, such as sapphire. We also mass-produce Fine Ceramic products.

Alumina Al_2O_3

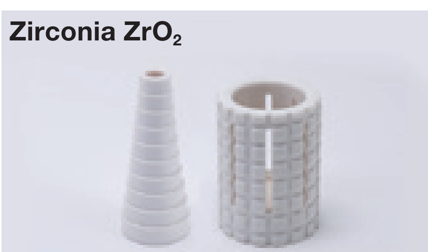


Alumina was quickly adopted by the electronics industry due to its high electrical insulation properties. In addition, because it has excellent corrosion resistance, wear resistance, and mechanical strength, it is used in many industrial machinery parts, and is the most widely used Fine Ceramic material.

Sapphire Al_2O_3

Sapphire, commonly known for the gemstone of the same name, is a single crystal alumina that creates a high-purity, high-performance material. Due to its excellent mechanical properties and chemical stability, it is applied to both mechanical and precision parts. In addition, it is a transparent material and has high optical properties in a wide wavelength range from infrared rays to near-ultraviolet rays. It is easier to mass produce than diamond and has better properties than quartz. It is used in optical components such as sensors and analytical instruments, contributing to longer component life and higher equipment productivity.

Zirconia ZrO_2

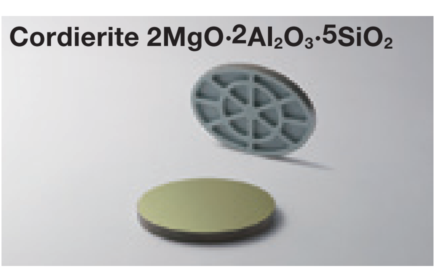


Zirconia is one of the engineering ceramics with the highest strength and toughness at room temperature. Due to its excellent surface finish, it is used for sliding parts such as in pumps. With its high toughness and wear resistance, it is also used for industrial cutters, scissors, and kitchen knives, contributing to a longer life for such products. Also, with a beautiful surface obtained by mirror processing, it is used for decorative parts such as in watches.

Zirconia Toughened Alumina

Zirconia Toughened Alumina is a composite material made of alumina and zirconia. It has a hardness and bending strength higher than that of alumina, with a lower thermal expansion than zirconia, and is characterized by high thermal conductivity. Taking advantage of its high wear resistance, it is widely used for wear-resistant parts that require cooling, including crusher parts.

Cordierite $2MgO{\cdot}2Al_2O_3{\cdot}5SiO_2$



Cordierite has a very small coefficient of linear thermal expansion and has a higher specific rigidity than glass-based materials. Taking advantage of these characteristics, it is used for structural parts in semiconductor processing equipment. It is also used as a mirror due to its high surface smoothness. In the field of astronomy and aerospace, it is applied to light observation in various wavelengths and for optical communication. It is also used as an optical system by assembling multiple cordierite components.

Cermet TiC·TiN (Ceramic and metal composites)

Cermet is a composite material containing titanium carbide (TiC) and titanium nitride (TiN) as the main components, with metals such as cobalt (Co), nickel (Ni), and molybdenum (Mo). It is about three times stronger than alumina ceramics and has excellent wear resistance. It demonstrates high performance when used in cutting tools or industrial cutters. It is also used as a decorative part because mirror processing can make it shiny like a precious metal.

Yttria Y_2O_3

Yttria is a material with excellent plasma resistance. It is effective in reducing contamination by particles and impurities, which is desired for parts in manufacturing processes that use plasma such as semiconductor processing equipment.

YAG-Dispersed Alumina

YAG-Dispersed Alumina is a material with improved plasma resistance by dispersing yttria and other materials within it. It also has the similar strength as alumina, so there's less risk when handling parts.
*YAG:$Y_3Al_5O_{12}$(Yttrium/Aluminium/Garnet)

YAG Single-Crystal

YAG Single-Crystal offers outstanding plasma resistance and optical transparency. It is used in the semiconductor manufacturing process.

Aluminum Nitride

Aluminum Nitride has high thermal conductivity and electrical insulation properties, and is used for heat dissipation or heat uniformity parts, such as those found in semiconductor processing equipment.

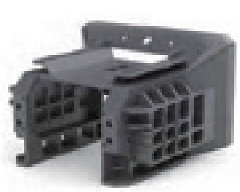
Silicon Nitride

Silicon Nitride is an outstanding Fine Ceramic material with high strength that it maintains even at high temperatures and excellent heat shock and wear resistance. Taking advantage of these characteristics, it is used in a wide range of industries, including parts for molten metal casting, steel manufacturing, milling, and automobile parts.

Silicon Carbide

Silicon Carbide has the highest chemical resistance and hardness of all Fine Ceramics. Especially, solid-phase sintered silicon carbide is an excellent heat-resistant material that does not deteriorate in strength even at 1400°C. Furthermore, it is used in a wide range of industries, including mechanical seals and pump parts due to its excellent sliding properties, and semiconductor processing equipment and general industrial machine parts due to its high thermal conductivity and electrical semi-conductivity.

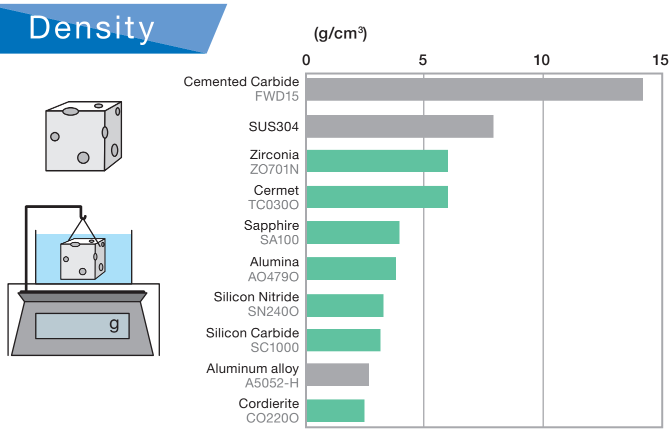
Silicon-Infiltrated Silicon Carbide SiSiC



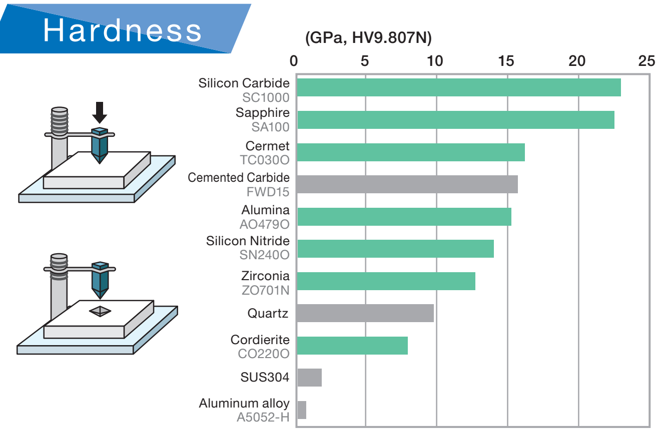
Silicon-Infiltrated Silicon Carbide is a silicon infiltrated composite material based on silicon carbide. Due to the infiltration of silicon, there are less pores and outgassing is suppressed. The material has a high specific rigidity with similar characteristics to Silicon Carbide and lower electrical resistance than Silicon Carbide, making it possible to eliminate static electricity from parts. Its unique manufacturing method and reactive sintering bonding facilitate
the production of large, complex-shaped parts or hollow structures, and are widely used in applications such as semiconductor processing equipment.

Characteristics of Fine Ceramics

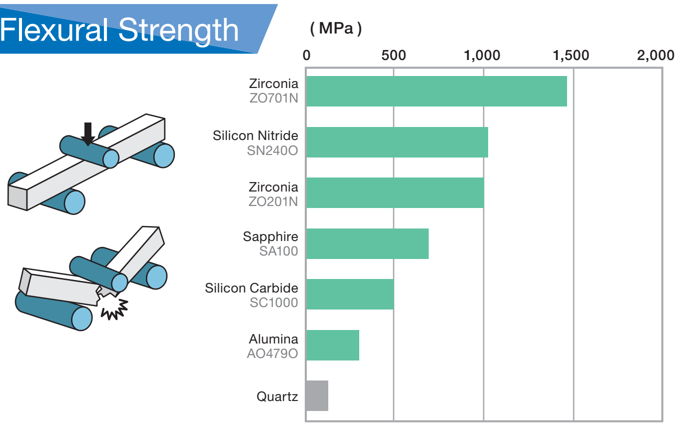
Density



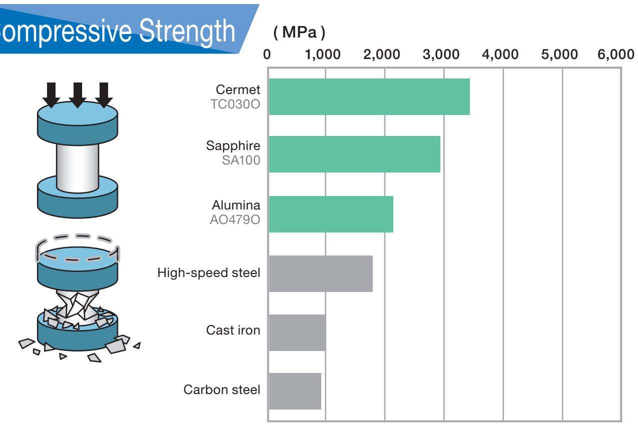
Hardness



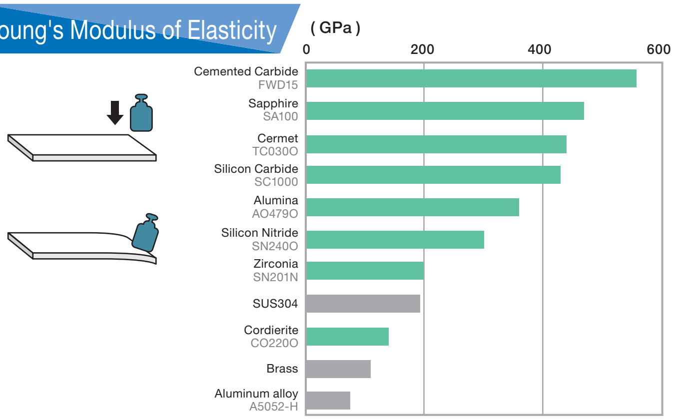
Flexural Strength



Compressive Strength

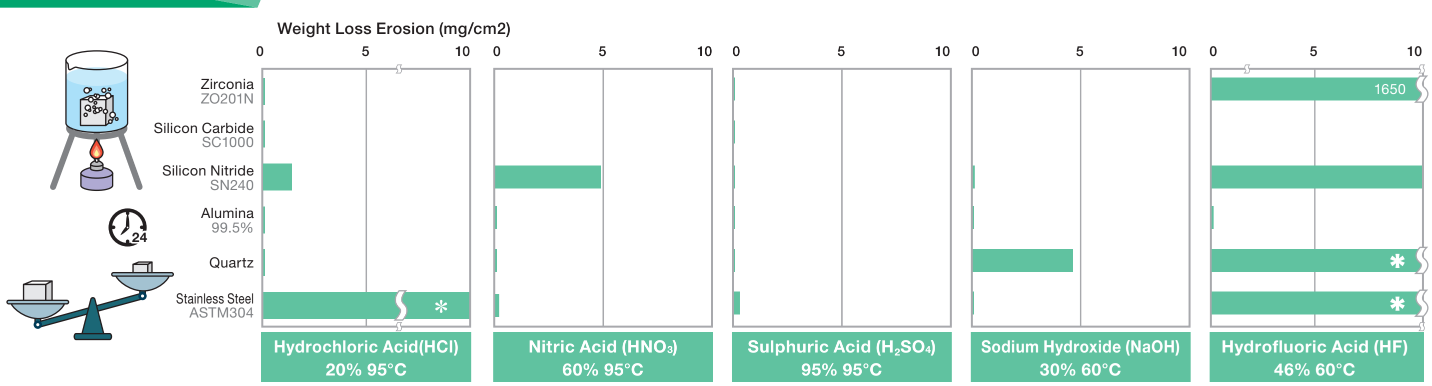


Young's Modulus of Elasticity



Chemical Resistance

Erosion loss per day
*Boil time: 144h

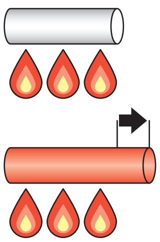


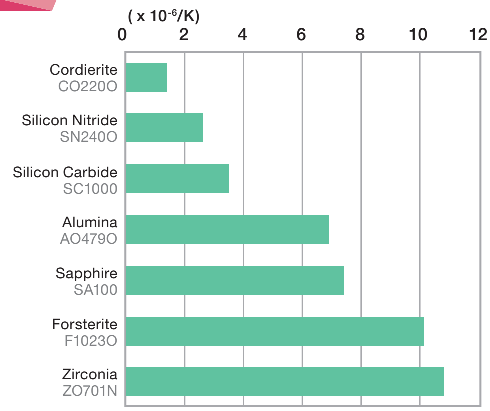
*Cannot be measured due to excessive erosion

*Cannot be measured due to excessive erosion

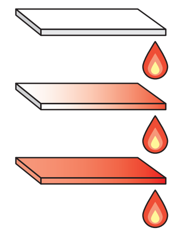
Thermal Expansion

*Coefficient of linear thermal expansion when heated at 400°C

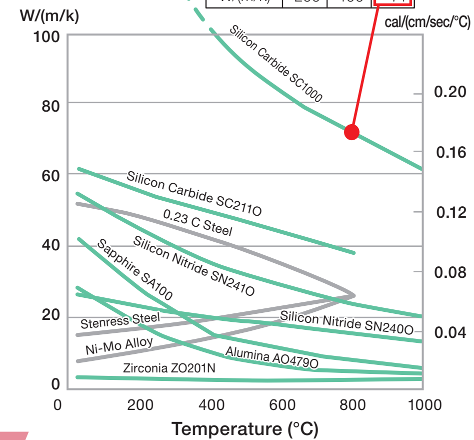




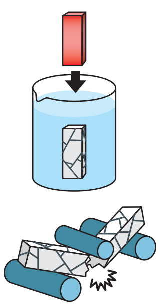
Thermal Conductivity

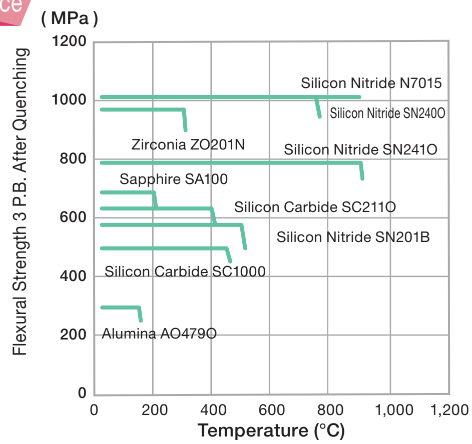


Silicon Carbide SC1000			
°C	20	400	800
W/(m/k)	200	100	71

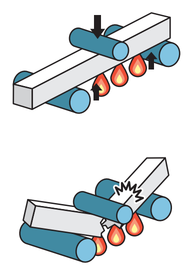


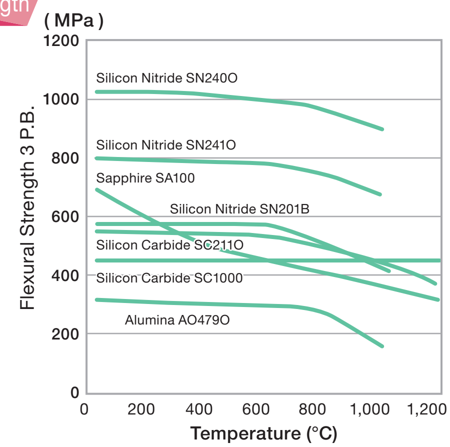
Heat Shock Resistance





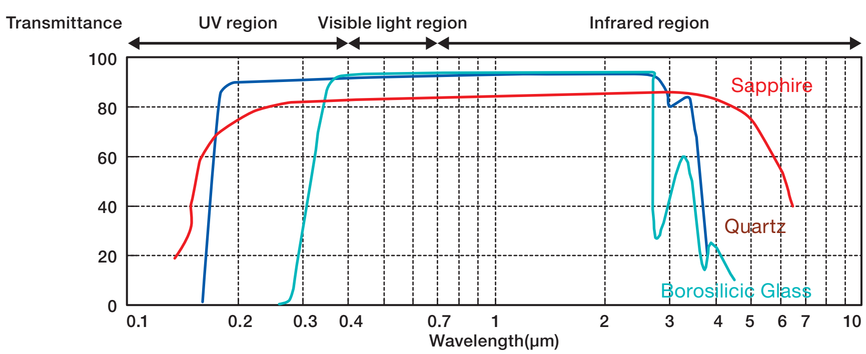
High-Temperature Strength



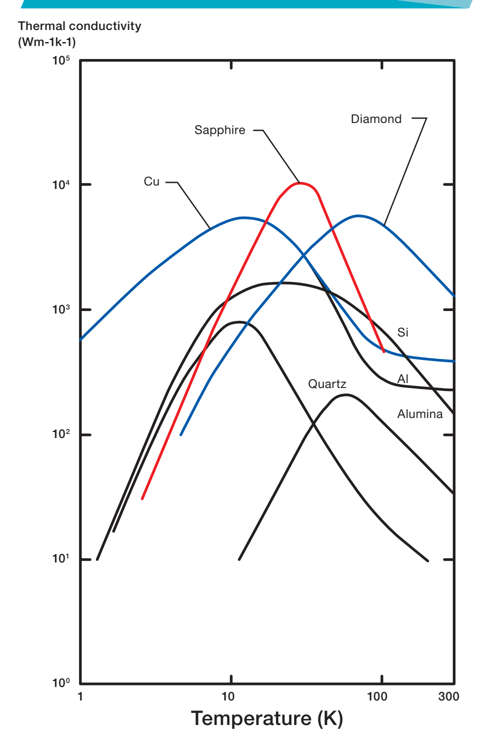


Single-Crystal Sapphire

Transmittance

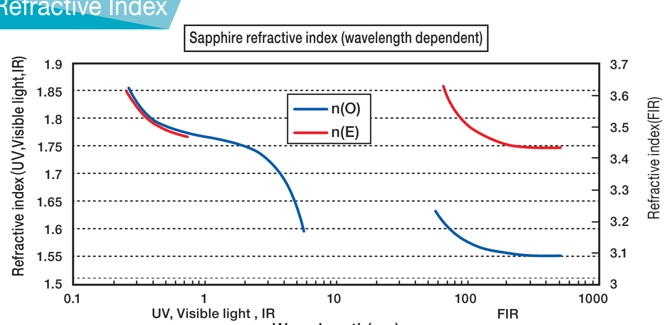


Low Temperature Thermal Conductivity



*Reference: NASA
(Proceedings of the Cold Electronics Workshop)

Optical Refractive Index



*According to our research.

Characteristic Table of Fine Ceramics

Item / Material	Unit	Test Method	ALUMINA (Al_2O_3)								
Material Code (New)			AO201B	AO445O	AO471O	AO473O	AO484O	AO484B	AO476O	AO479O	AO479S
Material Code (Old)			A201B	A445	A471	A473	A484	A484B	A476	A479	A479S
Appearance				Dense							
Color			Black	Dark Brown	White	White	White	White	White	White	Ivory
Content	(%)		91	90	92	92	92	92	96	99	99.5
Main Characteristics			•High Frequency Insulation •High Mechanical Strength •Wear Resistant •High Corrosion Resistance •High Temperature Resistance								
			•Low Light Reflectivity	•Intercepting •High Heat Dissipation	•Wear Resistance	•Metallizing •High Mechanical Strength	•High Wear Resistance	•High Wear Resistance	•Excellent Surface Finish •Excellent Printability	•High Hardness •High Corrosion Resistance	•High Hardness •High Corrosion Resistance •High Wear Resistance
Main Applications			•Semiconductor Processing Equipment	•IC Packages	•Liner •Pulverizer	•IC Multi-Layer Packages •Electrontube Housing •Wear Resistant Parts	•Wear Resistant Parts •Pulverizer	•Sliding Parts •Capstans	•Hybrid IC Substrates	•Heat, Corrosion and Wear Resistant Parts	•Corrosion and Wear Resistant Parts
Density (＊1)	g/cm^3	JIS R 1634	3.8	3.8	3.6	3.6	3.6	3.7	3.7	3.8	3.9
Water Absorption	%	JIS C 2141	0	0	0	0	0	0	0	0	0
Mechanical Characteristics: Vickers Hardness HV9.807N	GPa	JIS R 1610	12.0	12.7	11.8	12.3	12.3	12.3	13.7	15.2	16.0
Mechanical Characteristics: Flexural Strength 3 P.B.	MPa	JIS R 1601	400	320	390	340	370	460	350	310	400
Mechanical Characteristics: Compressive Strength	MPa	JIS R 1608	2,781	2,430	3,024	2,300	2,910	2,900	2,992	2,160	2,350
Mechanical Characteristics: Young's Modulus of Elasticity	GPa	JIS R 1602	320	320	280	280	280	300	320	360	370
Mechanical Characteristics: Poisson's Ratio	–	JIS R 1602	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Mechanical Characteristics: Fracture Toughness (SEPB)	$MPa \cdot m^{1/2}$	JIS R 1607	3.6	4.1	3.4	3.5	3.4	3.6	2.9	3~4	4
Thermal Characteristics: Coefficient of Linear Thermal Expansion 40-400°C	$\times10^{-6}/K$	JIS R 1618	7.0	7.3	7.1	6.9	6.8	6.6	7.2	7.2	7.2
Thermal Characteristics: Coefficient of Linear Thermal Expansion 40-800°C	$\times10^{-6}/K$	JIS R 1618	8.0	8.1	7.9	7.8	7.7	7.6	7.9	8.0	8.0
Thermal Characteristics: Thermal Conductivity 20°C	W/(m · K)	JIS R 1611	14	12	16	18	17	22	24	29	32
Thermal Characteristics: Specific Heat Capacity	J/(g · K)	JIS R 1611	0.79	0.75	0.79	0.78	0.78	0.79	0.78	0.79	0.78
Thermal Characteristics: Thermal Shock Temperature Difference (Put in Water,Relative Method)	°C	JIS R 1648	150	150	150	150	150	150	150	150	180
Electrical Characteristics: Dielectric Strength	kV/mm	JIS C 2141	14	12	16	16	14	14.5	15	15	15
Electrical Characteristics: Volume Resistivity 20°C	Ω · cm	JIS C 2141	$>10^{14}$	10^{11}	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$
Electrical Characteristics: Volume Resistivity 300°C	Ω · cm	JIS C 2141	10^{10}	10^{7}	10^{12}	10^{12}	10^{10}	10^{11}	10^{10}	10^{10}	10^{13}
Electrical Characteristics: Volume Resistivity 500°C	Ω · cm	JIS C 2141	10^{8}	10^{5}	10^{9}	10^{10}	10^{8}	10^{9}	10^{8}	10^{8}	10^{10}
Electrical Characteristics: Dielectric Constant (1MHz)	–	JIS C 2141	9.7	9.8	8.9	9.0	8.9	9.2	9.4	9.9	9.9
Electrical Characteristics: Dielectric Loss Angle (1MHz)	$(\times10^{-4})$	JIS C 2141	11	20	6	6	9	4	4	2	1
Electrical Characteristics: Loss Factor	$(\times10^{-4})$	JIS C 2141	106	190	53	54	80	37	38	20	10
Chemical Characteristics: Nitric Acid (60%) 90°C ,24H	(Weight Loss) mg/cm^2	–	0.00	1.17	–	0.32	0.14	–	0.02	0.10	0.00
Chemical Characteristics: Sulphuric Acid (95%) 95°C ,24H	(Weight Loss) mg/cm^2	–	0.01	0.33	–	0.65	0.34	–	0.01	0.33	0.00
Chemical Characteristics: Sodium Hydroxide (30%) 80°C ,24H	(Weight Loss) mg/cm^2	–	0.15	0.58	–	0.91	0.95	–	0.86	0.26	0.00

The values are typical material properties and may vary according to products configuration and manufacturing process. For more details, Please feel free to contact us.

＊1: All values for apparent density and bulk density are the same, except for the porous materials which lists apparent density only.

				SAPPHIRE (Al_2O_3)	ZIRCONIA TOUGHED ALUMINA ZTA		ZIRCONIA (ZrO_2)						YTTRIA (Y_2O_3)	YAG DISPERED ALUMINA
AO479M AO479G	AO479U	AO480S	AO601L	SA100	AZ201O	AZ205O	ZO220O	ZO201N	ZO206N	ZO701N	Z21H04	Z21H12	YO100A	AG1000
A479M A479G	A479U	A480S	A601L	SA100	AZ201	AZ205	Z220	Z201N	Z206N	Z701N	Z21H04	Z21H12	YO100A	AG1000
				Dense	Dense		Dense						Dense	Dense
Ivory	White	Ivory	Ivory	Transparent	White		Yellow	Ivory	White	Ash Black	Black	Black	White	Ivory
99.5	99.6	99.7	99.9	99.99	–		–	–	–	–	–	–	–	–
				Single Crystal	•High Mechanical Strength •High Hardness •High Wear Resistance		•High Mechanical Strength •High Fracture Toughness •Excellent Sliding Properties •Excellent Surface Finish				•Semi-conductivity •High Mechanical Strength •Excellent Sliding Properties •Excellent Surface Finish		•Good Plasma Resistance	•Good Plasma Resistance •High Mechanical Strength
•High Hardness •High Corrosion Resistance •High Wear Resistance	•High Hardness •High Corrosion Resistance •Low Dielectric Tangent	•High Purity •High Corrosion Resistance •Good Plasma Resistance •High Wear Resistance		•Optical Transparency •High Heat Resistance •High Frequency Insulation •High Corrosion Resistance	•Good Thermal Conductivity									
•Corrosion and Wear Resistant Parts •Semiconductor Processing Equipment	•Semiconductor Processing Equipment	•Corrosion and Wear Resistant Parts •Semiconductor Processing Equipment		•Thin Film Substrates •Windows •Corrosion Resistant Parts	•Pulverizer		•Industrial Cutlery •Pump Parts •Dies •Knives •Scissors •Wear Resistant Parts				•OA Equipment Jig	•Jig •Chip Mounter Nozzle	•Semiconductor Processing Equipment	•Semiconductor Processing Equipment
3.9	3.9	3.9	3.9	3.97	4.0	4.3	5.6	6.0	6.0	6.0	5.6	5.7	4.9	4.0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.7	15.2	17.2	17.5	a Plane 22.5	16.0	16.0	10.7	12.3	12.0	12.7	10.8	12.4	6.0	15.7
370	380	480	500	a Plane c Axis 690	600	705	750	1,000	1,100	1,470	740	1,000	130	420
2,984	2,530	2,900	3,229	2,940	3,455	3,390	2,312	3,000	3,100	–	3,100	3,100	1,832	3,600
370	387	380	380	470	380	330	200	200	210	220	210	220	160	370
0.23	0.23	0.23	0.23	Parallel to Axis c / Vertical to Axis c 0.18	0.24	0.25	0.31	0.31	0.32	0.31	0.32	0.31	0.3	0.24
4.3	4.3	4.3	4.5	2.1	3.5	3.9	7~8	6	6	6	3~4	4.5	1.1	2.9
7.2	7.2	7.2	7.2	Parallel to Axis c 7.7 / Vertical to Axis c 7.0	7.2	7.8	10	10.5	10.4	10.8	10.3	10.8	7.2	7.1
8.0	8.0	8.0	8.0	Parallel to Axis c 8.8 / Vertical to Axis c 7.9	8.2	8.7	10.5	11.0	10.8	11.3	11.4	11.0	7.6	8.0
32	32	32	34	42	26	16	3	3	3	3	3	4	14	30
0.78	0.77	0.79	0.78	0.75	0.71	0.71	0.46	0.46	0.44	0.46	0.48	0.49	0.45	0.76
180	180	180	180	180	150	200	450	300	300	350	250	200	–	200
15	14.6	15	15	48	14	12	13	11	14	–	1	≒ 0	11.0	16.6
$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	10^{13}	$>10^{14}$	–	10^{8}	10^{6}	$>10^{13}$	$>10^{14}$
10^{13}	10^{12}	10^{13}	10^{13}	10^{12}	10^{12}	10^{8}	10^{6}	10^{6}	10^{8}	–	10^{6}	–	10^{10}	10^{13}
10^{10}	10^{10}	10^{10}	10^{10}	10^{11}	10^{10}	10^{6}	10^{4}	10^{3}	10^{6}	–	10^{7}	–	10^{7}	10^{10}
9.9	10	9.9	9.9	Parallel to Axis c 11.5 / Vertical to Axis c 9.3	11	13	28	33	34	–	33	250	11	10
1	<1	1	1	<1	60	6	17	16	13	–	880	5700	5	<1
10	–	10	10	–	660	78	476	520	442	–	–	–	55	–
0.01	–	0.05	0.01	≒ 0.00	–	–	–	≒ 0.00	–	≒ 0.00	0.03	–	–	–
0.00	–	0.22	0.00	≒ 0.00	–	–	–	0.04	–	0.04	0.01	–	–	–
0.00	–	0.04	0.01	≒ 0.00	–	–	–	0.08	–	0.08	0.01	–	–	–

1kgf/mm2=9.807MPa 1cal/ (cm · sec · °C) =418.6W/ (m · K)

Characteristic Table of Fine Ceramics

Item	Unit	Standard	CORDIERITE ($2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$)		STEATITE ($MgO \cdot SiO_2$)	FORSTERITE ($2MgO \cdot SiO_2$)	TITANIA	CERMET	
Material Code (New)			CO220O	CO720O	SO210O	F1120O	TO716O	TC030O	GO102O
Material Code (Old)			CO220	CO720	S210	F1120	T716	TC30	G102
Appearance			Dense		Dense	Dense	Dense	Dense	
Color			Gray	Gray	White	Light Yellow	Light Brown	Silver	
Content	(%)		–	–	–	–	–	–	
Main Characteristics			•Very Low Thermal Expansion •Light Weight	•Void Less	•Good Insulation Property	•Excellent Surface Finish	•Excellent Surface Finish •CaTiO3	•High Mechanical Strength •Excellent Wear Resistance •High Heat Shock Resistance •Electrical Conductivity	•Nonmagnetic
Main Applications			•Lithography Stage Component •Wafer Inspection Stage Component •SEM/TEM		•Various Circuit Parts	•Substrate For Resistor •Core For Resistor	•Substrate •Slider Pads for Disk Drive Heads	•Cutting Tool Tips •Wear Resistant Parts •Metal Forming Tools	•Watch Parts •Wear Resistant Parts
Density (＊1)	g/cm^3	JIS R 1634	2.50	2.54	2.8	3.0	3.9	6.0	5.4
Water Absorption	%	JIS C 2141	0	0	0	0	0	0	0
Mechanical Characteristics: Vickers Hardness HV9.807N	GPa	JIS R 1610	8.0	8.5	5.8	7.3	8.5	15.7	18.4
Mechanical Characteristics: Flexural Strength 3 P.B.	MPa	JIS R 1601	190	200	190	180	320	1,810	1,290
Mechanical Characteristics: Compressive Strength	MPa	JIS R 1608	1,800	1,923	1,305	–	1,160	3,430	–
Mechanical Characteristics: Young's Modulus of Elasticity	GPa	JIS R 1602	140	145	120	150	260	430	440
Mechanical Characteristics: Poisson's Ratio	–	JIS R 1602	0.31	0.31	0.22	0.24	0.26	0.22	0.22
Mechanical Characteristics: Fracture Toughness (SEPB)	$MPa \cdot m^{1/2}$	JIS R 1607	1~1.5	1~1.5	1.9	1.8	1.8	7.6	5.7
Thermal Characteristics: Coefficient of Linear Thermal Expansion 40-400°C	$\times 10^{-6}/K$	JIS R 1618	1.5 (40°C~400°C) 2.1 (40°C~800°C)	1.5 (40°C~400°C) 2.1 (40°C~800°C)	7.7	9.7	11.5	7.6	7.1
Thermal Characteristics: Coefficient of Linear Thermal Expansion 40-800°C	$\times 10^{-6}/K$	JIS R 1618	< | 0.05 | (23°C) < | 0.02 | (22°C)	< | 0.05 | (23°C) < | 0.02 | (22°C)	8.0	10.8	12.1	8.5	8.2
Thermal Characteristics: Thermal Conductivity 20°C	$W/(m \cdot K)$	JIS R 1611	4	4	2	5	4	17	14
Thermal Characteristics: Specific Heat Capacity	$J/(g \cdot K)$	JIS R 1611	0.71	0.74	0.75	0.78	0.71	–	–
Thermal Characteristics: Thermal Shock Temperature Difference (Put in Water,Relative Method)	°C	JIS R 1648	450	400	150	–	150	310	–
Electrical Characteristics: Dielectric Strength	kV/mm	JIS C 2141	19.1	19.3	18	17	6.8	–	–
Electrical Characteristics: Volume Resistivity 20°C	$\Omega \cdot cm$	JIS C 2141	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	10^{12}	10^{-4}	10^{-4}
Electrical Characteristics: Volume Resistivity 300°C	$\Omega \cdot cm$	JIS C 2141	10^{12}	10^{12}	10^{10}	10^{13}	10^{10}	–	–
Electrical Characteristics: Volume Resistivity 500°C	$\Omega \cdot cm$	JIS C 2141	10^{10}	10^{10}	10^{7}	10^{10}	10^{7}	–	–
Electrical Characteristics: Dielectric Constant (1MHz)	–	JIS C 2141	4.9	4.9	6.0	6.5	177.7	–	–
Electrical Characteristics: Dielectric Loss Angle (1MHz)	$(\times 10^{-4})$	JIS C 2141	9	8.5	18	3	<1	–	–
Electrical Characteristics: Loss Factor	$(\times 10^{-4})$	JIS C 2141	30	35	108	20	–	–	–
Chemical Characteristics: Nitric Acid (60%) 90°C ,24H	(Weight Loss) mg/cm^2	–	–	–	0.01	–	0.07	6.0	–
Chemical Characteristics: Sulphuric Acid (95%) 95°C ,24H	(Weight Loss) mg/cm^2	–	–	–	0.00	0.00	0.79	0.26	–
Chemical Characteristics: Sodium Hydroxide (30%) 80°C ,24H	(Weight Loss) mg/cm^2	–	–	–	15.35	8.01	0.01	0.02	–

The values are typical material properties and may vary according to products configuration and manufacturing process. For more details, Please feel free to contact us.

＊1: All values for apparent density and bulk density are the same, except for the porous materials which lists apparent density only.

SILICON CARBIDE (SiC)				SILICON NITRIDE (Si_3N_4)			ALUMINIUM NITRIDE (AlN)		KFPG			KFSG	
									ALUMINIUM TITANATE (Al_2TiO_5)	SILICON CARBIDE (SiC)	SILICON NITRIDE (Si_3N_4)	ALUMINIUM (Al_2O_3)	ZIRCONIA (ZrO_2-Mg-PSZ-1)
SC120O	SC121P	SC211O	SC1000	SN201B	SN240O	SN241O	AN216A	AN2000	AT	SiSiC	N7015	F99.7	FZM
SC120	SC121	SC211	SC1000	SN201B	SN240	SN241	AN216A	AN2000					
Dense	Porous	Dense		Dense			Dense		POROUS	Dense	Dense	Dense	Dense
Black	Black	Black	Black	Black	Black	Black	Gray	Ivory	White/Gray	Black	Black	Ivory	Dark yellow
–	–	–	–	–	–	–	–	AlN 99.9	–	–	–	–	–
•High Temperature Strength •High Corrosion Resistance •Excellent Thermal Conductivity •Light Weight and High Stiffness •Good Surface Smoothness		•High Temperature Strength •High Corrosion Resistance •Wear Resistance •Excellent Thermal Conductivity •Light Weight and High Stiffness		•High Temperature Strength •Wear Resistance •Excellent Thermal Shock Resistance •Light Weight			•Insulation Property •High Thermal Conductivity •Lower Thermal Expansion		•Heat Shock Resistance •Thermal Insulation	•Including Si •Very High Thermal Conductivity •Light Weight •High Stiffness •Less Voids	•High-Temperature Strength •Wear Resistance •Heat Shock Resistance •Light Weight	•High Purity •High Corrosion Resistance •High Heat Resistance	•High Mechanical Strength •High Toughness •Excellent Surface Finish
		•High Toughness	•High Corrosion Resistance		•High Strength, High Temperature Durability	•Thermal Conductivity		•High Purity •Good Plasma Resistance					
•Mechanical Seal •Sliding Parts •High Temperature Resistance Parts •Pulverizer •Semiconductor Processing Equipment				•Anti Wear Liner •Pulverizer •Molten Metal Parts •Metal Forming Tool			•Heat Uniformity Parts •High-Temperature Treatment Fixtures •Semiconductor Processing Equipment		•Molten Aluminum	•Semiconductor Processing Equipment •Mechanical Seals	•Anti Wear Liner •Pulverizer •Molten Metal Parts •Metal Forming Tool	•Corrosion Resistant Parts •Heat Resistant Parts •Semiconductor Processing Equipment	•Pump Parts •Wire Drawing Machine Parts •Pressure Sensors
3.15	3.1	3.2	3.16	3.2	3.3	3.2	3.4	3.2	3.4(＊1)	3.05	3.2	3.93	5.76
0	0.01	0	0	0	0	0	0	0	1.2	0	0	0	0
23.0	22.0	22.0	23.0	13.9	14.0	13.8	10.4	11.2	3.2	22	14.2	17	10.0
500	296	600	500	580	1,020	790	310	220	30	350	1,020	400	605
4,300	3,064	4,200	4,200	3,160	3,551	3,292	3,200	2,900	230	2,300	3,880	2,500	2,012
430	410	430	440	290	300	290	320	310	30	380	300	388	207
0.16	0.16	0.16	0.17	0.28	0.28	0.28	0.24	0.24	–	0.18	0.3	0.24	0.31
2.5	2.3	4~5	2~3	4~5	7	6~7	3.2	2.5	–	3	5.7	5	8.5
3.7	3.6	3.7	3.7	2.4	2.8	2.9	4.6	4.6	0.0	3.5	2.4	7.0	10.2
4.4	4.3	4.4	4.4	3.2	3.3	3.5	5.3	5.2	0.7	4.2	3.0	8.0	10.6
190	190	60	200	25	27	54	150	67	2	185	20	33	3.5
0.67	0.70	0.67	0.67	0.64	0.65	0.66	0.71	0.72	0.80	0.70	0.63	0.74	0.50
300	250	400	350	550	800	900	250	200	–	350	>900	180	250
–	–	–	–	9.7	13	12	14	16	10	–	13.2	–	–
10^{6}	$>10^{6}$	10^{5}	10^{8}	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{8}$	$>10^{3}$	$>10^{14}$	–	–
10^{4}	10^{5}	10^{4}	10^{4}	10^{12}	10^{12}	10^{12}	10^{10}	10^{11}	–	–	10^{13}	–	–
10^{4}	10^{3}	10^{3}	10^{3}	10^{10}	10^{10}	10^{10}	10^{8}	10^{9}	–	–	10^{11}	–	–
–	–	–	–	8.9	9.6	9.6	8.6	8.5	13.2	–	8.1	–	–
–	–	–	–	17.0	19	18	3	2	–	–	4.0	–	–
–	–	–	–	–	–	–	26	17	–	–	–	–	–
–	–	0.04	≒ 0.00	–	1.11	0.18	–	–	–	0.01	–	0.00	0.30
–	–	0.01	≒ 0.00	–	0	0	–	–	–	0.01	–	0.00	0.20
–	–	≒ 0.00	≒ 0.00	–	0.22	0.07	–	–	–	3.53	–	0.10	0.00

1kgf/mm2=9.807MPa 1cal/ (cm · sec · °C) =418.6W/ (m · K)

Manufacturing Process (Polycrystal)

Raw Material processing

- Mill the raw material to achieve uniform particle size and mix with the binder.
  Then dry in a dryer to produce highly fluid granules.

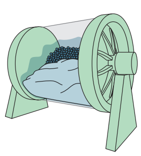
Forming Process

- Material powders are solidified and formed into a shape close to that of the finished product.
- The formed part is designed with consideration of sintering shrinkage and grinding / polishing margin. Green machining is performed as necessary to bring it closer to the product shape.

Compounding / Milling / Mixing

Ball Mill

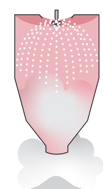
Raw materials, binder, balls, and water are put into the mill, then milled and mixed repeatedly to achieve uniform particle size of the raw materials and make a slurry.

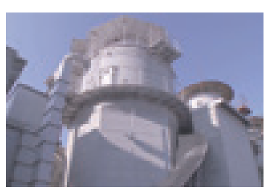


Spraying & Drying

Spray Drying

The slurry is sprayed and instantly dried with hot air to form granules.

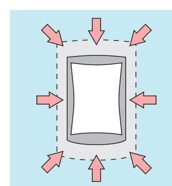




Forming

CIP (Cold isostatic pressing)

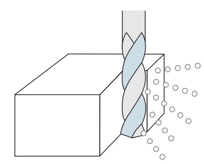
A rubber mold filled with raw material powders is placed into a water tank in a high pressure vessel and water pressure is applied.

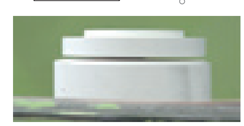


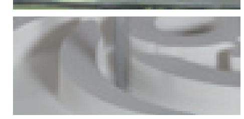
Green Machining

Green Machining

A pressure-formed round bar or square lumber is cut into shapes containing 20% volume which shrinks by the sintering.





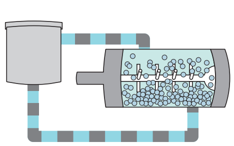


OPTION

We have unique grinding methods and equipment to meet our production volume and various raw material types.

Bead Mill

A small mill and a drum are connected with a pipe to circulate raw materials, binders, and water, and the particle size is refined by repeating milling and mixing many times.



OPTION

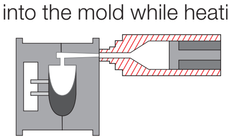
We select an efficient method suitable for size, shape, and quantity from various forming methods.

Die Pressing
(Press Forming)

A die with a split structure close to the final shape is filled with powder and then pressed.

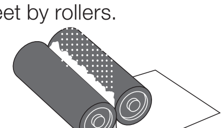
Injection Molding

Plastic resin is added to the raw material and injected into the mold while heating.



Tape Molding
(Roll Compaction)

Powders are pressed into a sheet by rollers.



Cast Molding

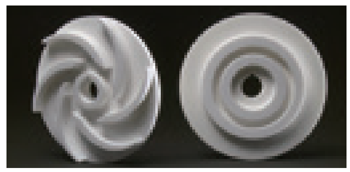
The fluid raw material is poured into a plaster mold, and then the mold is removed after drying.

Sintering Process

- The formed part is sintered at a temperature of 1000°C or higher. During the sintering process, powder particles are fused together to form a dense and extremely hard part.
*Sintering process shrinks the dimensions by 20% and the volume by 50%.

Grinding Process

- The sintered part, which now has the hardness close to diamond, is ground to the final specifications with a designated grinding tool, and the surface is polished.
- We have machining technology to meet a wide variety of requests, including complicated shapes, high precision specifications, and in combination with other materials.



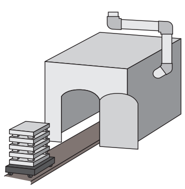
Inspection / Cleaning / Packaging

- Processes to deliver high quality products.
- Inspection, cleaning, and packaging suited for product specifications.

Sintering → Grinding → Polishing → Inspection / Cleaning / Packaging

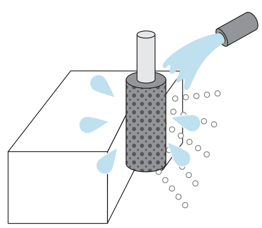
Batch Furnace

Sintering at a temperature of 1000 °C or higher is achieved by strictly controlling the atmospheric gas temperature in accordance with the size of the product and the material being used.



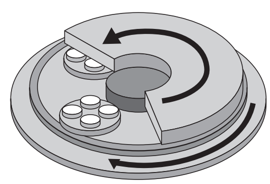
Grinding

A sintered material is ground with diamond tools to form the final shape.



Polishing

Finish to face accuracy according to specifications.



Inspection

High quality is assured by using high-precision measuring equipment and other devices.

Cleaning

Impurities are removed based on requirement.

OPTION

We have various sintering furnaces suited for material types, product sizes and shapes, with the know-how of optimum temperature control.

Tunnel Kiln

Suitable for small products with a fast sintering cycle.

Vacuum Furnace / Atmospheric Furnace

After being rendered a vacuum, the inside of the furnace is filled with an inert gas and used for firing sintered non-oxides.

Hot Pressing

Material powders are placed in a mold and sintered at high temperature while applying pressure in a uniaxial direction. The part becomes void-less in the direction of the pressure, leading to improved properties.

HIP (Hot Isostatic Pressing)

After pre-sintering, the product is placed in a pressure vessel, and high isotropic pressure is applied with heat to make a high-density sintered body.

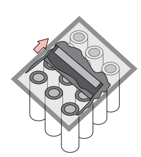
OPTION

We have a large number of manufacturing technologies that enhance the functions and added value of ceramic parts, and we continue to develop new processes.

Laser Processing (see P.27)

Metallization (see P.29)

Firmly bond Fine Ceramis with metal



Coating (see P.27)

Joining (see P.29)

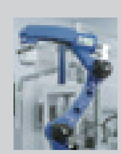
OPTION

We are equipped to achieve the high level of cleanliness required for components to be installed in medical and analytical equipment, semiconductor manufacturing equipment, etc.

Ultra-Precision Cleaning Line

Removes small particles such as deposits and airborne particles from the manufacturing process

Smart Factories



In order to meet various demands, designing and manufacturing process selection are important, on top of abundant material equipment and manufacturing technology.We are responding to the product realization satisfying specifications by efficient designing that makes full use of IT in addition to abundant ceramic design know-how.
In addition, by utilizing smart factories, we have a stable supply capacity that is not affected by changes in the environment. We are also working on the automation of production lines that continue improvement by accumulating manufacturing data and by AI analysis.

Manufacturing Process (Single Crystal Sapphire)

Crystal Growth

Seed crystals are immersed in the raw material melted and liquefied at 2000°C or higher, and the crystals are gradually grown larger.

Outside Grinding

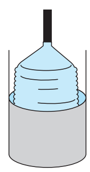
Crystals are machined with a diamond tool to refine the shape and thickness.

POINT!

We have multiple sapphire crystal growth technologies, and we select an effective and efficient manufacturing method depending on the shape of the product.

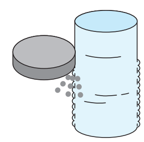
Crystal Growth (CZ method)

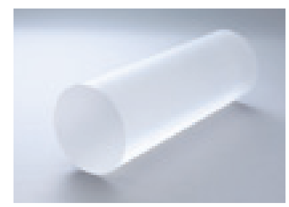
- Suitable for circular substrates
- Suitable for mass production



Outer Diameter Grinding

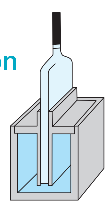
Cut off unnecessary portion and adjust the crystal orientation and outer shape.



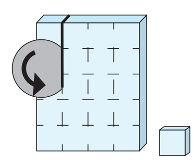


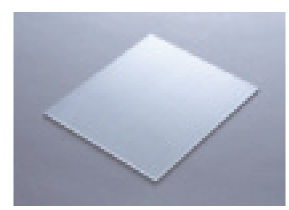
Crystal Growth (EFG Method)

- Suited for specific crystal orientation
- Suited for square shape, hollow structure, complicated shape



Sizing



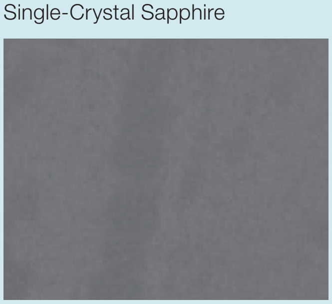


Characteristics of Single-Crystal Sapphire

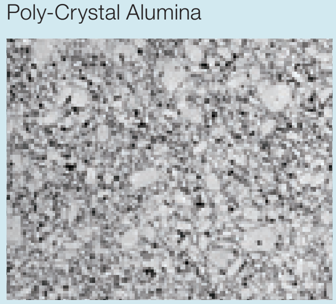
Single-Crystal Sapphire is a high-purity single crystal without voids or grain boundaries, so it has better mechanical properties and chemical stability than Polycrystalline Alumina of the same elements, Al2O3. In addition, it is a transparent material and has high transmittance in a wide wavelength range from infrared rays to near-ultraviolet rays.It is more mass producible than diamond and has superior properties to quartz in various characteristics, contributing to a higher performance and longer life for various industrial equipment.

Crystal Comparison

Single-Crystal Sapphire

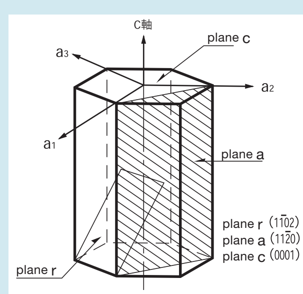


Poly-Crystal Alumina



POINT! Without voids or grain boundaries, it exhibits excellent mechanical properties.

Crystal Orientation of Sapphire



Typical Orientation of Single-Crystal Sapphire

POINT! Characteristics change depending on the crystal orientation

KYOCERA

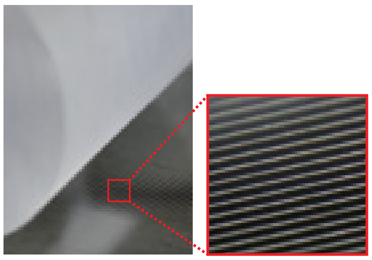
Outside Grinding

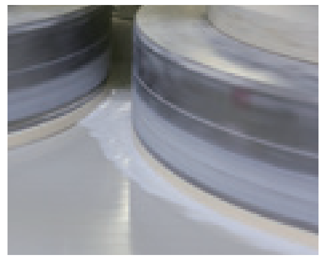
Lapping

Lap with diamond abrasive grains to finish the thickness, surface roughness, and flatness.

Inspection / Cleaning / Packaging

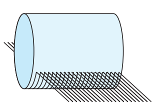
After multiple inspections, including surface orientation, shape and surface accuracy, and optical transparency, then cleaning and packaging are performed.



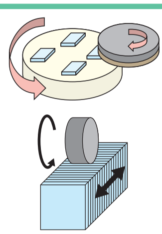


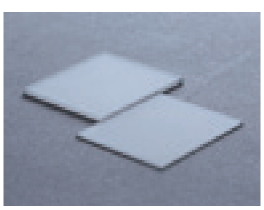
Slicing

Crystal is cut to the specified plate thickness.

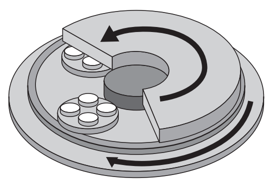


Thickness Grinding and Outer Diameter Grinding





Lapping and Polishing



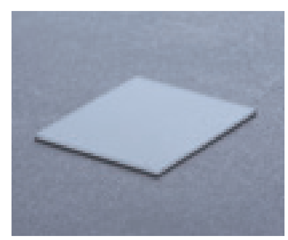
Lapping

Finish to a smooth surface by mechanical lapping with diamond abrasive grains (surface roughness Ra 100 nm or less)

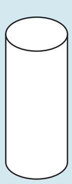
Polishing

Finished to a glossy mirror surface by chemical mechanical polishing (CMP) (surface roughness Ra 0.3 nm or less)

Inspection / Cleaning / Packaging

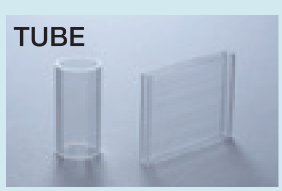


Shape and Specifications



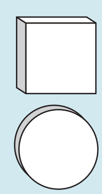
Diameter	Length
ϕ0.04"~0.4"	~40"L
ϕ0.4"~2.36"	~9"L

Grinding Finish	Ra<1μm
Lapping Finish	Ra<0.1μm
Crystal Orientation	C Axis in longitudinal direction



Diameter	Length	Thickness
ϕ0.1"~1"	~40"L	~0.4"L
ϕ1"~2.76"	~9"L	~1.2"L

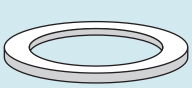
Grinding Finish	Ra<1μm
Lapping Finish	Ra<0.1μm
Crystal Orientation	C Axis in longitudinal direction



Size	Thickness
~□16"	~4"T
~ϕ16"	~4"T

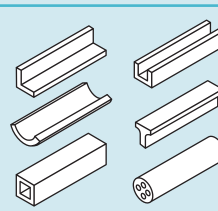
Grinding Finish	Ra<1μm
Lapping Finish	Ra<0.5nm
Crystal Orientation	a/r/c Plane

RING



Diameter	Length
~ϕ16"	~4"T

Grinding Finish	Ra<1μm
Lapping Finish	Ra<0.1μm
Crystal Orientation	a/r/c Plane



Not only can we produce various shapes, but we can also produce structures with hollows or multi-holes. Please contact us for more details.

2 Fine Ceramic Components Supporting a Wide Range of Industries

Semiconductor Processing Equipment

The performance of semiconductors continues to improve and their applications continue to expand. The various manufacturing equipment that produces them is required to respond to technological trends such as miniaturization of wiring and multi-layering, all while achieving higher productivity. For this reason, lithography equipment components require high-precision parts made of lightweight and rigid materials, and etching and deposition equipment components require plasma resistance and low particles. Also, they may require heat resistance of 600 °C or higher or low dielectric loss. All of these demands have led to an increased use of ceramics. Kyocera's Fine Ceramic products with high-precision and excellent mechanical properties are widely used in inspection equipment such as probers, wafer cutters, back grinders, and wafer transfer arms. In addition, sapphire is used for such applications as windows that require optical transparency, wafer carrier plates, wafer contact lift pins, and plasma introduction tubes.

Chamber Components

Chambers

High purity and excellent plasma resistance contribute to extending the life of parts.

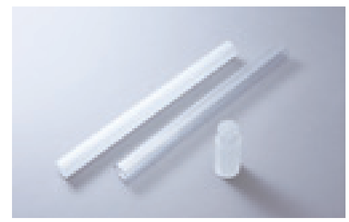
Insulation Parts

Parts Around Wafers / Parts for Plasma Introductions

Focus Rings

Nozzles

Plasma Introduction Tubes



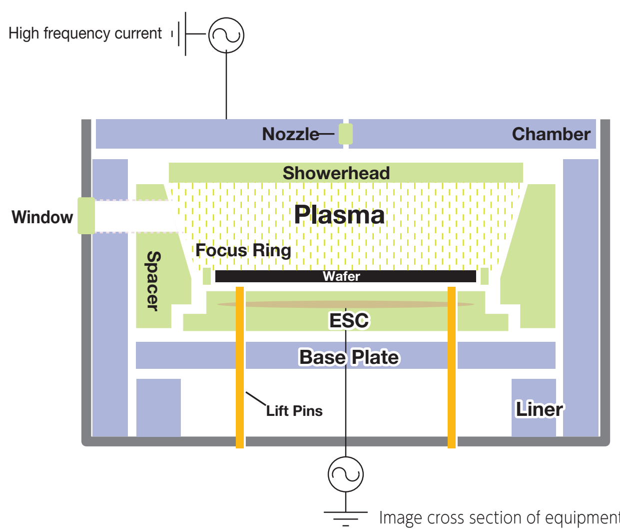
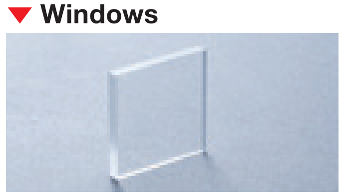


Image cross section of equipment

Windows



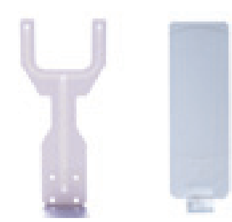
End Effectors

Lift Pins

Excellent wear resistance contributes to extending the life of parts.

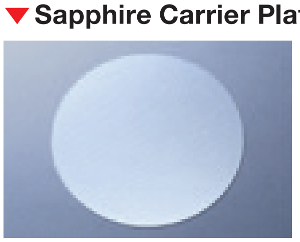
Handling Arms

Various coatings can be applied



Other product examples

Sapphire Carrier Plates



Vacuum Chucks

- Highly accurate wafer chucking is possible by high precision processing and measurement technology.
- The chucking surface type: Groove type, Pin type, Porous type

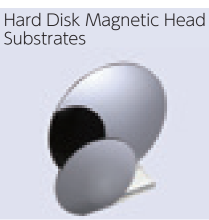
Electronic Component Manufacturing Equipment


Pushing Jigs
Suction Heads
Transport Guides

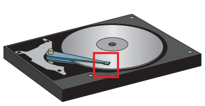

Tweezers with Electrostatic Discharges Countermeasures (ESD countermeasures)

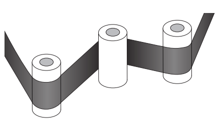
Using electronic component manufacturing equipment, hundreds of thousands or even millions of products are manufactured each day. The challenge is therefore, to reduce wear and static electricity at the contact points between the products and the equipment. For this reason, semi-conducting ceramics with high wear resistance and electrostatic discharge (ESD) countermeasures are being increasingly used for the suction heads of chip mounters and the handling parts of ultra-small parts such as tweezers. In addition, ceramics have little metal elution and excellent chemical resistance, and are expected to improve product quality.

Information Equipment


Hard Disk Magnetic Head Substrates

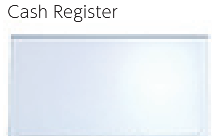

Tape Guides



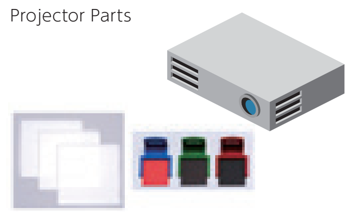


With the improvements in the performance of recording devices such as hard disks and information devices such as printers and projectors, ceramics are being applied to key parts that require high accuracy, wear resistance, and high thermal conductivity. Ceramic parts with excellent smoothness, sliding properties, and wear resistance are used for magnetic tape guides and magnetic heads, and sapphire, which has optical transparency, high thermal conductivity, and scratch resistance, is used for projector parts, cash register scanner windows, and cover glass for mobile phones.

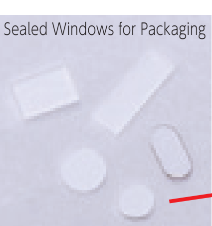
Scanner Window for Cash Register

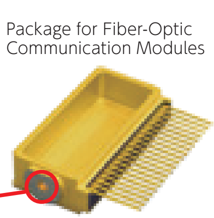


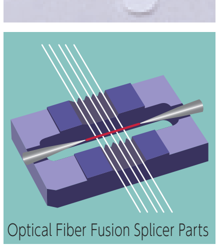
Projector Parts

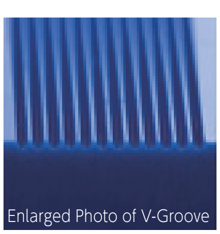


Optical Communication


Sealed Windows for Packaging


Package for Fiber-Optic Communication Modules


Optical Fiber Fusion Splicer Parts


Enlarged Photo of V-Groove

A broadband network using optical fiber with fast line speeds and stable communication is an important aspect of the infrastructure connecting wireless base stations such as 5G and 6G in order to realize autonomous driving, remote control of equipment, and high-precision video. Many ceramics are used for the parts that support this technology.

Sealed Windows for Packaging

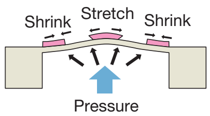
Ceramics with precise dimensional accuracy and high reliability against environmental changes are used for the parts to transmit optical signals with high accuracy and low loss. In addition, sapphire, which has heat resistance and optical transparency, is used for the sealing windows of optical communication packages.

Optical Fiber Fusion Jig (High-Precision V-Groove Machined Product)

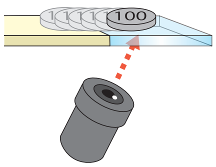
It is a high-precision V-grooving jig used for aligning and fixing fibers on the process to fusion splice the optical fiber. Fine ceramics with high precision and little dimensional change due to temperature are used to join the fibers together at high coaxial and concentricity.

Sensors


Parts for Pressure Sensor



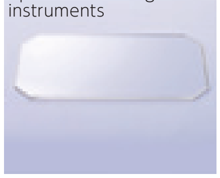

Coin Guides

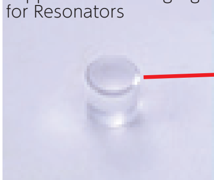


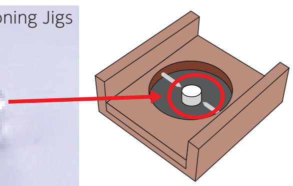
Sensor components are required to for higher sensing accuracy that can be maintained for a long time.
Fine Ceramics possess excellent properties, including wear resistance, chemical resistance, and optical properties, and can be used stably even in harsh usage environments such as in chemicals or at high temperatures.
In particular, for sensors for automobiles, there is an increasing need for ceramic parts with high performance and resistance to environmental changes. Ceramic membranes and substrates with excellent corrosion and heat resistance are already used for pressure sensor parts in brakes and transmissions. In addition, sapphire, which has optical transparency, has been adopted for the infrared sensor window of coin sensors, because there is no wear due to the passing contact of the coins, it contributes to sensing for a long time.

Measuring Equipment


Surface plates for measuring instruments
Parts for Measuring Instruments


Sapphire stages for optical measuring instruments


Sapphire Positioning Jigs for Resonators



High-precision measurement is indispensable for high-quality manufacturing, thus, high-precision and high-reliability are also required for the components for measuring instruments.
Ceramics have excellent mechanical properties including high dimensional accuracy and wear resistance, and thus enable highly repeatable measurements, and are widely used in reference jigs, measuring tools, and stages for optical measuring instruments.

Food Machinery


Valves for Drink Dispenser

Ceramic parts are also seeing increased usage in parts for food machinery, including filling machine parts, valve parts, kneading rollers, pump parts, and valves for drink dispensers used in vending machines, restaurants, and convenience stores. Ceramics not only maintain long-term production quality due to their excellent mechanical properties, but also have excellent heat, chemical, and environmental resistance, making them suitable for cleaning at high temperatures and chemical solutions, contributing to an improved level of hygiene management.
In addition, automation is progressing in food manufacturing, creating an increased need for light-transmitting sapphire as various sensor components.

Milling Equipment & Classifiers

Alumina, zirconia, and silicon nitride, which have excellent wear resistance, are widely used for milling chemical substances and dyes, and for kneading food manufacturing. Nowadays, ceramic parts are also being adopted to kneaders and mills for secondary battery manufacturing, which cannot allow mixture of metal impurities.
Depending on the application and usage conditions, zirconia toughened alumina (ZTA) or silicon carbide, which are materials with excellent thermal conductivity and corrosion resistance, are also available. We can propose ceramic material that suit your needs.

Molten Metal Casting & Steel Manufacturing

Ceramic parts are used in the manufacturing process for various metal parts, contributing to improved productivity by reducing the frequency of replacement and maintenance of equipment parts. Parts used in the casting process for molten metals at 700 °C or higher need high thermal shock resistance, high temperature strength, and high corrosion resistance. Silicon nitride is used for thermocouples, heater protection tubes, and casting stalk tubes. In addition, silicon nitride has low wettability with molten aluminum and is widely used in aluminum foundry. In steel manufacturing processes, it is used for molding of various steel materials, transfer rolls, bearings for plating baths, liners, and parts for caulking and drawing. In addition, sapphire is used for applications that require higher heat resistance and the prevention of impurities.

Related Sites

Wire Drawing Machinery

For capstans and wire drawing rings used in wire drawing machines, ceramics usage is increasing due to excellent durability and corrosion resistance, and availability of fine surface finishes. In particular, in recent years, ceramics have been widely used in capstans that manufacture the coil wires used in motors for hybrid and electric vehicles, contributing to improved productivity and stable quality.

Related Sites

Papermaking Machinery

Alumina has been the main material for blades for a long time.
In recent years, with the increase of machine speed and the improvement of plastic wire, problems due to wear and frictional heat have become more prominent, and the blade is required to be more resistant to wear and heat shock. Materials are selected out of alumina, silicon carbide, and silicon nitride, depending on the specifications of the machine. Sapphire can also be used as required.

Textile Machinery

Textile Machine Parts

Ceramics are used in various textile machines, such as spinning machines, winding machines, draw false-twist texturing machines, and weaving machines, for general guide parts, yarn processing nozzles, oiling nozzles, rollers, and twisting parts. The smoothness and wear resistance of the parts are contributing to reduced damage to threads running at high speed. Even for diversified yarn types and multifunctional yarns (ultrafine fiber yarns, irregularly shaped yarns), we propose the optimal specifications from a wide variety of ceramic materials and surface finishes so that we can contribute to productivity improvement.

Cutters

Cutters

Ceramic cutters have excellent strength and wear resistance, as well as chemical resistance, heat resistance, and are non-magnetic. Zirconia and cermet cutters have high toughness, and we propose selection depending on the material to be cut. Zirconia is characterized by having no metal marks, and cermet is characterized by having less adhesion when cutting metal (especially aluminum). Since the sharpness of the cutter is maintained for a long time, it contributes to high productivity by improving yields and reducing the frequency of replacement.

<u>Industrial Cutters & Slitters</u>

- Zirconia / Sapphire: For cutting textiles, papers, films, etc.
(Good for materials or process which dislike metal transfer)
- Cermet: For metal cutting (suppression of adhesion of metal materials, especially aluminum)

We also handle other materials, such as cemented carbide. Please contact us for further details.

Pumps / Valves

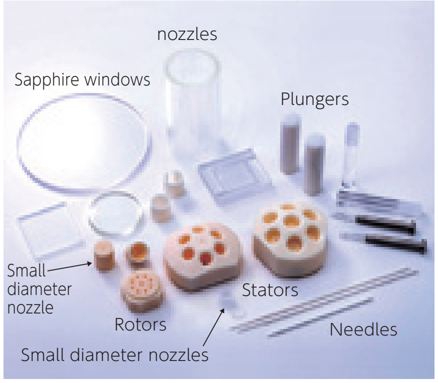
Metal pump valve products have been the mainstream, but due to the excellent wear and corrosion resistance of ceramics, they are being replaced with ceramics in various industries, including semiconductors, medical care, and food processing. Ceramics are used not only for valves in the chemical industry, that require corrosion and heat resistance, but also for ball valves that open and close the flow path, and plungers and shafts for pumps. They contribute to the excellent sealing and stable discharging.
In addition, high-precision machining of plungers and cylinders enables clearance to the order of microns. This technology is used in pump parts for artificial dialysis equipment.
If single-crystal sapphire is selected, it provides a high-purity, voidless, and extremely smooth surface, which leads to a reduction in liquid residue and dust generation. It is used for parts that could cause severe wear due to frequent opening and closing, such as for a pump part for high pressure washers.

Medical & Surgical Equipment

In an attempt to ease the burden on patients, the requirement is increasing for early detection and early treatment of diseases, and lesser invasive treatment. Thus, medical devices have been actively developed recently.

<u>Surgical treatment tools (incision scalpel, endoscopic parts, medical and surgical equipment parts)</u>
Since ceramics offer insulation, strength, heat resistance, and biocompatibility, small and complicated ceramic parts are used in treatment tools, such as electric scalpels. Among them, sapphire is used for laser scalpels because it offers optical transparency.
<u>Medical diagnostic imaging equipment parts</u>
Since X-ray CT is used at high voltage, ceramics with high insulation are often used. Ceramic parts are also required to have higher reliability, improved performance, and smaller size. In addition to manufacturing ceramic parts, we can also offer technical support such as the development of high dielectric resistant material, optimum design proposals, and electric field simulations.

Physical & Chemical Analysis Equipment



In recent years, increasing awareness of health and the living environment has led to the sophistication of analyzers in the medical field and in research institutions, and the diversification of needs for measurement and analysis. Along with this, various physicochemical analytical instruments have been developed. Analyzers that detect atomic states for solids, liquids, and gases use electron beams, X-rays, lasers, and plasma, so they use ceramics with high corrosion resistance. Biometric instruments that perform DNA analysis need to analyze minute amounts of components without affecting the sample. Chemically stable ceramics are used to minimize unwanted ingredients. Ceramics are also used in parts for chemical analysis such as cylinders, plungers and flow cells, as well as in parts for supercritical decomposers. In addition, sapphire's optical properties are used in analytical instruments, and its excellent washability is used in pump components for blood analysis and small-diameter nozzles.

Related Sites

Nozzles

<u>For Textile Machinery and Crushers</u>
Alumina ceramics with excellent wear resistance are widely used for thread ejection nozzles, oiling nozzles, and sandblast nozzles, and they are contributing to longer life of components.

<u>Welding Nozzles</u>
Silicon nitride and silicon carbide are used due to excellent oxidation resistance and high-temperature strength.
Also, since it reduces the adhesion of spatters, it contributes to longer life of welding parts.

<u>For Semiconductor Processing Equipment</u>
A material with high corrosion resistance is necessary in order to inject highly corrosive gas evenly.
So, ceramic nozzles with high-precision hole processing are used.

<u>For 3D Printers</u>
Sapphire and ruby are used due to their compatibility with ink.

Related Sites

Decorative Parts (Colored Ceramics)

These are high-tech materials that combine the beauty of jewels and precious metals with the excellent mechanical properties of Fine Ceramics. The color tone can be adjusted by adding a pigment to the ceramic raw material prior to sintering. Unlike painting or coating, the surface does not peel off, deteriorate, or become discolored, and maintains a deep color for a long time. These are used for watch and decorative parts because they are not easily scratched. In some cases, ceramics are also used as a measure against metal allergies.

Lifestyle & Everyday

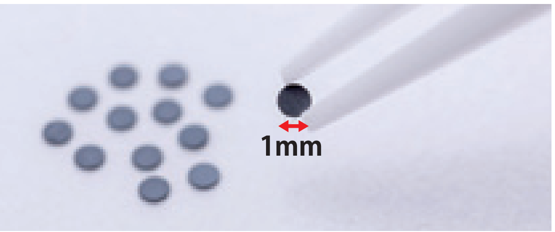
The use of Fine Ceramics is expanding not only in the industrial market but also in our daily lives. They are used for kitchen knife blades because they don't elute metal, and also for sharpeners due to wear resistance and high hardness. Ceramics are also used in fishing gear guides that take advantage of high wear resistance. Sapphire, which has optical transparency in addition to wear resistance, is used in watches and smartphone parts.

3 High Value-Added Products and Technologies

Size Ultra-Small and Ultra-Large Products

We develop technologies and introduce equipment necessary for manufacturing both small and large products.

POINT! We have monthly production experience of several hundred millions of extremely small parts. We can provide products with various shapes and a size of 0.4 x 0.2 mm or larger.



We have accumulated and innovated pressing technology for many years, and we are mass-producing small and thin products with various shapes.

POINT! We have succeeded in growing larger than 16" diameter sapphire crystals.

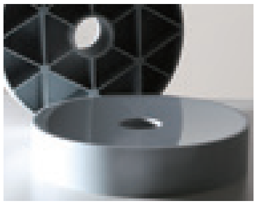
We are researching and developing larger sapphire crystals with less strain.

High-Precision Polishing Process

We finish surfaces, straight lines, right angles, and curved surfaces with high processing technology, and provide high-quality products based on inspections by our own high-precision measuring equipment.

For valveless pumps, which require smooth movement and highly precise quantitative discharge, we achieve high cylindricity and roundness by mirror polishiing with minimized clearance.

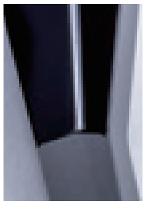
Ceramics that hardly change over time are suitable for reference jigs, and maintain the high accuracy of flatness and squareness required as a reference for a long period of time.



Concave Surface

3D

Normal Process

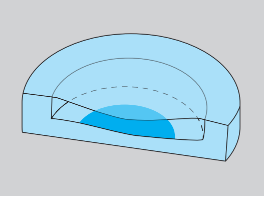


Machining with Less Droop

Mirroring can be performed not only on flat surfaces but also on uneven surfaces and curved surfaces. In addition, sharp edges can be processed with less shear droop.

Doctor Blade

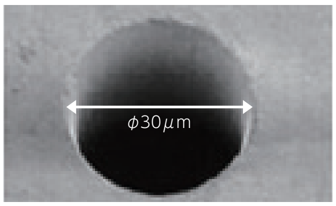
Ultra-thin zirconia blades with high strength and toughness using high-precision machining technology.



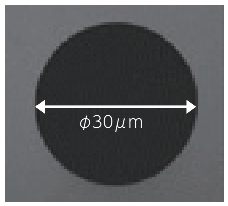
High-sensitivity pressure sensors require a thin, elastic film substrate that changes with a slight pressure. Among ceramics with excellent corrosion resistance to gas and chemicals, sapphire has superior hardness and can be processed into ultra-thin substrates. It can be processed to a thickness (50um or less) that can be bent, and the thickness is precisely controlled to the micrometer level so that the detection results do not vary depending on the thickness variation of each substrate.

High-Precision Precision Machining of Holes and Grooves

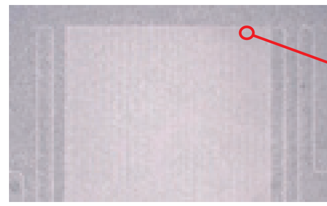
We have the manufacturing capabilities and know-how to process holes and grooves in Fine Ceramics at high speed and with high-precision. With our high-precision machining methods, cracks due to thermal shock generated by conventional laser machining can be suppressed and machining can be performed without burrs or dross. So, it is used for hole processing on printed circuit boards, as well as for highly precise fine hole & groove processing such as resin flow holes for synthetic fiber manufacturing and the break grooves on parts. The materials to be processed are alumina, silicon carbide, silicon nitride, aluminum nitride, zirconia, and even sapphire, a transparent material. We have processing know-how for each material, and the position, size, shape, tapering, and surface can all be finished as desired with high-precision and speed.



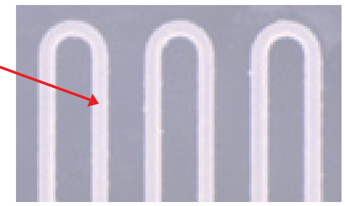
Dross-Free and No-Tapering Processing
Substrate thickness: 0.3mm or less



Micromachining of Sapphire

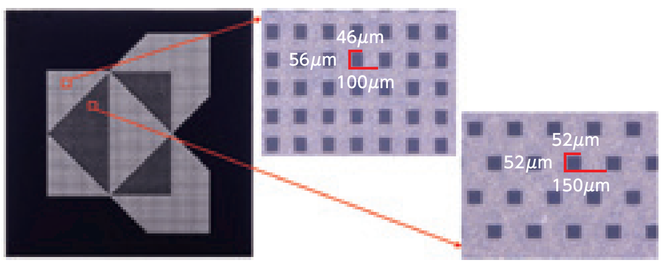


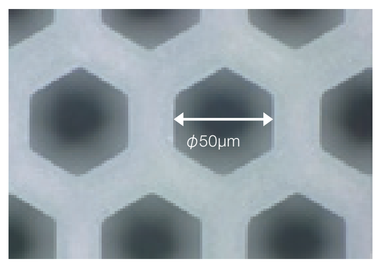
Micromachining of Irregular Shapes



Micro channels
Chanel width 20μm / channel depth 30μm

Example





Multiple Processing of Small Holes is Possible.

Related Sites

Surface Modification Surface Modification Coating

Various coatings with metal, resin, and ceramics are possible over the base material of Fine Ceramics.
On top of the excellent properties of ceramics, including high hardness, low thermal expansion, high stiffness, light weight, and high chemical resistance, coating can add functions or further enhance characteristics such as added conductivity, reduced friction coefficient, improved plasma resistance, wear resistance, and less voids.
We will propose base materials, manufacturing methods, and coating quality according to your desires.

POINT!

Main Coating Examples

Please contact us for the other production methods.

Method	Coating Material
thermal spraying	Yttria, Alumina, Aluminum, Stainless
PVD	Yttria, TiN, TiC
CVD	Silicon carbide, DLC
Plating	Gold, Silver, Chrome, Nickel
Baking	Fluorine resin, Conductive Fluorine resin, Polyimide, Urethane, Celazole®

With sapphire, it is possible to provide optical coatings, such as a dichroic mirror coating that allows selection for wavelength of transmitted light and anti-reflection IR coating.

<Coating Examples>

DLC (Silicon carbide)

CVD (DLC)

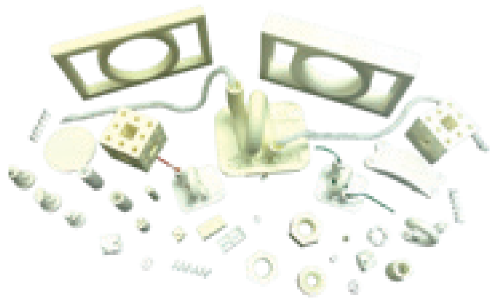
PVD Yttria Coating

Dichroic Mirror Coating

Shape Three-Dimensional Complex Shapes

In addition to normal processing, we also offer 3D printer molding that does not require a mold, injection molding for mass production, and casting molding for large shapes. We can select the suitable manufacturing method for shape specifications and price requirements based on our various manufacturing processes and accumulated experience.

3D Printer Molding



Injection Molding

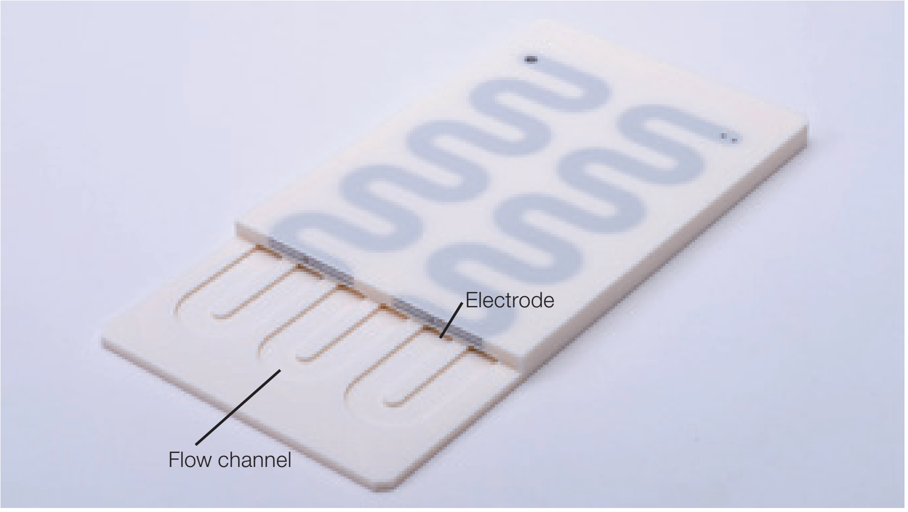
Related Sites

Cast Molding

Shape Hollows, Internal Flow Channels & Embedded Electrode Heaters

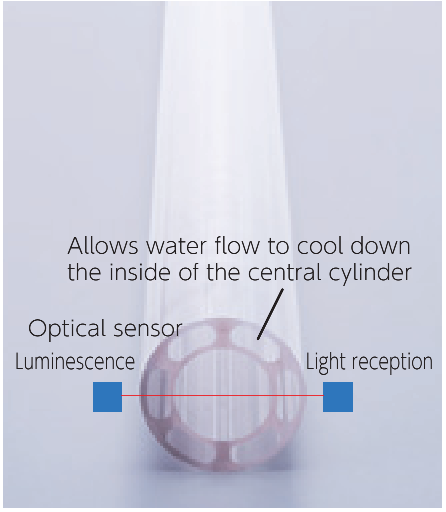
We can also manufacture ceramic parts with hollow and internal flow channels and functional parts with embedded electrode heaters. Integration at the molecular level without using adhesives makes it possible to maximize the characteristics of ceramics.

Heat Exchange Parts



Ceramics with inside flow channels for cooling water and products with embedded electrodes for heating are used for equipment parts that require the excellent properties of ceramics, including high-temperature strength, insulation, and plasma resistance.

Analytical Instrument Parts



Sapphire, which has light transmission and corrosion resistance, is used in laser-based analytical equipment.

POINT!

Cold water is poured into the outer channel of the cylinder to cool down the middle channel, and measurement is done by sensor utilizing the transparency of sapphire.

Mixing Equipment Parts

In the chemicals and food industry, mixing processes for liquids or gases have adopted superior anti-corrosive monolithic ceramic parts with internal flow channels to prevent the mixture of impurities.

3 High Value-Added Products and Technologies

Joining Combinations of Metal, Resin, and Ceramics


Bolted Joint

Fix ceramics and metal with bolts and screws. Allowing metal to absorb a certain amount of impact helps to overcome some of the drawbacks of ceramics that can be vulnerable to impact and easily chipped.


Shrink-fitting

A heated metal is fitted on the outer circumference of the ceramics and compressive stress applied to the ceramics due to shrinkage during metal solidification, which improves the strength of the ceramics. This is effective for ceramic pipes that are subject to internal pressure.


Metal molding

Fused metal (aluminum or zinc) is poured around ceramics with high heat shock resistance, such as silicon nitride, and the strength of the ceramics is improved by the compressive stress due to shrinkage during metal solidification. One example is use in the rocker arm of an engine.


Resin molding

This method is to place ceramics into a mold and then pour resin to harden. It is effective when the characteristics of ceramics and resin are required in different portion. It is also used to reduce overall weight.


Organic adhesive

Joining method by epoxy resin or ceramic adhesive. It is for the purpose such as joining non-penetrating holes with inserts. The usage of this method is restricted due to low heat resistance and outgasses of organic components.


Inorganic joining

Since it uses an inorganic substance as a joining material, it has excellent heat resistance and it is anti-outgassing. It is often used in a clean environment, such as semiconductor manufacturing processes.

Related Sites

Ceramic-to-Metal Bonding Technology

A method of firmly joining ceramics and metals.

Molybdenum-Manganese Process

It is a joining method that enables strong and high hermeticity. A metal paste is applied to ceramics and baked to form a diffusion layer of metal and ceramics.

The metal and ceramics are then joined by plating with metal and brazing the metal fittings. This method is often used for ultra high vacuum hermetic parts.

Active Metal Bonding Method

As the name suggests, a reaction bonding layer is formed on the surface by baking at high temperature using active metals such as titanium or platinum. The metal is joined by plating and brazing to form the final product. An appropriate joining method will be selected according to the desired heat resistant temperature and operating environment conditions.

Nickel Paste Process

A method to form an integrated metal film of Ni by baking a paste. Placing the nickel paste to surround the outside of the ceramics allows the heat-shrunk metal layer to bond more tightly, and so this method is often used for rod-shaped products.

Diffusion Bonding

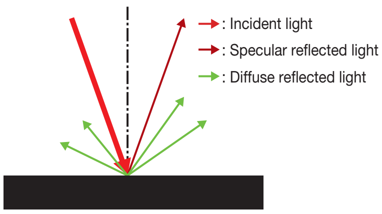
A method to firmly bond ceramics of the same material or different materials. Although there are restrictions on the possible shapes, the bonding surface is directly bonded by forming a diffusion layer, creating the highest-possible bonding strength. The characteristics of both ceramics are also not impaired, making this the most chemically stable bonding method. Directly bonded sapphire and ceramic parts are used for the optical sensor components in analytical equipment.

Related Sites

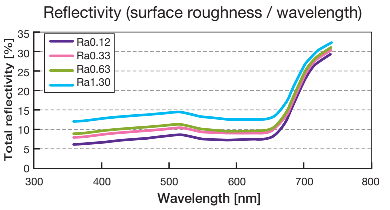
Material High Value-Added Materials

Low Light Reflectivity Material (AO201B)

Generally, high-purity alumina has a white color, but it is possible to make it a different color by adding sub-compositions that serve as pigments. AO201B, which is low light reflectivity alumina, has a black color. The total reflectivity is less than 15% (measured by our company) in the wavelength region of 630 nm or less. Taking advantage of this, it is widely used for the purpose to reduce the influence of reflection from ceramic parts in processes that use light.

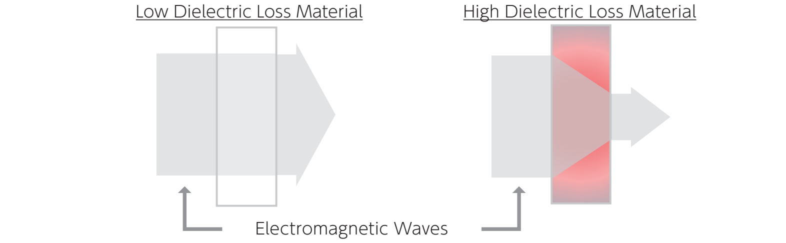


Total reflectivity = specular reflectivity + diffuse reflectivity



Low Dielectric Loss Material (AO479U)

High strength alumina material that exhibits low dielectric loss tangent characteristics over a wide frequency range. For equipment that uses high frequencies, such as plasma etching, this material makes it possible to reduce the energy loss due to heat generation and the variations among equipment.



When passing through a substance, some electromagnetic waves are converted into heat and energy loss occurs.

High Temperature and High Strength Materials (SN282A/SN287A)

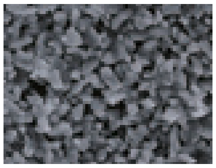
SN282A was developed as a material for parts for high-temperature combustors such as gas turbines. It is a material with high strength of 500 MPa to 600 MPa even in the temperature range of 1200 ~ 1400 degrees Celsius where many silicon nitride materials lose strength.

SN287A is a derivative of SN 282 A, and is used in high-power gyrotrons and other components for RF windows because it combines low dielectric loss, high thermal conductivity, and high strength properties and can be used in the high-frequency band (GHz band) where heat is generated by dielectric loss during high-frequency transmission.

Low Friction and Abrasion Resistant Materials (SC121P)

A silicon carbide material developed to improve low friction and wear resistance, used as sealing component for automotive water pumps. The lifespan of an automobile is said to be 10 years or 150,000 km. Water pump seal parts are required to have high sealing performance that does not leak liquid while also offering low friction and solid wear resistance. This is why there has been progress in the replacement of rubber materials such as o-rings with Fine Ceramics. Silicon carbide is also becoming the mainstream for ceramic materials as higher properties become required. It is also expected to be used in motor cooling parts for EVs (electric vehicles).

Porous Materials (Porous Ceramics)



Porous ceramics are materials that have pores inside their crystals. The porosity and pore diameter can be controlled according to desired specifications. In addition to the excellent material properties of ceramics, they have the function of allowing liquids and gases to pass through them. They are applied to such items as functional membrane supports, water & moisture absorption parts, and fuel cell parts.

New Subsidiary Companies of the Kyocera Group

KYOCERA Fineceramics Europe GmbH Mannheim Plant

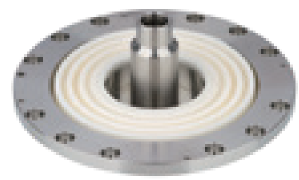
Established in 1863, a German ceramics manufacturer that has been a member of Kyocera since 2019.

It mainly produces oxide ceramics, and has expertise in high production technologies for long products, medium-sized complex shape products, and metallized products.

High Temperature Process Materials

Maintains high dimensional accuracy even in harsh temperature environments above 1500°C. It is used in the metal and glass manufacturing and chemical manufacturing industries. Standard products such as tubes and rods are also available.

Joining Metal and Ceramics

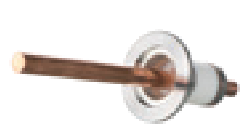


It also has excellent joining technology, and can perform co-sintering of ceramics with Pt electrodes used for sensors.

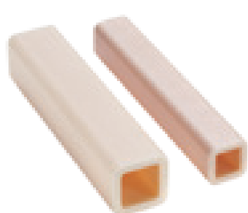
Product Examples

High Dielectric Resistance Applications

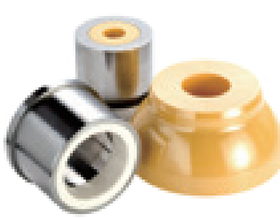
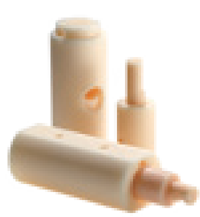





High Temperature Process Applications

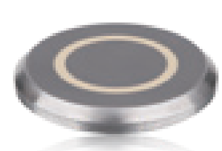
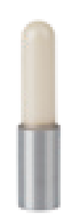



Abrasion Resistant Application

Sensor Applications



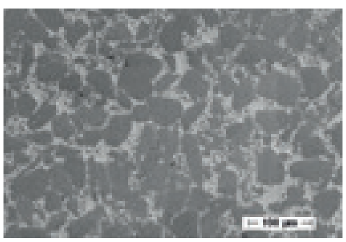
KYOCERA Fineceramics Europe GmbH Selb Plant

Established in 1985, a German ceramics manufacturer that has been a member of Kyocera since 2019.

It mainly produces non-oxide ceramics, having expertise in large-scale products using SiSiC materials.

Silicon Impregnated Reactive Sintered Silicon Carbide, SiSiC

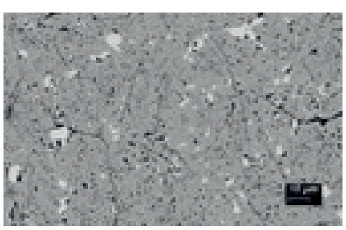
SiSiC is a silicon infiltrated composite material based on silicon carbide. It is a high specific rigidity material with similar characteristics to silicon carbide, and has lower electrical resistance than silicon carbide, making it possible to eliminate static electricity from parts. Also, due to the infiltration of silicon, there are less pores and outgassing is suppressed. Its unique manufacturing method and reactive sintering bonding facilitate the production of large, complex-shaped parts or hollow structures, and are widely used such in semiconductor processing equipment.



Density		g/cm^3	3.05
Vickers Hardness HV9.807N		GPa	22
Flexural Strength 3 P.B.		MPa	350
Young's Modulus of Elasticity		GPa	380
Thermal Conductivity 20°C		W/mK	185
C.T.E. Coefficient of linear Thermal Expansion	40-400°C	$\times 10^{-6} K^{-1}$	3.5
	40-800°C		4.2

Aluminum Titanate

Aluminum titanate is a material characterized by low coefficient of linear thermal expansion and low thermal conductivity.
It is suitable for aluminum casting parts due to its excellent heat shock resistance and heat insulation, and its low wettability against molten aluminum.



Density		g/cm^3	3.4
Vickers Hardness HV9.807N		GPa	3.2
Flexural Strength 3 P.B.		MPa	30
Young's Modulus of Elasticity		GPa	30
Thermal Conductivity 20°C		W/mK	2
C.T.E. Coefficient of linear Thermal Expansion	40-400°C	$\times 10^{-6} K^{-1}$	0.0
	40-800°C		0.7

Product Examples

Semiconductor Manufacturing Equipment Parts



Aluminum Cast Parts



Industrial Machine Parts


R&D that Continues to Reshape the Future

Kyocera promotes open innovation that creates new value through interaction between people.

Primary R&D facilities

Minatomirai Research Center
(Yokohama City, Kanagawa)

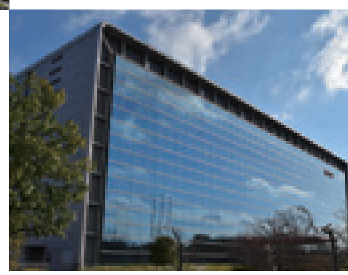
We are conducting research and development of systems related to the automobile, information and communication, and energy markets.

Kirishima R&D Center
(Kirishima City, Kagoshima)

We are conducting research and development on the basics and applied t e chnologie s o f Fine Ceramics and manufacturing with an eye to future applications.

Keihanna Research Center
(Soraku-gun, Kyoto)

Utilizing material and thin film technologies, we are conducting basic research and application development of materials, parts, and devices.



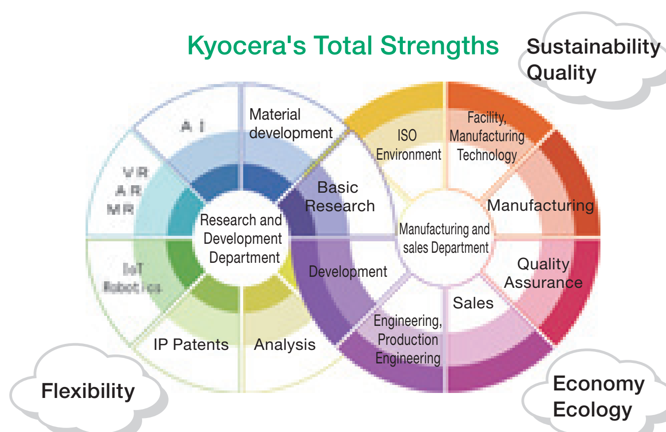
Inside Yasu Plant Production technology development
(Yasu City, Shiga)

We are developing production processes that utilize advanced technologies such as AI and robots, and research and development related to medical care and energy.

With Minatomirai and Keihanna as the core research and development bases, we are trying to organically integrate resources within the group, and also to promote open innovation that utilizes collaboration with outside parties, so that we support Kyocera's wide range of businesses by thorough basic research and process development, as well as engage in truly creative research activities, such as the space industry and advanced technology research corresponding to ADAS. Furthermore, we are actively engaged in joint research with industry, government, and academia.

An era of constant change.
Innovation unbound by common sense is continually required.

At Kyocera, R&D, which continues future oriented challenges in various fields, and each business division where engineering, production, quality assurance and sales optimally respond to market and customer needs, jointly responding to difficult challenges flexibly from materials to finished products. In addition, we are pursuing reliable product manufacturing by high technology and strict quality control.



"What we like to do next is what people tell us we can never do."

Kazuo Inamori

Kyocera wants to continue to be a pioneer, willing to forge paths that others have not or cannot take.
Continuing the legacy of our founder Kazuo Inamori, we will master unique manufacturing, always create new value at the cutting edge, and continue to try and bring a brighter future to people and society.

Problem Solving Through Analysis

An in-house structure with abundant experience and reliable analytical capabilities supports Kyocera's manufacturing.

Analysis professionals with many years of experience and data are taking a leading role in finding solutions to create innovative materials and devices, and continuously supply high quality products. The Kyocera Analysis Center was founded in 1982.
Currently, there are 5 sites in Japan, "Gamo, Shiga" "Yasu, Shiga" "Keihanna, Kyoto" "Kokubu, Kagoshima" and "Sendai, Kagoshima".

Advantages of Kyocera's In-House Analysis Center / CAT Center:

1. Speedy problem solving

The ability to provide objective and reproducible data with short delivery times under a quality control system that complies with ISO9001.

2. Analytical engineers who are well familiar with the product

Based on the analysis experience of Kyocera products and the data cultivated over many years, we can work on solutions using the optimal process.

3. Addressing long-term issues

We may face difficult issues that would take a long time to solve, but we are able to address continuously with like-minded colleagues.

4.Confidentiality

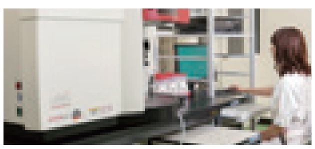
■106 analytical test items (as of May 2022)

The analysis items range from structural analysis and morphological observation to reliability tests, with 106 items. In the analysis of ceramics, each analysis item specialist analyzes using XRD, TEM, SEM and ICP-OES. We are also developing new analytical methods.

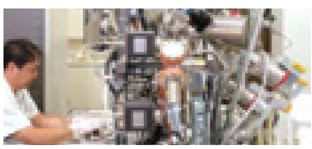
— Major cases —

Structural analysis

Morphological observation



Inorganic analysis



Surface analysis

Reliability testing

Non-destructive test

■Number of annual analysis requests

Approximately 45,000

(actual results from April 2021 to March 2022)

Based on product information, we will discuss analysis item proposals and the expected mechanisms for analysis data. We will promptly respond to customer concerns and requests, such as the kind of analysis to perform and how to interpret the resulting data.

■Capital investment:

over 2.8 billion yen

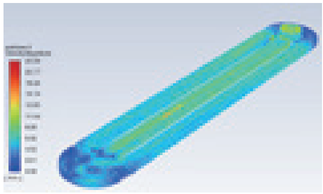
(For the past 5 years from April 2017 to March 2022)

We are actively promoting the introduction of the latest analytical equipment in order to respond to the diversification of requests as manufacturing evolves. It is not uncommon for a single piece of equipment to cost more than 100 million yen.

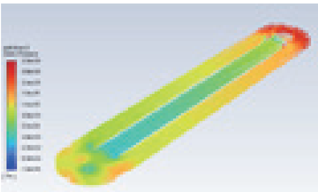
■Analysis by the Kyocera CAT Center

The Kyocera CAT Center has been conducting analysis by simulation since the 1980s. We are constantly challenging new technologies such as principle simulation, inorganic and organic connection simulation, which are necessary for complete manufacturing understanding.

Velocity vector diagram



Pressure vector diagram



KYOCERA Corporation

Corporate Fine Ceramics Group

https://global.kyocera.com/prdct/fc/

Kyocera Fine Ceramics

Product Inquiries→

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Application and the using conditions are required to be consulted when considering to purchase.

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