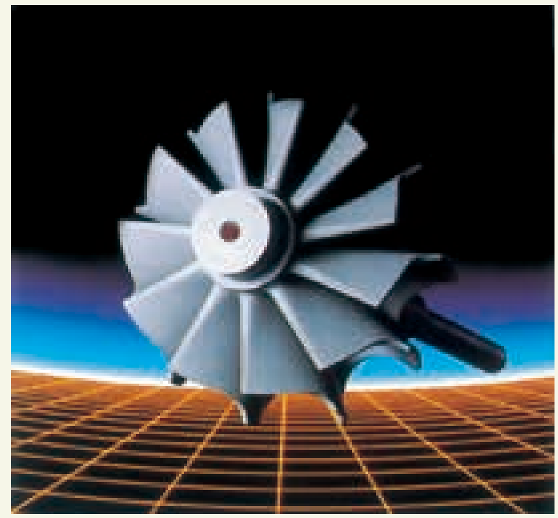
THE NEW VALUE FRONTIER

KYOCERA



MECHANICAL & INDUSTRIAL CERAMICS

KYOCERA ENGINEERING CERAMICS

Today, at the dawn of the 21st century, materials are continually being developed and improved, blending a wide spectrum of technologies. The most exciting evolution of all materials, however, is occurring in engineering ceramics.

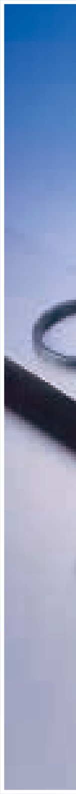
In Kyocera's advanced manufacturing of fine ceramics, it is possible to bring forth ceramics maximum performance.

Kyocera's fine ceramic products are widely used in industrial machines and electronic equipment and devices. The superior electrical characteristics of fine ceramics are utilized in a variety of circuit boards and electronic parts. Their wear and corrosion resistance is beneficial in pumps, nozzles and valve parts, and their high heat and thermal shock resistance is useful in ceramic engine parts.

Based on its advanced ceramics technology, Kyocera put into practical use its ultra-precision processing technology in the manufacturing of OA equipment parts and fiber optic connectors where high precision is required. The applications of fine ceramics continue to expand, from single to multiconponent products such as air slides and X-Y tables.

Kyocera, with its highly sophisticated technology and expanding capacity, is determined to disseminate fine ceramics into every corner of industry. It is dedicated to enhancing human productivity, cultivating the future of tomorrow's technological society.

Silicon Nitride



Sili

Alumina

Zirconia

con Carbide

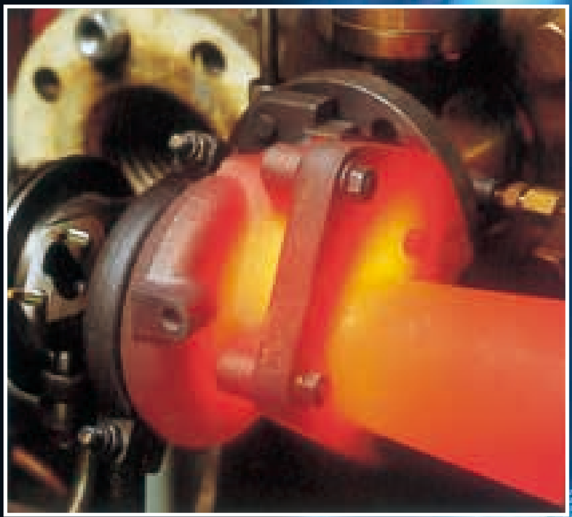
UNRIVALED R&D

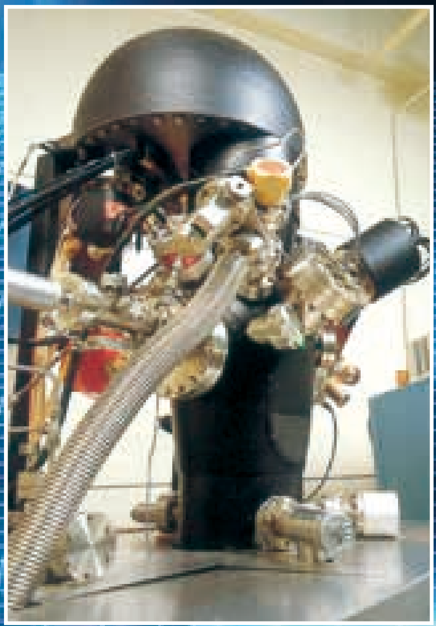
In today's information society, marketing research and technical development capacities hold the key to the future of an enterprise. In order to accurately meet client needs, Kyocera established an integral R&D organization. Performing stringent quality control over every detail of the manufacturing process.

In developing new products, Kyocera's R&D operations are centralized in the General Research Institute. They conduct thorough studies to continually enhance and develop materials and manufacturing techniques. The engineering and business divisions perform commercialization, repeating product reliability tests until complete confidence is reached.

Under supervisors with a strong sense of responsibility, everyone, from development to manufacturing, conducts thorough product control, so that highly reliable, high performance products will be delivered.

Using the best combination of materials and technologies available, Kyocera promotes flexibility to meet the diversified industry needs with is ultimate goal to produce superior products.





ASSEMBLY PRODUCTS

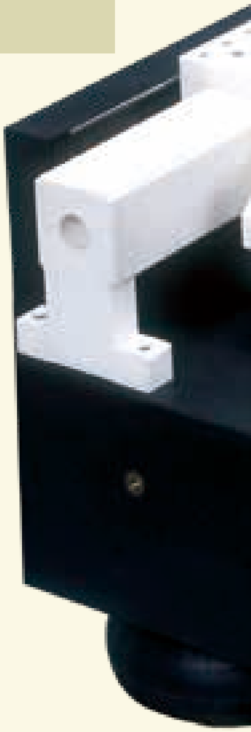
AUTOMOTIVE PARTS

●Gas turbine parts

The gas turbine, clean in energy consumption and superior in thermal efficiency is being heralded as the leading engine for the 21st century. The development and commercialization of engineering ceramics, which can withstand severe conditions such as high temperatures and heavy loads, holds the key to the success of the gas turbine engine.

●Engine parts

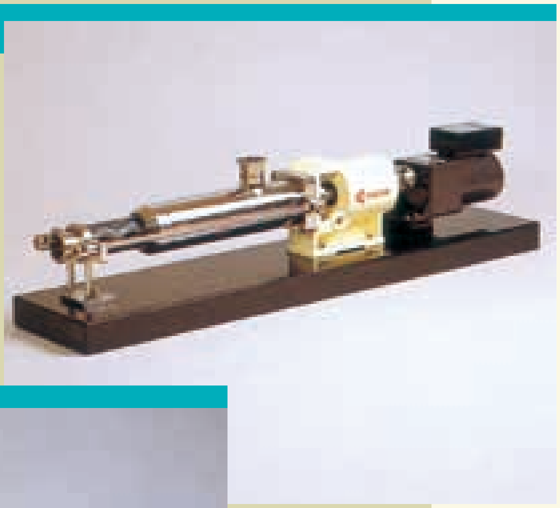
Triggered by the commercialization of the ceramic glow plug, the application of ceramics to engine parts has increased due to ceramics superior heat resistance and high temperature strength.



PUMP PRODUCTS

●Progressive cavity pump

The pump's rotor and stator consist of wear and heat resistant ceramics in order to transport high temperature liquids, slurry fluids and foods.



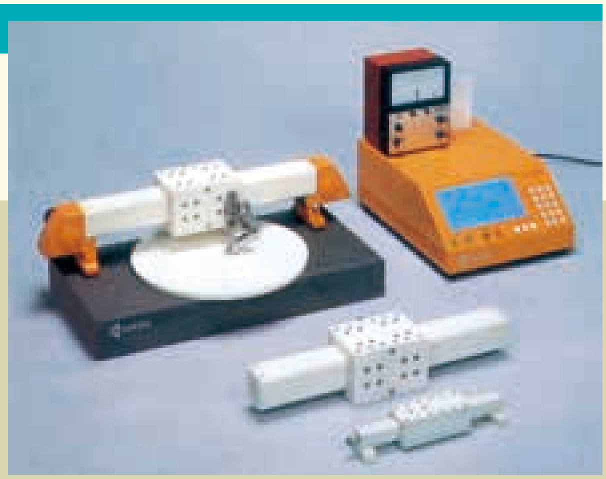
●Ceramic centrifugal pump

In this type of pump, all liquid-contact parts are made of 99.5% pure alumina, which is best suited for the transportation of chemical liquids, orgainc solvents and slurry fluids.

PRECISION UNIT PRODUCTS

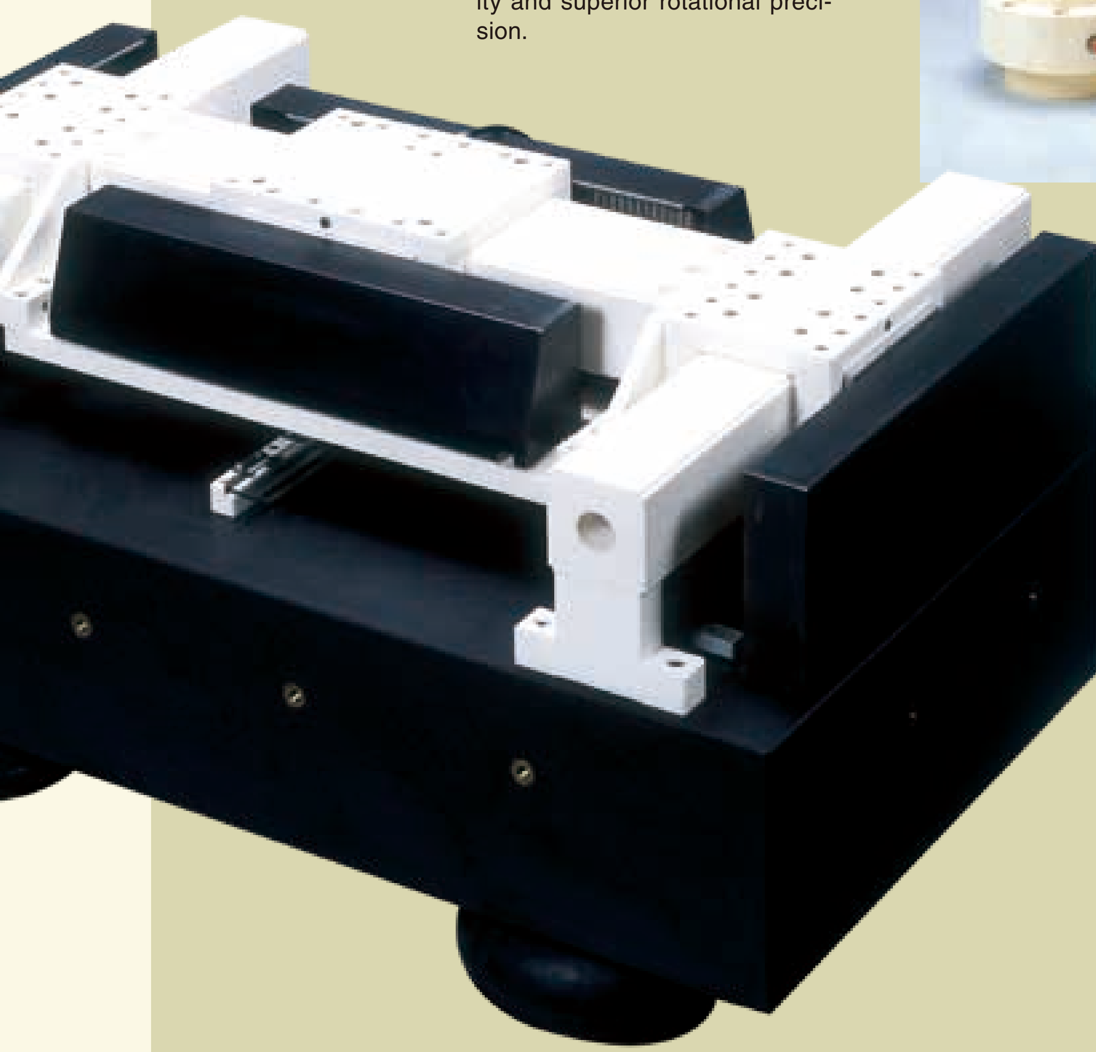
●Air slide

Air slides, for X-Y tables and measuring units, are manufactured using Kyocera's advanced processing technology, creating unprecedented high precision and reliability.



●Air spindle

In the high-tech industry, there is a demand for light-weight air spindles Kyocera's ceramic air spindles are used in rotary tables or, coupled with a motor to form turning units. These applications benefit from ceramics high rigidity and superior rotational precision.



●X-Y table

X-Y tables benefit from the ceramic air slides high precision, simple maintenance and non-magnetism. X-Y tables are used in semiconductor manufacturing equipment, precision measuring instruments, and high precision processing machines.

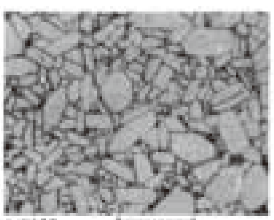
CERAMIC PRODUCTS

TYPES OF CERAMICS

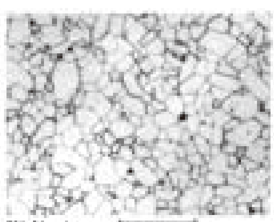
With sintered alumina as a base, many other types of ceramic materials have been developed. These fine ceramics are classified according to their use, specifically functional materials (electroceramics) and structural materials (engineering ceramics). As the pioneer in the fine ceramics materials revolution, Kyocera continually develops and provides the most advanced ceramics.

■ALUMINA CERAMICS (Al_2O_3)

Alumina is the most widely used type of ceramic. Its high dielectric properties are beneficial in electrical products, Alumina offers corrosion and wear resistance and high strength. It is widely used for industrial machine parts.



A479SS 25 μm



3N Alumina 25 μm

■SILICON NITRIDE CERAMICS (Si_3N_4)

Silicon nitride exceeds other ceramics in thermal shock resistance. Its strength does not deteriorate at elevated temperatures, hence it is most appropriate for engine and gas turbine parts, including turbo charger rotors, diesel engine glow plugs and hot plugs.

SN220 5 μm

■MULLITE CERAMICS ($3Al_2O_3$, $2SiO_2$)

Mullite has a low thermal expansion coefficient and is used in parts requiring heat and thermal shock resistance, such as burner nozzles and tiles.

■TITANIA CERAMICS

Titania excels in surface smoothness and wear resistance. By the addition of CaO or BaO titania, the materials conductivity allows it to be used in static free applications such as guides and sliders.

■CERMET (TiC, TiN)

By the addition of metal components such as cobalt, nickel, or molybdenum, composite ceramics knows as cermets are formulated.

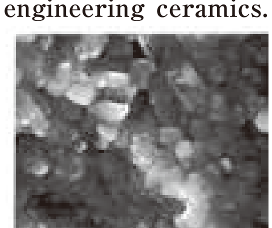
■SILICON CARBIDE CERAMIC (SiC)

Silicon carbide retains its strength at elevated temperatures as high as 1400℃. It has the highest corrosion resistance of all fine ceramic materials. Applications include mechanical seals and pump parts.

SC211 5 μm

■ZIRCONIA CERAMICS (ZrO_2)

Zirconia ceramic has the highest strength and toughness at room temperature of all engineering ceramics. Before zirconia, ceramics were considered impractical for scissor or knife applications. With its excellent surface smoothness, zirconia is also used for pump parts.



Z201N 1 μm

■CORDIERITE CERAMICS (2MgO, $2Al_2O_3$, $5SiO_2$)

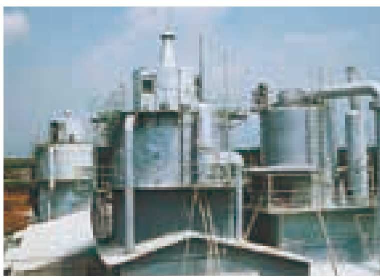
Cordierite features a very low thermal expansion coefficient.

MANUFACTURING PROCESS

■RAW MATERIAL MILLING AND MIXING

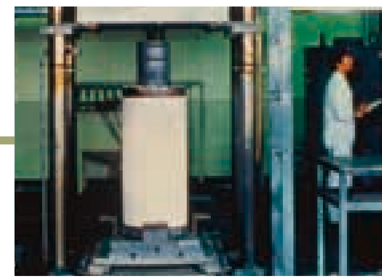
■ISOSTATIC PRESSING

■MACHINING



■SPRAY DRYING

■DRY PRESSING



■HOT PRESSING

RAW MATERIAL

FORMING

SINTERING

■EXTRUSION

■SINTERING

CASTING

■INJECTION MOLDING

■SINTERING

■GRINDING AND LAPPING

GRINDING AND BONDING

INSPECTION

PRODUCT

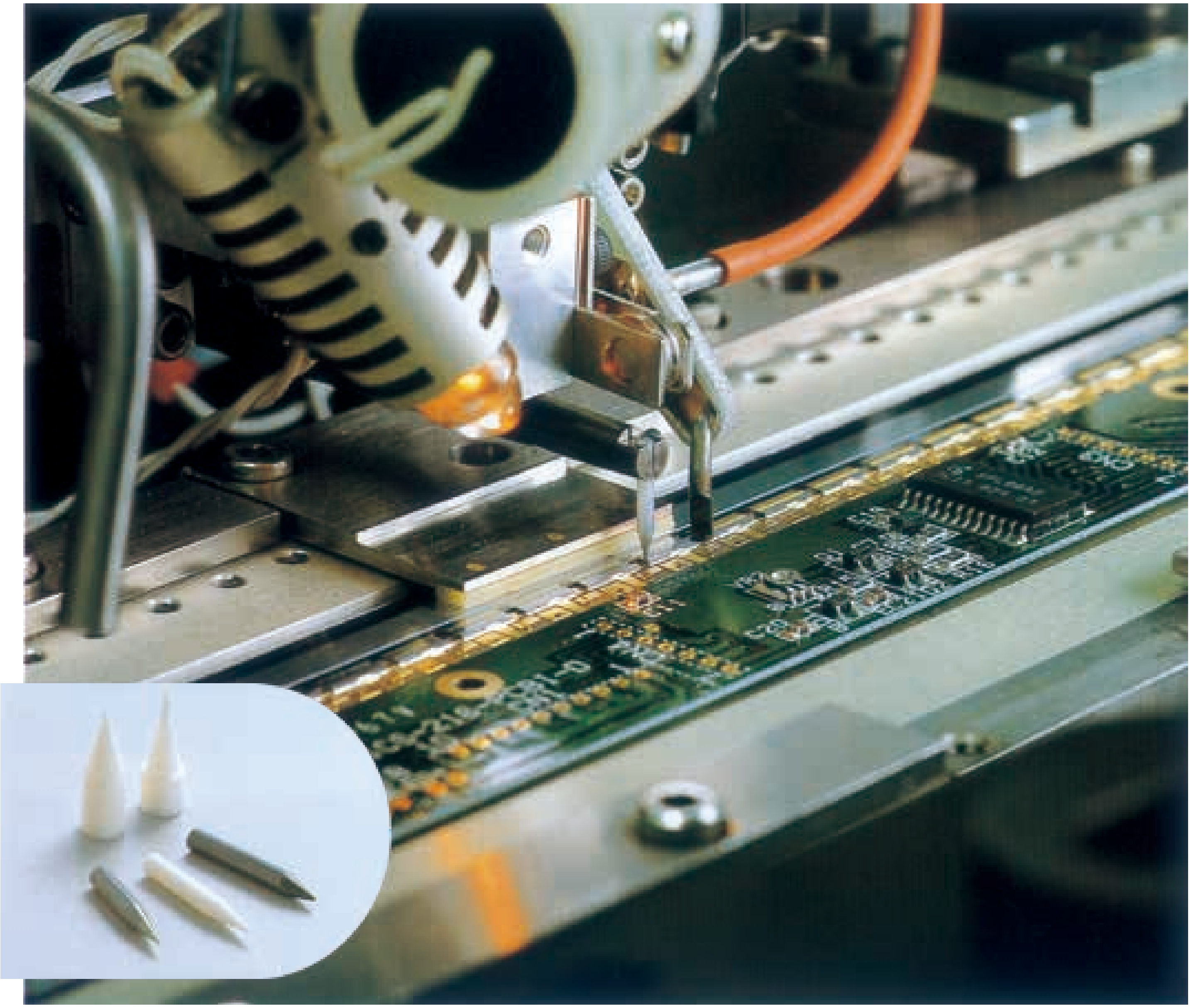
■METALLZING

■HIP (HOT ISOSTATIC PRESSING)

■BONDING

■INSPECTION

PRECISION MACHINED PRODUCTS



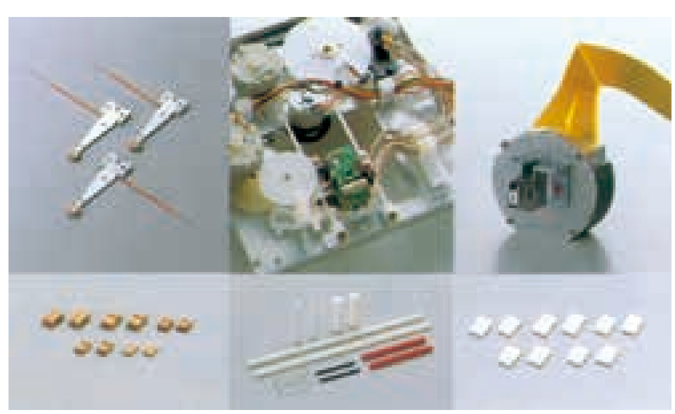
Wire bonding using ceramic capillaries.

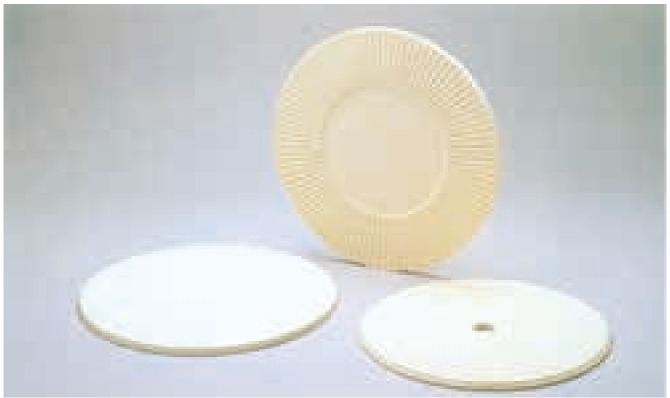
OA equipment parts

As computers increase in memory capacity, floppy and hard disk drives use ceramic sliders that possess superior characteristics and high precision.

With the size reduction and sophistication of OA equipment, ceramic shafts, lighter in weight and with increased wear resistance and precision, are quickly replacing metal shafts.

In meeting the need for greater speed and higher density dot matrix printers, precision ceramic wire guides are used.





Wafer polishers

Ceramic plates are used to mount and adhere wafers during finishing to enhance flatness and other surface conditions. Ceramics are also used for the dressing plate.

Semiconductor processing machine jigs

Superior in chemical, heat and wear resistance, ceramics are used in semiconductor processing machines such as CVD equipment, etching machines and light exposers, to hold, transport and heat-treat wafers.

Measuring instrument parts

Ceramics are widely used in measuring instruments for their structual and non-corrosive properties. Their hardness prevents gouging, bulging and burring along with consistent precision measurements.

Fiber optic connectors

Ceramic parts, such as ferrules and sleeves, finished to ultra-precision are used in connectors requiring sub-micron precision.

CORROSION AND WEAR RESISTANT PARTS

All fine ceramic centrifugal pump used in chemical plants.

Pump and valve parts

Ceramics are used in pump plungers, magnetic pump shafts and sleeves for superior wear resistance. In ball and faucet valves, ceramics are used to provide excellent sealing quality and wear resistance.

Medical equipment and chemical analyzer parts

The chemical stability of ceramics permits their application to the artificial kidney pump. Free from corrosion and superior in cleaning properties, ceramic materials are also used in blood valves.

Nozzles

Scrubber nozzles require ceramics excellent chemical and wear resistance. In cleaning nozzles, through which water flows at a high rate, wear resistance is essential ceramics superior heat resistance is utilized in welder and burner nozzles.

Grinding mill parts

Benefiting from high wear resistance, grinding mills use ceramics for their liners, agitator screws and rollers. Ball mill balls are manufactured from the same materials being milled.

Food machine parts

The inherent cleanliness and simple cleaning procedures of ceramics are greatly appreciated in kneading rollers, and in parts for filling machines such as valves and pumps.

Ceramic parts used for paper processing machinery.

Papermaking parts

Ceramics, superior in wear resistance, are used in cleaner cones separating foreign matter from pulp slurry.

Molten metal processing parts

Wire drawing machine parts

To benefit from ceramics wear resistance and light weight, wire drawing machine parts use ceramics in capstan rollers and wire guide rollers.

Thread guides

Ceramic is used in guide parts for thread processing and oiling nozzles, rollers and twining parts because of its high wear resistance, very low susceptibility to damage by high-speed running of thread, and low friction coefficient.

WEAR AND HEAT RESISTANT PARTS

Cutters

Of all ceramic materials, zirconia exceeds in strength, toughness and wear resistance, and is used in industrial cutters and slitters to process fiber, paper, film and similar materials. Cermet, which can be brazed and electric charge-processed, is used in cutters and wear resistant precision parts, in combination with metal.

Physiochemical equipment parts

Superior chemical and heat resistance with no outgasing at high temperatures allow high purity alumina ceramics to be used in analytical equipment.

Ceramic heaters

Alumina heaters, are manufactured by printing resistors on alumina sheets, then laminating and sintering them into one piece. Silicon nitride heaters are manufactured by printing resistors on silicon nitride or embedding them therein. Ceramic heaters find use in a wide range of industrial fields.

Living and household appliances

Less subject to rust and more wear resistant than conventional metal, ceramics are used for knives, golf and baseball spikes, clock casings and many other sport and recreational appliances.

KYOCERA

PRECISION SHAPING AND MACHINING

With Kyocera's unique ceramic precision machining technology, formed material is cut, ground and lapped after sintering to required shapes.

These products are used for their unrivaled performance in OA sliding parts as general structural members, precision jigs and tools, in wear and chemical resistant sliding parts and also in electromagnetic fields and chemical solutions.

Dimensional precision achieved by machining

When dimensional precision is required for machined ceramics, Kyocera is capable of achieving the tolerances as shown in the table below. If greater tolerances are required, please consult us.

■MACHINING DIMENSIONAL PRECISION

(Data are in mm unless otherwise specified)

1 Ground ceramic blocks and plates

Tolerance / Dimension / Parameter	Standard Tolerance	
	ϕ (□) 5～ ϕ (□) 30	ϕ (□) Over 30
Parallelism	0.02	0.05
Flatness	0.01	0.03
Surface Roughness	1.5 μ Ra	1.5 μ Ra
Mirror Polishing	0.2 μ Ra	

2 Round and Square Bars

ϕ 100 (□100) × 100 ℓ

Tolerance / Parameter	Standard Tolerance
Roundness	0.01
Perpendicularity	0.01 (30′)
Straightness	0.05/100
Surface Roughness	1.5 μ Ra

■PRECISION MACHINED PRODUCTS

Ultra-precision is possible with Kyocera's unique techniques. Precision machining is affected by shape and material. Some practical examples are shown in the table below.

Parameter / Example of Machining	Dimensions	Material	Dimensional Tolerance (μm)	Roundness (μm)	Perpendicularity Straightness (μm)	Surface Roughness (μPa)
Inner Diameter	ϕ 6xL20	AO479S	±3	0.3	0.3	0.2
	ϕ 30xL20	AO479O	±3	0.3	0.3	0.3
Outer Diameter	ϕ 4xL20	AO479O	±1	0.3	0.3	0.3
	ϕ 40xL30	AO479S	±1	0.3	0.3	0.3
Plate	ϕ 40xT5	AO479S	±1	Parallelish 1	Parallelish 1	0.2
	ϕ 100xT5	AO479O	±1	Parallelish 0.3	Parallelish 1	0.1

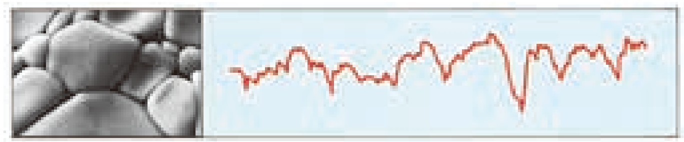
＊ Surface roughness depends on the material. The data shown hear indicates where alumina is used.

Surface Characteristics

Kyocera's comprehensive technology, from material control to forming and sintering allows its fine ceramic products excellent surface smoothness and flatness.

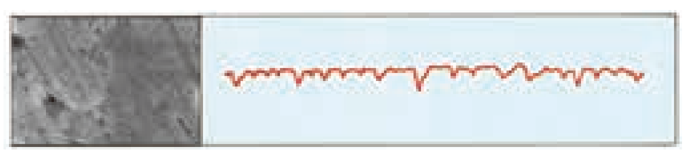
■SURFACE ROUGHNESS (ALUMINA)

1 As fired (3 μ Ra)



2 Ground (1 μ Ra)

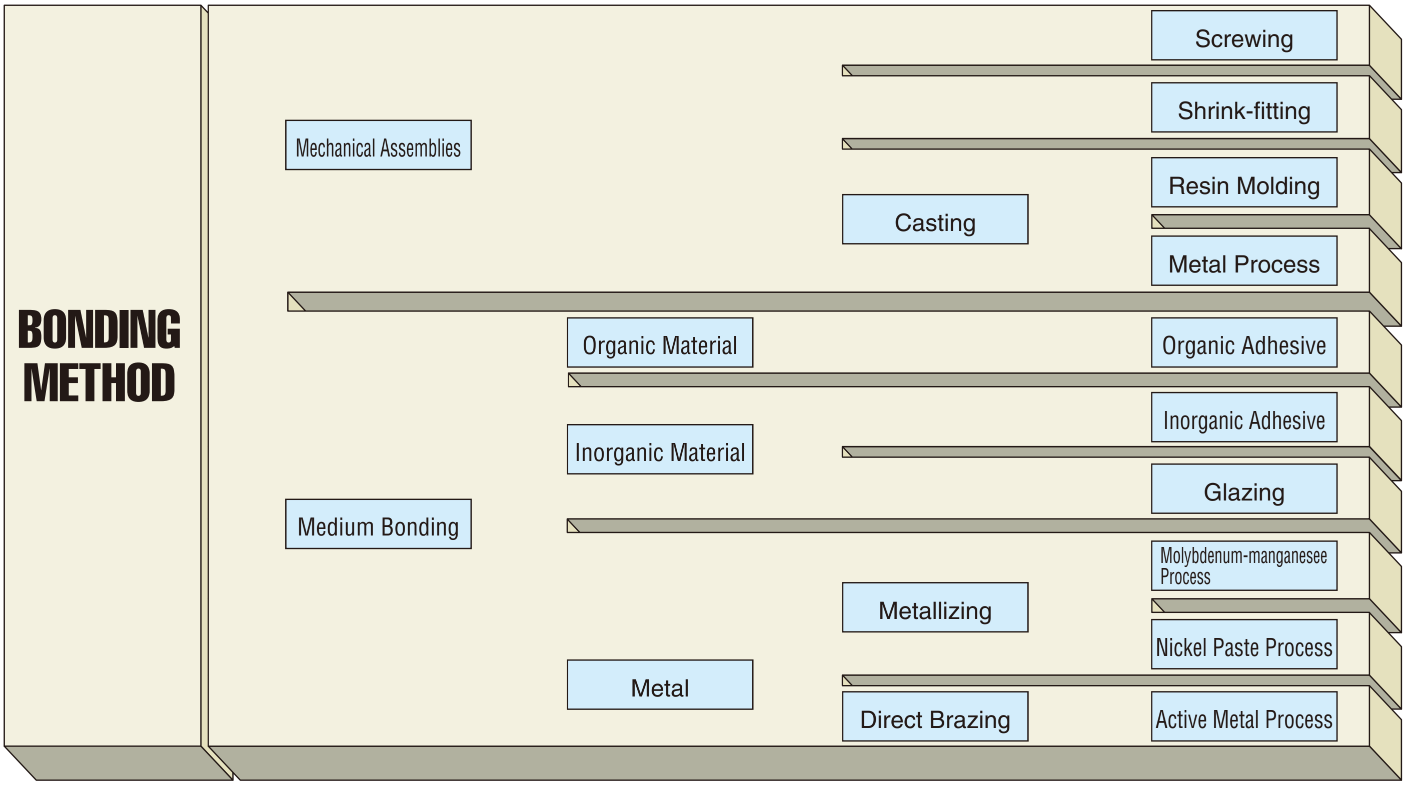
3 Lapped (0.4 μ Ra)



4 Polished (0.2 μ Ra or less)

■ROUNDNESS MEASUREMENT

JOINING CERAMICS TO OTHER MATERIALS



Screwing

Used for junctions subject to strong impact such as in machine mechanisms.

Shrink-fitting

Based on the higher compression resistance and lower thermal expansion of ceramics, it is used to reinforce ceramic pipes subject to internal pressure.

Resin molding

Ceramic parts are inserted and formed into desired shapes.
Simple design is possible.

Metal casting

The thermal shock resistance of silicon carbide is beneficial in metal casting Molten metal (aluminum and zinc) is cast around ceramic material, then formed.

Organic adhesive

Used to bond ceramics and various materials. The method is simple and is applied to parts at room temperature.

Glazing

Used when special reliability, such as straightness, is required for junctions or when external gas must be kept out or the vacum condition.

Molybdenum-manganese process

A typical method used to seal ceramics and metal.
Molybdenum-manganese paste is used as metal film is baked on the ceramics surface. The film formed is bonded to metal by high temperature brazing.

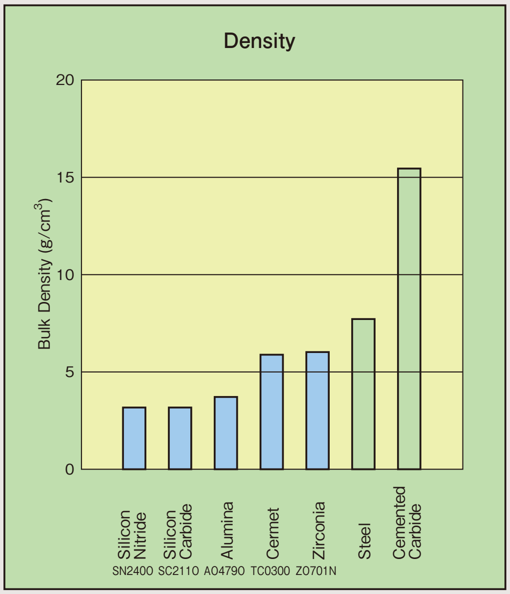
Nickel paste process

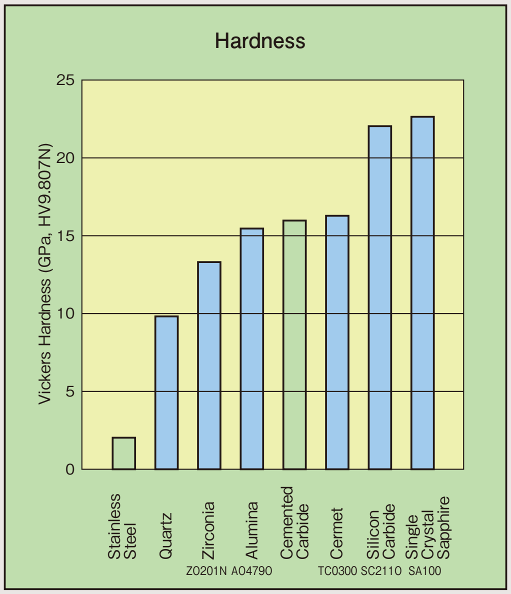
Nickel paste is used as metal film is baked on the ceramics surface.

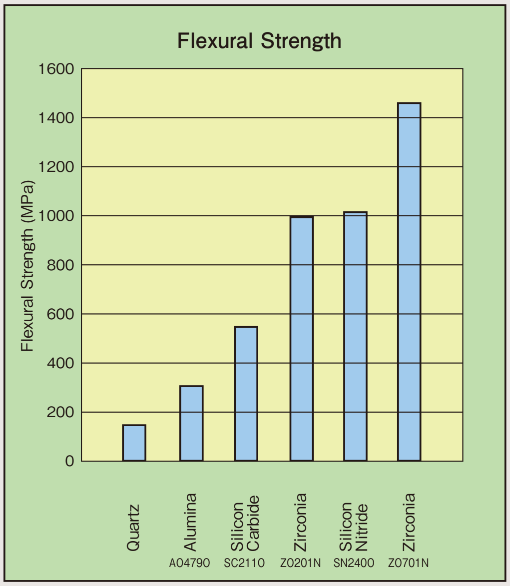
Active metal method

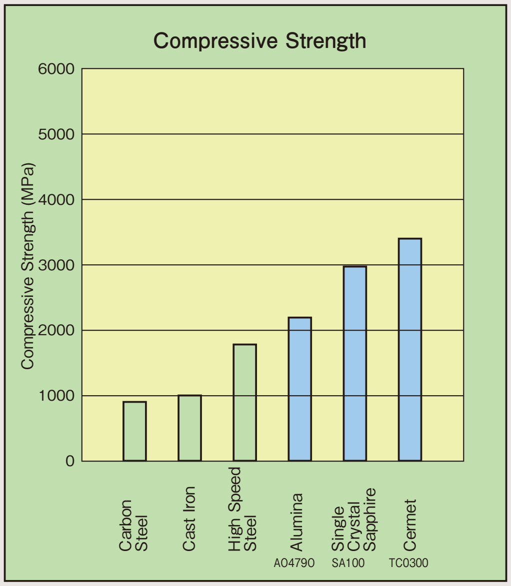
Very active metals, such as titanium, zircon, nickel, copper and silver are inserted between the ceramics and the material to be bonded, then heated in a special atmosphere.

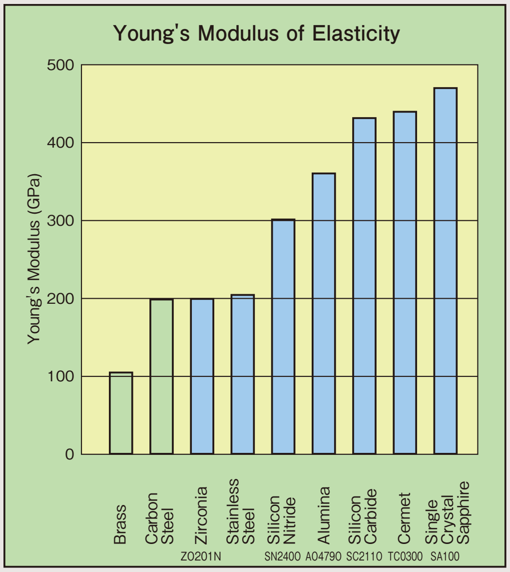
MATERIALS COMPARISON CHART

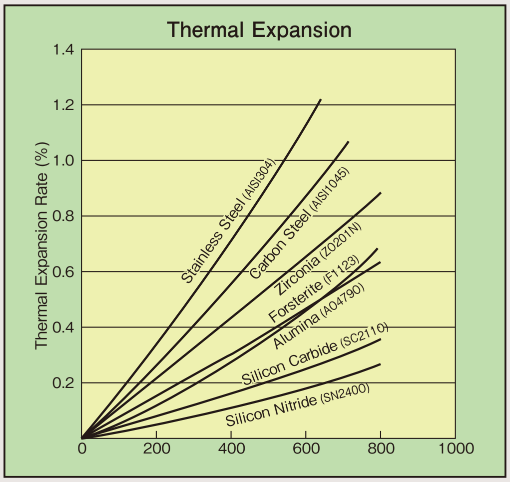


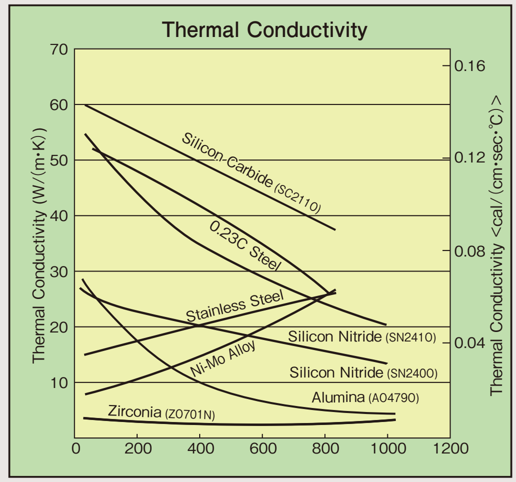


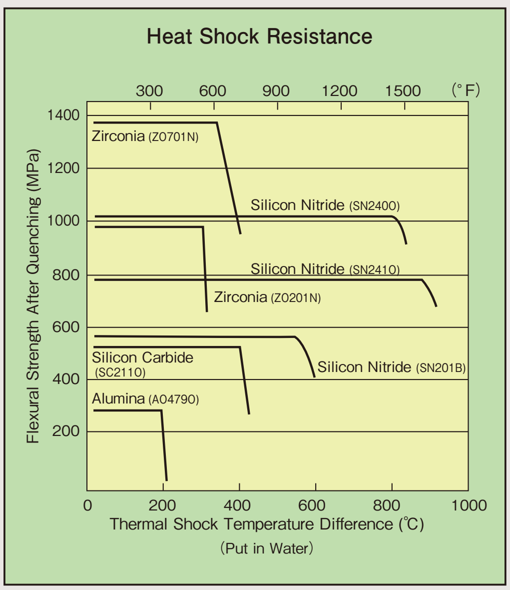


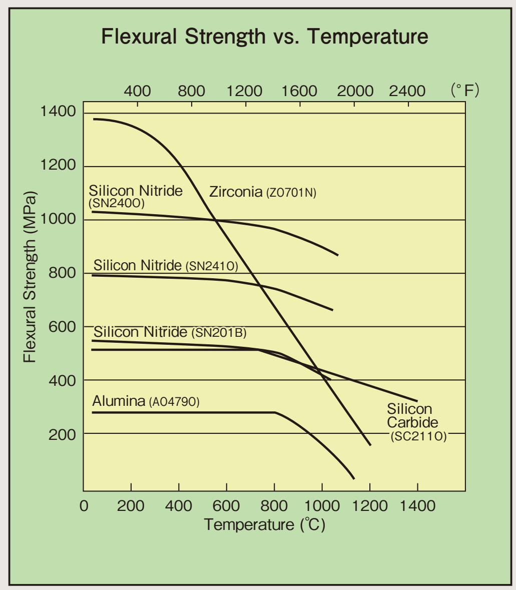


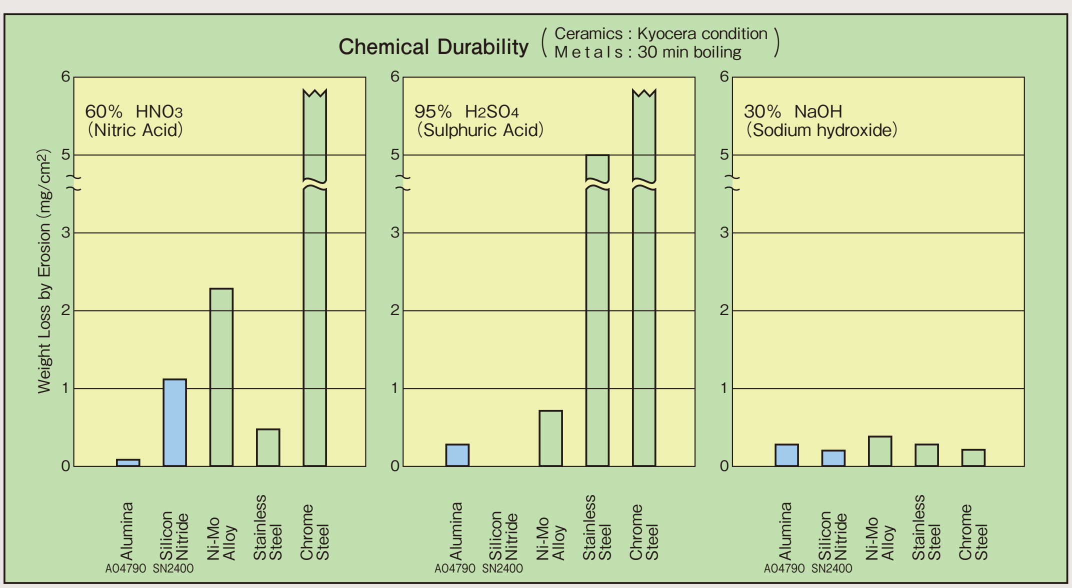












Unit Conversion Table

■Stress

MPa or N/mm^2	kgf/mm^2	psi(=lbf/in^2)
1	1.020×10^{-1}	1.450×10^{2}
9.807	1	1.422×10^{3}
6.895×10^{-3}	7.031×10^{-4}	1

■Thermal Conductivity

W/(m・k)	kcal/(m・h・℃)	cal/(cm・sec・℃)
1	8.600×10^{-1}	2.389×10^{-3}
1.163	1	2.778×10^{-3}
4.186×10^{2}	3.600×10^{2}	1

CHARACTERISTICS

Item		Unit	Standard	ALUMINA (Al_2O_3)							
Material Code (Old)				A482R	A459	A445	A471	A473	A484	A476	A479
Material Code (New)				AO482R	AO459K	AO445O	AO471O	AO473O	AO484O	AO476O	AO479O
Appearance				Porous	Dense						
Color				Pink	Russet	Dark Brown	White	White	White	White	White
Content		(%)		$A\ell_2O_3$ 76	89	90	92	92	92	96	99
Main Characteristics				High Mechanical Strength, High Temperature Resistance, High Frequency Insulati							
				• High Heat Resistance	• Good for Metallizing	• Light Intercepting, • High Heat Dissipation	• Wear Resistant	• Good for Metallizing, • Mechanically Strong	• Wear Resistant	• Good Surface Smoothness	• Hard and Chemically Stable
Main Applications				• Welding Nozzle, • Nozzle for Glass Fiber Manufacturing	• Magnetron	• IC Packages	• Liner • Pulverizer	• IC Multi-Layer Packages, • Electron-tube Housing	• Wire- Drawing Parts, • Capstans, Mechanical Seal Rings	• Hybrid IC Substrates	• Heat, Corrosion and Wear Resistant Parts
Density (＊1)		g/cm^3	JIS R 1634	3.6	3.6	3.8	3.6	3.6	3.6	3.7	3.8
Water Absorption		%	JIS C 2141	0.6	0	0	0	0	0	0	0
Mechanical Characteristics	Vickers Hardness HV9.807N	GPa	JIS R 1610	9.0	12.1	12.7	11.8	12.3	12.3	13.7	15.2
	Flexural Strength 3 P.B.	MPa	JIS R 1601	120	310	320	390	340	370	350	310
	Compressive Strength	MPa	JIS R 1608	–	–	–	–	2,300	–	–	2,160
	Young's Modulus of Elasticity	GPa	JIS R 1602	160	280	320	280	280	280	320	360
	Poisson's Ratio	–	JIS R 1602	0.17	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	Fracture Toughness (SEPB)	$MPa \cdot m^{1/2}$	JIS R 1607	–	–	–	–	–	–	–	3～4
Thermal Characteristics	Coefficient of Linear Thermal Expansion 40 – 400℃	$\times 10^{-6}/K$	JIS R 1618	7.1	7.0	7.3	7.1	6.9	6.8	7.2	7.2
	Coefficient of Linear Thermal Expansion 40 – 800℃	$\times 10^{-6}/K$	JIS R 1618	7.5	7.9	8.1	7.9	7.8	7.7	7.9	8.0
	Thermal Conductivity 20℃	$W/(m \cdot K)$	JIS R 1611	8	14	12	16	18	17	24	29
	Specific Heat Capacity	$J/(g \cdot K)$	JIS R 1611	0.75	0.75	0.75	0.79	0.78	0.78	0.78	0.79
	Thermal Shock Temperature Difference (Put in Water, Relative Method)	℃	JIS R 1648	320	–	–	200	200	200	200	200
Electrical Characteristics	Dielectric Strength	kV/mm	JIS C 2141	12	15	12	16	16	14	15	15
	Volume Resistivity 20℃	$\Omega \cdot cm$	JIS C 2141	$>10^{14}$	$>10^{14}$	10^{11}	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$
	Volume Resistivity 300℃	$\Omega \cdot cm$	JIS C 2141	10^{10}	10^{10}	10^{7}	10^{12}	10^{12}	10^{10}	10^{10}	10^{10}
	Volume Resistivity 500℃	$\Omega \cdot cm$	JIS C 2141	10^{8}	10^{8}	10^{5}	10^{9}	10^{10}	10^{8}	10^{8}	10^{8}
	Dielectric Constant (1MHz)	–	JIS C 2141	8.4	8.8	9.8	8.9	9.0	8.9	9.4	9.9
	Dielectric Loss Angle (1MHz)	$(\times 10^{-4})$	JIS C 2141	180	6	20	6	6	9	4	2
	Loss Factor	$(\times 10^{-4})$	JIS C 2141	1,500	52	190	53	54	80	38	20
Chemical Characteristics	Nitric Acid (60%) 90℃, 24H	(Weight Loss) mg/cm^2	–	–	–	–	–	0.32	0.14	–	0.10
	Sulphuric Acid (95%) 95℃, 24H	(Weight Loss) mg/cm^2	–	–	–	–	–	0.65	0.34	–	0.33
	Sodium Hydroxide (30%) 80℃, 24H	(Weight Loss) mg/cm^2	–	–	–	–	–	0.91	0.95	–	0.26

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 A482R which lists apparent density only.

				SAPPHIRE	CORDIERITE (2MgO・2Al_2O_3・5SiO_2)		STEATITE (MgO・SiO_2)		FORSTERITE (2MgO・SiO_2)	
A479S	A479M A479G	A480S	A601D A601L	SA100	CO220	CO720	S210	S211	F1120	F1023
AO479S	AO479M AO479G	AO480S	AO601D AO601L	SA100	CO220O	CO720O	SO210O	SO211O	F1120O	F1023O
				Dense	Dense	Dense	Dense		Dense	
Ivory	Ivory	Ivory	Ivory	Transparent	Gray	Gray	White	Dark Brown	Light Yellow	
99.5	99.5	99.7	99.9	99.99	–	–	–	–	–	–
on, High Chemical Resistance				Single Crystal	•Very Low Thermal Expansion •Light Weight		•Thermal Insulator	•Good Light Shield	•Good Surface Finish	•High Thermal Expansion
•Hard and Chemically Stable, •Fine Grain Strong and Smooth	•High Chemical Resistance,	•Good Anti-Plasma, •Wear Resistance •High Purity		•High Heat Resistance, •High Chemical Resistance		•Void Less				
•Pump •Shafts	•Wear Resistant Parts •Chemically Ressitant Parts •Semiconductor Processing Equipment Parts			•Thin Film Substrates, •Windows, •Chemically Resistant Parts	•Lithography Stage Component •Wafer Inspection Stage Component •SEM/TEM		•Various Circuit Parts		•Substrate For Resistor •Core For Resistor	
3.9	3.9	3.9	3.9	3.97	2.5	2.5	2.8	3.1	3.0	3.0
0	0	0	0	0	0	0	0	0	0	0
16.0	15.7	17.2	17.5	Surface a 22.5	8	8.5	5.8	6.7	7.3	5.9
360	370	380	400	Surface a Axis c 690	190	200	190	220	180	160
2,350	–	–	–	2,940	–	–	–	–	–	–
370	370	380	380	470	140	145	120	130	150	150
0.23	0.23	0.23	0.23	–	0.31	0.31	0.22	0.22	0.24	0.24
4	–	–	5 ~ 6	–	1 ~ 1.5	1 ~ 1.5	–	–	–	–
7.2	7.2	7.2	7.2	Parallel to Axis c 7.7	1.5 (40℃~400℃) 2.1 (40℃~800℃)	1.5 (40℃~400℃) 2.1 (40℃~800℃)	7.7	9.2	9.7	10.1
8.0	8.0	8.0	8.0	Vertical to Axis c 7.0	<| 0.05 | (23℃) <| 0.02 | (22℃)	<| 0.05 | (23℃) <| 0.02 | (22℃)	8.0	10.4	–	–
32	32	32	34	41	4	4	2	3	5	5
0.78	0.78	0.79	0.78	0.75	0.71	–	0.75	0.72	0.78	0.75
250	–	–	–	–	–	400	–	–	–	–
15	15	15	15	48	19.1	19.3	18	14	17	13
$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$>10^{14}$	$> 10^{14}$	$> 10^{13}$	$> 10^{14}$	$> 10^{14}$
10^{13}	10^{13}	10^{13}	10^{13}	–	10^{12}	10^{12}	10^{10}	10^{9}	10^{13}	10^{9}
10^{10}	10^{10}	10^{10}	10^{10}	10^{11}	10^{10}	10^{10}	10^{7}	10^{7}	10^{10}	10^{9}
9.9	9.9	9.9	9.9	Parallel to Axis c 11.5 Vertical to Axis c 9.3	4.9	4.9	6	8	6.5	6.5
1	1	1	1	< 1	9	8.5	18	750	3	5
10	10	10	10	–	–	–	108	6,000	20	30
0.07	–	0.05	0.03	≒ 0.00	–	–	–	–	–	–
0.25	–	0.22	0.19	≒ 0.00	–	–	–	–	–	–
0.05	–	0.04	0.03	≒ 0.00	–	–	–	–	–	–

$1kgf/mm^2 = 9.807MPa$　　1cal/(cm・sec・℃) = 418.6W/(m・K)

CHARACTERISTICS

Item		Unit	Test Method	YTTRIA (Y_2O_3)	TITANIA			SILICON CARBIDE (SiC)		SI
Material Code (Old)				YO100A	T716	T716H	T792H	SC211	SC1000	SN201B
Material Code (New)				YO100A	TO716O	TO716H	TO792H	SC211O	SC1000	SN201B
Appearance				Dense	Dense			Dense		
Color				White	Light Brown	Light Brown	Grayish Yellow	Black	Black	Black
Content		(%)		–	–	–	–	–	–	–
Main Characteristics				●Good Plasma Resistance	Good Surface Finish ●$CaTiO_3$		●$BaTiO_3$	●High Temperature Strength ●High Chemical Resistance, Excellent Thermal ●Conductivity ●Fracture Toughness	●Chemical Resistance	
Main Applications				●SPE Parts	●Slider Pads for Disk Drive Heads			●Mechanical Seal, ●High Temperature Resistance Parts		
Density (∗1)		g/cm^3	JIS R 1634	4.9	3.9	4.0	4.5	3.2	3.16	3.2
Water Absorption		%	JIS C 2141	0	0	0	0	0	0	0
Mechanical Characteristics	Vickers Hardness HV9.807N	GPa	JIS R 1610	6.0	8.5	8.8	8.1	22.0	23.0	13.9
Mechanical Characteristics	Flexural Strength 3 P.B.	MPa	JIS R 1601	130	320	320	230	540	450	580
Mechanical Characteristics	Compressive Strength	MPa	JIS R 1608	–	–	–	–	–	–	–
Mechanical Characteristics	Young's Modulus of Elasticity	GPa	JIS R 1602	160	260	270	180	430	440	290
Mechanical Characteristics	Poisson's Ratio	–	JIS R 1602	–	–	–	–	0.16	0.17	0.28
Mechanical Characteristics	Fracture Toughness (SEPB)	$MPa \cdot m^{1/2}$	JIS R 1607	1.1	–	–	–	4～5	2～3	4～5
Thermal Characteristics	Coefficient of Linear Thermal Expansion 40－400℃	$\times 10^{-6}/K$	JIS R 1618	7.2	11.5	11.5	9.6	3.7	3.7	2.4
Thermal Characteristics	Coefficient of Linear Thermal Expansion 40－800℃	$\times 10^{-6}/K$	JIS R 1618	7.6	12.1	12.1	–	4.4	4.4	3.2
Thermal Characteristics	Thermal Conductivity 20℃	W/(m・K)	JIS R 1611	14	4	4	2	60	200	25
Thermal Characteristics	Specific Heat Capacity	J/(g・K)	JIS R 1611	0.45	0.71	0.71	0.59	0.67	0.67	0.64
Thermal Characteristics	Thermal Shock Temperature Difference (Put in Water, Relative Method)	℃	JIS R 1648	–	–	–	–	400	–	550
Electrical Characteristics	Dielectric Strength	kV/mm	JIS C 2141	11	–	–	–	–	–	–
Electrical Characteristics	Volume Resistivity 20℃	Ω・cm	JIS C 2141	$>10^{13}$	10^{12}	10^{12}	10^{12}	10^5	10^8	$>10^{14}$
Electrical Characteristics	Volume Resistivity 300℃	Ω・cm	JIS C 2141	10^{10}	–	–	–	10^4	10^4	10^{12}
Electrical Characteristics	Volume Resistivity 500℃	Ω・cm	JIS C 2141	10^7	–	–	–	10^3	10^3	10^{10}
Electrical Characteristics	Dielectric Constant (1MHz)	–	JIS C 2141	11	–	–	–	–	–	–
Electrical Characteristics	Dielectric Loss Angle (1MHz)	$(\times 10^{-4})$	JIS C 2141	5	–	–	–	–	–	–
Electrical Characteristics	Loss Factor	$(\times 10^{-4})$	JIS C 2141	55	–	–	–	–	–	–
Chemical Characteristics	Nitric Acid (60%) 90℃,24H	(Weight Loss) mg/cm^2	–	–	–	–	–	0.04	≒0.00	–
Chemical Characteristics	Sulphuric Acid (95%) 95℃,24H	(Weight Loss) mg/cm^2	–	–	–	–	–	0.01	≒0.00	–
Chemical Characteristics	Caustic Soda (30%) 80℃,24H	(Weight Loss) mg/cm^2	–	–	–	–	–	≒0.00	≒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 A482R which lists apparent density only.

LICON NITRIDE (Si_3N_4)		ALUMINIUM NITRIDE (AlN)		ZIRCONIA (ZrO_2)				CERMET
SN240	SN241	AN216A	AN2000	Z220	Z201N	Z701N	Z21H04	TC30
SN240O	SN241O	AN216A	AN2000	ZO220O	ZO201N	ZO701N	Z21H04	TC0300
Dense		Dense		Dense				Dense
Black	Black	Gray	Ivory	Yellow	Ivory	Ash Black	Black	Silver
—	—	—	AlN 99.9	—	—	—	—	—
●High Temperature Strength ●Wear Resistant ●Excellent Thermal Shock Resistance ●Light Weight		●High Electrical Insulation, ●High Thermal Conductivity		●High Mechanical Strength, ●Excellent Wear Resistance, ●Good Surface Finish, ●High Fracture Toughness				●High Mechanical Strength, ●Excellent Wear Resistance, ●High Heat Shock Resistance, ●Electrical Conductivity
●Haigh Strength, High Temperature Durability	●High Thermal Conductivity	●Excellent Thermal ●Conductivity	●High Purity, ●Good Plasma Resistance					
●Anti Wear Liner ●Powder Equipment ●Molten Metal Parts ●Metal Forming Tool		●Heat Uniformity Parts, ●High Temperature Treatment Fixtures, ●Semiconductor Processing Equipment Parts		●Pump Parts, Dies, Knives, ●Cutting Blades, Spikes, ●Club Faces, Scissors				●Cutting Tool Tips, ●Wear Resistant Parts, ●Metal Forming Tools
3.3	3.2	3.4	3.2	5.6	6.0	6.0	5.6	6.0
0	0	0	0	0	0	0	0	0
14.0	13.8	10.4	11.2	10.7	12.3	12.7	10.8	16.2
1,020	790	310	220	750	1,000	1,470	710	1,470
—	—	—	—	—	—	—	—	3,430
300	290	320	310	200	200	220	210	440
0.28	0.28	0.24	0.24	0.31	0.31	0.31	—	0.21
7	6～7	—	—	7～8	4～5	4～5	3～4	—
2.8	2.9	4.6	4.6	10	10.5	10.8	10.3	7.4
3.3	3.5	5.3	5.2	10.5	11.0	11.3	11.4	8.3
27	54	150	67	3	3	3	3	17
0.65	0.66	0.71	0.72	0.46	0.46	0.46	0.48	—
800	900	—	—	450	300	350	—	310
13	12	14	16	13	11	—	—	—
$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	10^{13}	—	10^{8}	10^{-4}
10^{12}	10^{12}	10^{10}	10^{11}	10^{6}	10^{6}	—	—	—
10^{10}	10^{10}	10^{8}	10^{9}	10^{4}	10^{3}	—	—	—
9.6	9.6	8.6	8.5	28	33	—	—	—
19	18	3	2	17	16	—	—	—
—	—	26	17	476	520	—	—	—
1.11	0.18	—	—	—	≒0.00	≒0.00	—	6.0
0	0	—	—	—	0.04	0.04	—	0.26
0.22	0.07	—	—	—	0.08	0.08	—	0.02

$1kgf/mm^2 = 9.807MPa$　　$1cal/(cm \cdot sec \cdot ℃) = 418.6W/(m \cdot K)$

<JAPAN: Headquarters>

KYOCERA Corporation

Corporate Fine Ceramics Group

6 Takeda Tobadono-cho, Fushimi-ku, Kyoto 612-8501, Japan
Tel: +81-(0)75-604-3441 Fax: +81-(0)75-604-3438

WEB global.kyocera.com/prdct/fc/index.html

<U.S.A.>

KYOCERA International, Inc.

San Jose, CA
49070 Milmont Dr. Fremont, CA 94538
Tel:+1-510-257-0200 Fax:+1-510-257-0125

San Diego, CA
8611 Balboa Avenue, San Diego, CA 92123
Tel:+1-858-614-2520 Fax:+1-858-715-0871

Chicago, IL
25 NW Point Blvd., #660 Elk Grove Village, IL 60007
Tel:+1-847-981-9494 Fax:+1-847-981-9495

Boston, MA
24 Superior Dr, Suite 106, Natick, MA 01760
Tel: +1-508-651-8161 Fax: +1-508-655-9139

Mountain Home, NC
100 Industrial Park Rd, Hendersonville, NC 28792
Tel:+1-828-693-8244 Fax:+1-828-692-1340

New Jersey, NJ
220 Davidson Ave., Suite108, Somerset, NJ 08873
Tel:+1-732-563-4336 Fax:+1-732-627-9594

Austin, TX
7801 Capital of Texas Highway, Ste 330 Austin, TX 78731
Tel:+1-512-336-1725 Fax:+1-512-336-8189

Vancouver, WA
5713 East Fourth Plain Blvd.,Vancouver ,WA 98661
Tel:+1-360-696-8950 Fax:+1-360-696-9804

<EUROPE>

KYOCERA Fineceramics GmbH

Esslingen, Germany
Fritz-Mueller-Strasse 27, 73730 Esslingen, Germany
Tel:+49-(0)711-93934-0 Fax:+49-(0)711-93934-950

Neuss, Germany
Hammfelddamm 6 41460 Neuss, Germany
Tel:+49-(0)2131-1637-0 Fax:+49-(0)2131-1637-150

KYOCERA Fineceramics Ltd.

U.K.
Prospect House, Archipelago, Lyon Way, Frimley, Surrey GU16 7ER, U.K.
Tel:+44-(0)1276-6934-50 Fax:+44-(0)1276-6934-60

KYOCERA Fineceramics S.A.S.

France
Parc Tertiaire, Silic, 21 Rue De Villeneuve
BP 90439 94583 Rungis Cedex, France
Tel:+33-(0)141-7373-30 Fax:+33-(0)141-7373-59

<ASIA>

KYOCERA Korea Co.,Ltd.

Korea
2F MYUNGIN-TOWER, 267 Hyoryeong-Ro
Seocho-Gu, Seoul, 06653, Korea
Tel: +82-(2)-3463-3538 Fax: +82-(2)-3463-3539

KYOCERA (China) Sales & Trading Corporation

Shanghai
Floor 9,Dushi Headquarters Building, No. 168, Middle Xizang Road, Shanghai, 200001
Tel: +86-(0)21-5877-5366 Fax: +86-(0)21-5888-5096

Shenzen
Unit 06-08,29/F,AVIC Center NO.1018 Huafu Road,
Futian District, Shenzhen, Guangdong, 518033
Tel: +86-(0)755-8272-4107 Fax: +86-(0)755-8279-0487

KYOCERA (Hong Kong) Sales & Trading Ltd.

Hong Kong
Room 801-802, Tower 1, South Seas Centre,
75 Mody Road, Tsimshatsui East, Kowloon, Hong Kong
Tel: +852-(0)2722-3912 Fax : +852-(0)2724-4501

KYOCERA Asia Pacific,Ltd.

Taiwan
8FL., No.101, Sec.2, Nanjing East Road, Taipei 10457, Taiwan
Tel:+886-(0)2-2567-2008 Fax:+886-(0)2-2567-2700

Singapore
298 Tiong Bahru Road, #13-03/05 Central Plaza, 168730, Singapore
Tel:+65-6271-0500 Fax:+65-6271-0600

Philippines
11B, Kingston Tower, Block 2, Lot 1, Acacia Avenue,
Madrigal Business Park, Alabang, Muntinlupa City 1780, Philippines
Tel:+63-(0)2-771-0618 Fax:+63-(0)2-775-0532

KYOCERA Asia Pacific (Thailand) Co., Ltd.

Thailand
1 Capital Work Place, Building 7th Floor, Soi Chamchan, Sukhumvit 55 Road, Klongton Nua, Wattana, Bangkok 10110, Thailand.
Tel: +66-(0)2030-6688 Fax: +66-(0)2030-6600

KYOCERA Sdn. Bhd.

Malaysia
Lot 4A, Lower Level 3, Hotel Equatrial, Penang No.1,
Jalan Bukit Jambul 11900 Penang, Malaysia
Tel: +60-4-641-4190 Fax: +60-4-641-4209

KYOCERA Asia Pacific India Pvt. Ltd.

India
1004A & 1004B, 10th Floor, JMD Regent Square, M.G. Road Gurugram Haryana, India
Tel: +91-124-4714298 Fax: +91-124-4683378

The contents of this catalog are subject to change without prior notice for further improvement.
Application and usage conditions should be consulted upon when considering purchase.

002/024/2206
Printed in Japan