KYOCERA

Fine Ceramics for Electronics

KYOCERA

Expanding Applications of Ceramic Components-1

Contributing to Down-sizing & Improved Functionality of Electronics

The electronics industry is continuously making remarkable progress and development. Kyocera, with its Fine Ceramics material and processing technologies developed during its history, supports the increased functionality of equipment used in a wide range of fields such as various electronic components and semiconductor devices along with equipment components required to support manufacturing.

Expanding Applications of Ceramic Components-2

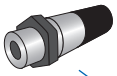
Enhancing Automotive Performance

Fine Ceramics provide excellent characteristics in mechanical strength at high temperature and electrical insulation. As automotive electronics evolve to require more robustness for long-term durability and safety to protect drivers and passengers, ceramic components are widely used in hybrid vehicles (HV/PHV) and electric vehicles (EV).

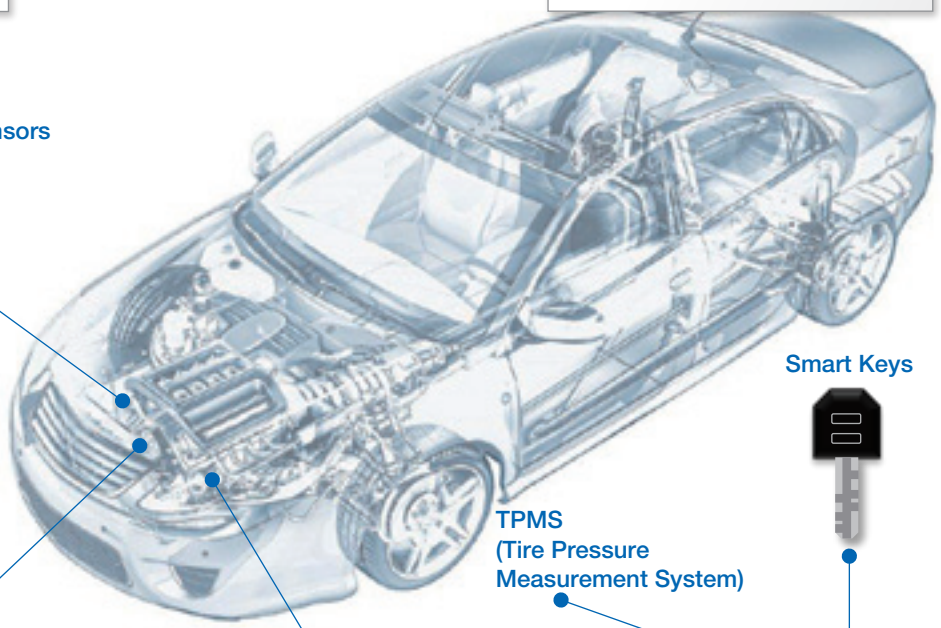
Ceramic Diaphragms

Ferrites for Automotive Common Mode Noise Filters

Hydraulic Pressure Sensors



- Engine Oil
- Automatic Transmission
- Air Conditioning
- Power Steering



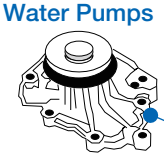
Smart Keys

TPMS (Tire Pressure Measurement System)

HV, PHV, EV Components

- Insulation Plates for Electrical Boosters
- Large Current Terminal Parts
- Heat Dissipation Substrates for Power Modules
- ECU (Engine Control Unit) Substrates

Water Pumps



Ferrite Antennas

Seal Rings

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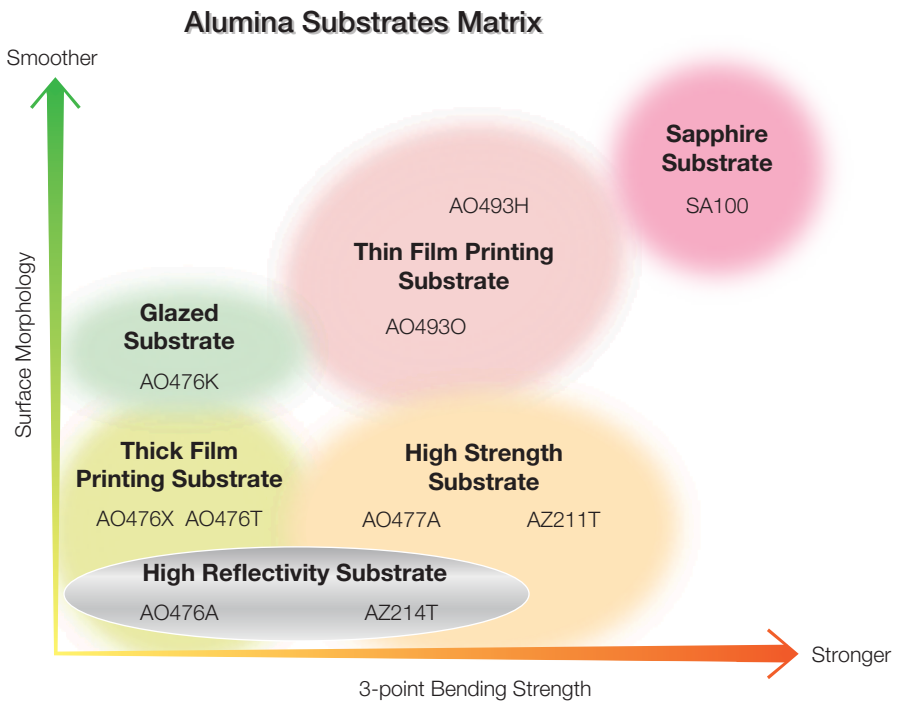
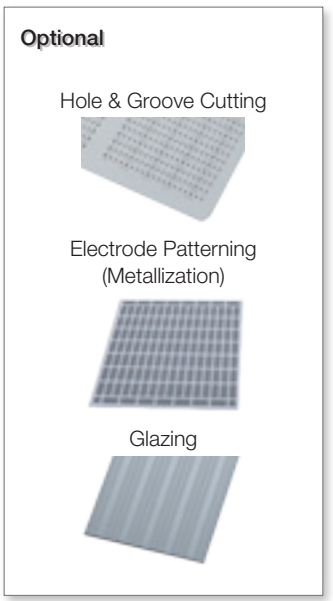
Ceramic Substrates

Ceramic substrates are mainly used as hybrid IC substrates, thin film IC substrates, heat dissipation substrates, and LED sub-mount substrates. Our micro-grain material structure enables substrates which have a smooth surface with less voids, and high flexural strength and electrical insulation under high temperature environments. Upon request, we can also cut through-holes or scribe lines, or form electrode patterns (metallization) by printing or plating the substrates.





Material Characteristics of Ceramic Substrates

Main Applications				Thick Film Printing		Thin Film Printing		Glazing	Power I (High S
Item \ Material				Alumina Al_2O_3	Alumina Al_2O_3	Alumina Al_2O_3	Alumina Al_2O_3	Alumina Al_2O_3	Alumina Al_2O_3
Material Code				AO476X	AO476T	AO493O	AO493H	AO476K	AO477A
Content			(%)	96	96	99.6	99.6	96	97
Density		g/cm³	JIS R 1634	3.70	3.78	3.86	3.96	3.70	3.79
Mechanical Characteristics	Vickers Hardness HV9.807N	GPa	JIS R 1610	13.7	13.9	16.0	17.7	13.7	14.6
	Flexural Strength 3 P.B.	MPa	JIS R 1601	310	380	550	550	350	480
	Young's Modulus of Elasticity	GPa	JIS R 1602	330	340	390	390	330	340
Thermal Characteristics	Coefficient of Linear Thermal Expansion (40-400°C)	×10⁻⁶/K	JIS R 1618	7.2	7.0	7.2	7.2	7.2	7.0
	Thermal Conductivity 20°C	W/(m·K)	JIS R 1611	26	26	26	30	24	26
Electrical Characteristics	Dielectric Strength	kV/mm	JIS C 2141	12	15	15	18	15	16
	Volume Resistivity 20°C	Ω·cm		>10¹⁴	>10¹⁴	>10¹⁴	>10¹⁴	>10¹⁴	>10¹⁴
	Dielectric Constant (1MHz)	–		9.4	9.6	9.6	10.2	9.4	9.1
	Dielectric Loss Tangent (1MHz)	(×10⁻⁴)		4.0	3.0	3.0	2.0	4.0	2.0
Reflectivity (Wavelength: 450nm Thickness: 1mm)		%	–	–	–	–	–	–	–
Standard Specifications	Substrate Thickness	mm	–	0.15 ~1.016mm	0.32~2.7	0.1~1.0	<0.7	0.5~1.0	0.32~1.0
	Surface Roughness		–	Ra0.2 ~0.8μm	Ra0.2 ~0.8μm	Ra0.05 ~0.08μm	<Ra0.01μm (Mirror Surface)	Ra0.2 ~0.3μm	Ra0.3 ~0.5μm

Module trength)	LED Sub-mount Substrate (High Reflectivity)				LED	
Alumina $Al_2O_3+ZrO_2$	Alumina Al_2O_3	Alumina Al_2O_3	Alumina Al_2O_3	Alumina $Al_2O_3+ZrO_2$	Single Crystal Sapphire Al_2O_3	
AZ211T	AO476K	AO476T	AO476A	AZ214T	SA100	
–	96	96	96	–	–	
4.01	3.70	3.78	3.65	3.75	3.97	
–	13.7	13.9	12.9	12.3	a-plane	22.5
650	350	380	360	450	a-plane c-axis	690
360	330	340	320	–	470	
7.0	7.2	7.0	7.1	–	Parallel to c-axis	0.18
24	24	26	19	19	42	
16	15	15	12	22.6	48	
$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	
10.8	9.4	9.6	9.2	9.6	Parallel to c-axis	11.5
					Vertical to Axis c	9.3
2.7	4.0	3.0	2.1	2.0	<1	
–	86.7%	88.6%	91.0%	95.0%	–	
0.32~1.0	0.5~1.0	0.32~2.7	0.32~2.7	0.38~1.0	–	
Ra0.3 ~0.5μm	Ra0.2 ~0.3μm	Ra0.3 ~0.5μm	Ra0.3 ~0.5μm	Ra0.3 ~0.5μm	–	

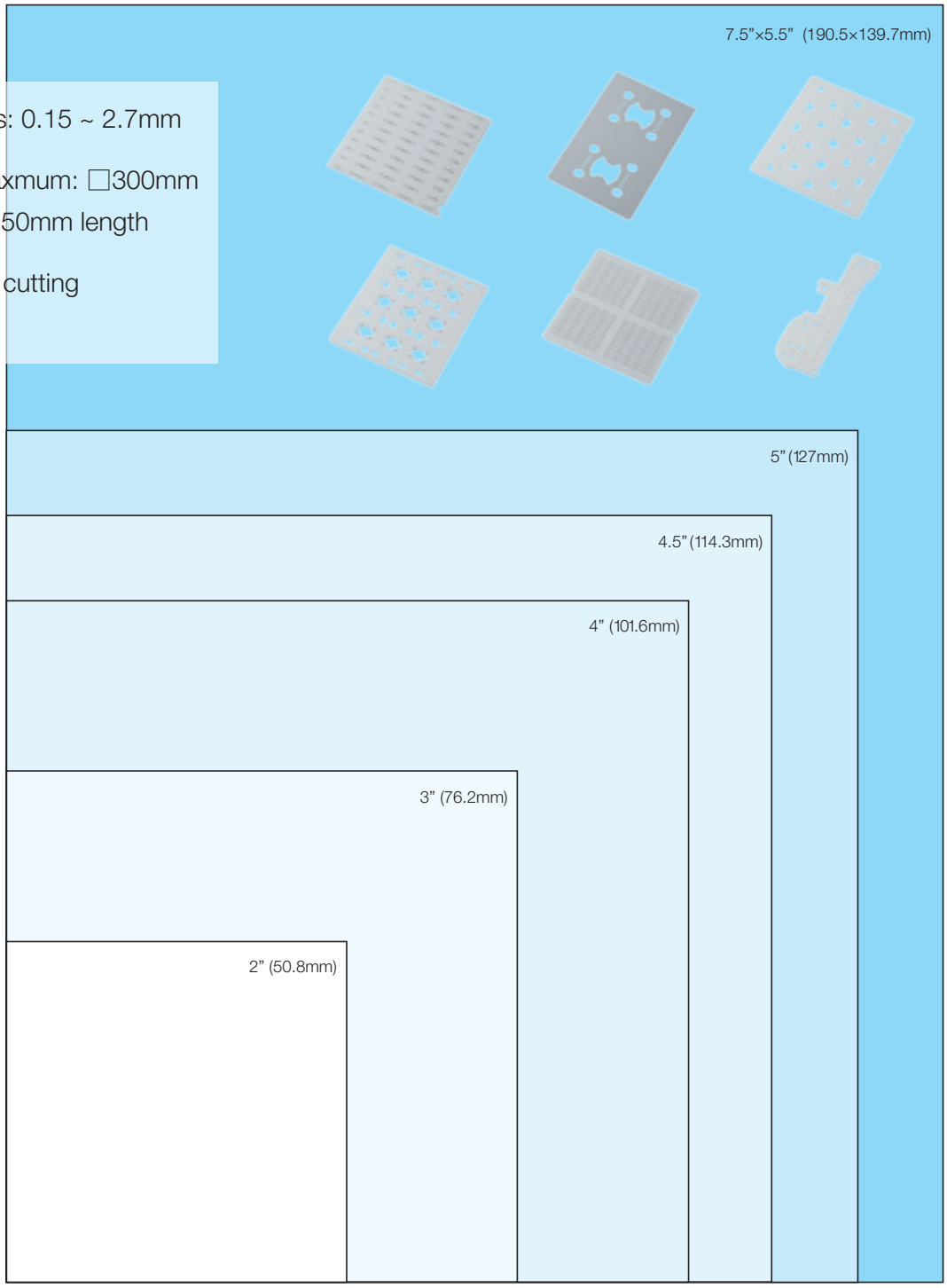
* Values are typical properties of each material, and may vary depending on product configurations or manufacturing processes. For more details, please feel free to contact us.

Thick Film Printing Substrates

Available in large sizes or different shapes, suitable for thick film printing process

Features

- Standard Thickness: 0.15 ~ 2.7mm
- Size flexibility to maxmum: □300mm
  * Scalable up to 1,250mm length
- Small through-hole cutting (Ø0.2mm)

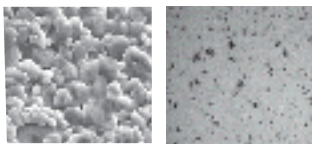
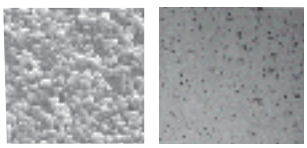


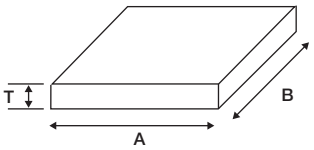
► Standard Substrate Size:

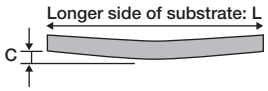
Outer Dimension:
2"sq. / 3"sq. / 4"sq.
4.5"sq. / 5"sq.
7.5" × 5.5"

Thickness (mm):
0.180
0.254
0.381
0.508
0.635
0.762
0.800
1.016
1.800

Standard Substrate Specifications

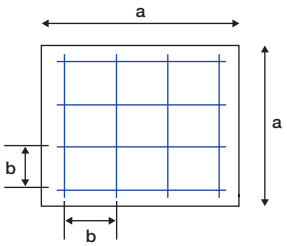
Material		AO476X	AO476T
Size Availability (A,B)		12.7mm sq. - 152.4mm sq.	12.7mm sq. - □300mm
Thickness Availability (T)		0.15~1.016mm	0.32~2.7mm
Thickness Tolerance	Standard	±10% (minimum ±0.05mm)	
	Premium	±7% (minimum ±0.05mm)	
As Fired Camber (C)		0.3% of longer side of substrate	0.2% of longer side of substrate
Surface Roughness		Ra0.2~0.8μm	
Internal Void		 ×1500 ×400	 ×1500 ×400

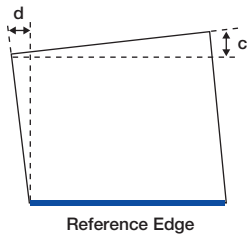


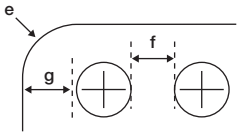


Standard Green-punching / Laser-cutting Specifications

Process	Green Punching		Laser Cutting
Substrate Dimensional Tolerance (a)	Standard	±0.8% (minimum ±0.1mm)	+0.20mm -0.05mm
	Premium	±0.5% (minimum ±0.08mm)	
	Super Premium	±0.25% (minimum ±0.05mm)	
Singulation Scoring Tolerance (b)	Standard	±0.8% (minimum ±0.1mm)	Edge to Scoreline: +0.2/-0.05mm Scoreline to Scoreline: ±0.05mm
	Premium	±0.5% (minimum ±0.08mm)	
	Super Premium	±0.25% (minimum ±0.05mm)	
Parallelism (c) / Perpendicularity (d)	Standard	0.5% of outer dimension	±0.05mm
	Premium	0.3% of outer dimension	
Corner Radius (e)	0.51mm		–
Hole Size	Round Hole: minimum 0.20mm diameter Square Hole: minimum 0.38mm square		–
Spacing between Holes (f) / Spacing between Edge to Hole (g)	Same tolerance as substrate thickness (minimum ±0.51mm)		–





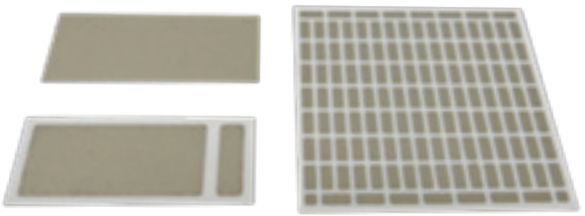


Alumina Metallized Substrates

Wide range of applications from circuit boards to power devices

Features

- Available with high adhesion strength Mo-Mn
- Various options for conductive layer (incl. Ag or Cu)
- Customized pattern printing
  (Please consult us in advance regarding design)



Applications

- Circuit Board Substrates
- Power Device Substrates

■ Electrode pattern example

Thin Film Printing Substrates

Super smooth substrates used for thin film printed circuit boards

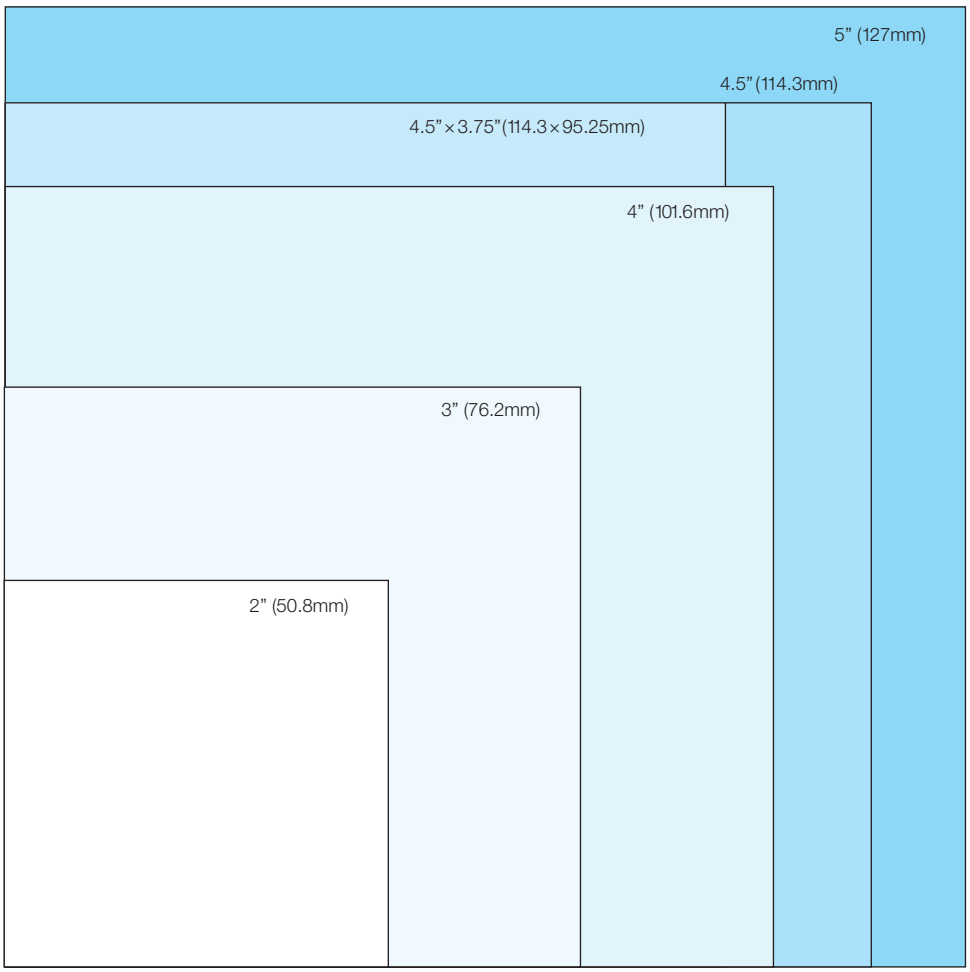
Features

- Excellent smoothness with less voids (Standard: Ra0.05~0.08μm)
- High mechanical strength
- Maximum available size: 165mm sq.

► Standard Substrate Size

Outer Dimension:
2”sq. / 3”sq. / 4”sq.
4.5” × 3.75” / 4.5”sq.
5”sq.

Thickness (mm):
0.100 / 0.127
0.200 / 0.254
0.381 / 0.500
0.635 / 1.000



Polished Thin Film Printing Substrates

Ceramic substrates contribute to the advancement and diversification of thin film technology

Features

- Dimensional stability at high temperature for multilayer thin film technology (for metal, glass or resin)
- Thin film quality improvement with high level of flatness and smoothness

Low Voids Alumina Substrate (AO493H)

Features

- Best-in-class low voids, produced from tight process control
- Excellent surface smoothness
- Mitigation of electrical disconnection in thin film printed circuits

■ Internal Voids

Standard (AO493O)

Premium (AO493H)

Design Guideline

Item	AO476T	AO493O	AO493H
Substrate Thickness (mm)	0.32~2.7	0.05~0.7	0.05~0.7
Flatness (mm)	0.05~0.6	0.05~0.4	0.05~0.4
Surface Roughness (Mirror Polish) (μm)	<Ra0.05	<Ra0.02	<Ra0.01

* Values may vary depending on the size and thickness of substrates.
Please contact us for further information.

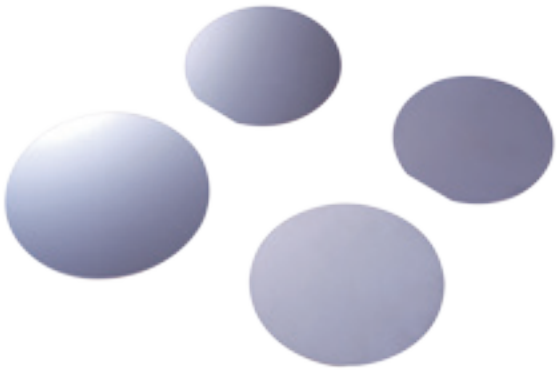
Single Crystal Sapphire Substrates

Base substrate applications for various epitaxies or depositions

The epitaxial growth of semiconductor film (e.g. Si, GaN, AlN, ZnO, etc.) requires a base substrate with similar lattice constant and no grain boundary. Single crystal sapphire with its smooth surface provides excellent performance, not only as the base substrate for LED, LD, SOS but also as a deposition substrate for super-conductive, metal, oxide, organic, or inorganic films.

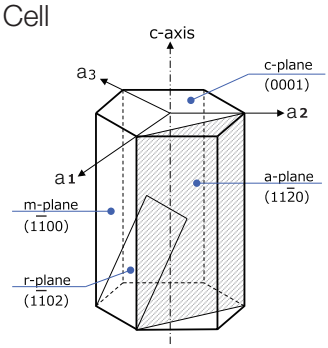
Features

- Single crystal atomic layout
- Smooth surface finish with no grain boundary
- High electrical insulation with low dielectric loss
- Availability in customized crystal orientation
- High mechanical strength, heat resistance, chemical durability, and plasma resistance properties



Crystal Orientation / Lattice

Crystal Unit Cell

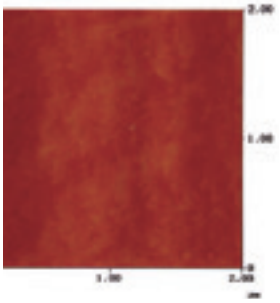


Lattice Constant (for reference)

(Unit: Å)

Reference value	a-axis	c-axis
Sapphire	4.758	12.991
GaN	3.189	5.185
InN	3.548	5.76
Si	5.43095	
GaAs	5.6533	
ZnO	3.252	5.213
AlN	3.112	4.982

Surface Roughness (reference AFM)



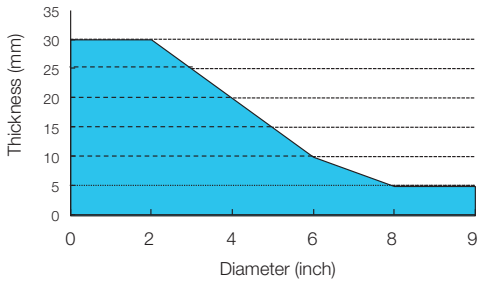
Standard Size

Standard Substrate Specification

* Please contact us for more details. (Unit: mm)

Diameter	Thickness	Orientation Flat Length
Ø 50.8 ±0.25	0.33 or 0.43 ±0.025	16 ±3
Ø 76.2 ±0.25	(Common for any) ±0.025	22 ±3
Ø 100 ±0.25	(Common for any) ±0.025	32.5 ±2.5
Ø 125 ±0.25	(Common for any) ±0.025	42.5 ±2.5
Ø 150 ±0.25	(Common for any) ±0.025	47.5 ±2.5
Ø 200 ±0.25	(Common for any) ±0.025	–

Standard Size Availability



Size is dependent on crystal orientation

High Reflectivity Alumina Substrates

Contributing to improved LED efficiency, with both high reflectivity and high thermal conductivity

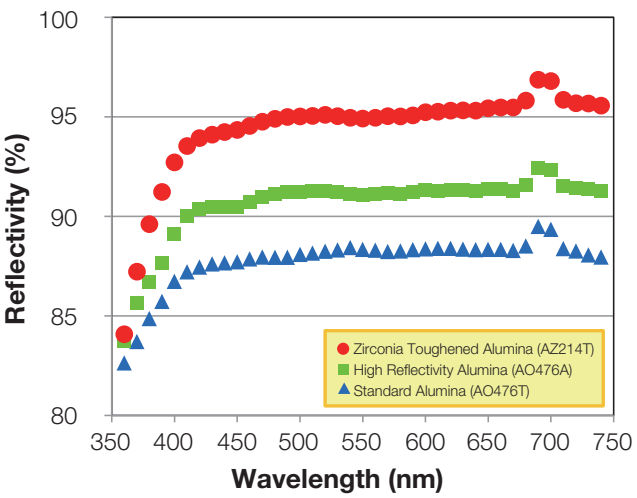
Features

- White ceramic substrate with both high reflectivity and high thermal conductivity
  Reflectivity: 95%
  Thermal Conductivity: 19W/mk
- High level of dimensional accuracy by laser cutting
- Multiple pieces from a larger size substrate

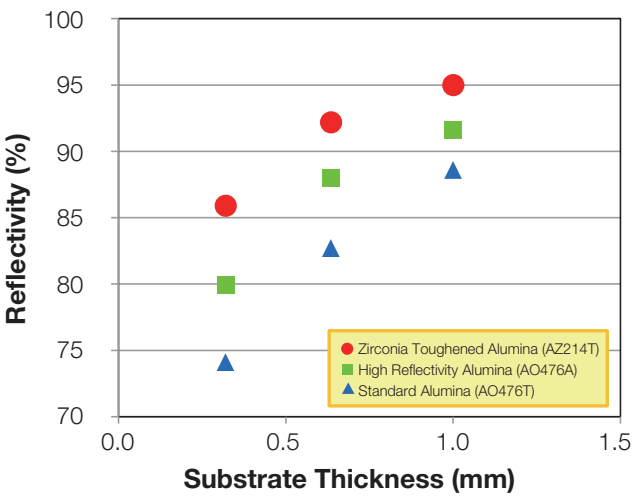
Applications

- Base substrate for LED sub-mount assembly
  for various types of LEDs such as down lights, tube lights, or bulbs
- LED sub-mount substrate for automotive applications

► **Reflectivity by Wavelength**



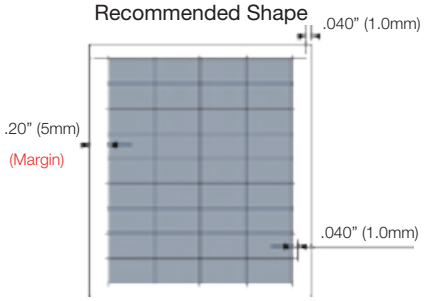
► **Reflectivity by Substrate Thickness**



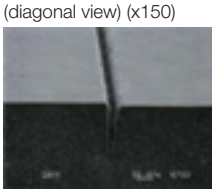
Laser Cutting Design Guideline

Scribe Line

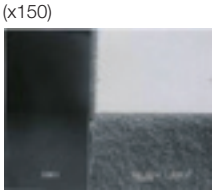
Recommended Shape



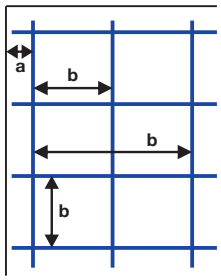
Cross section
(diagonal view) (x150)



After snapped
(x150)



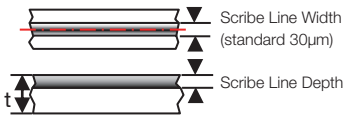
Substrate Edge



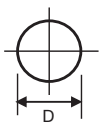
a = +.008" / -.002"
(+0.20 / -0.05mm)
b = ±.002" (±0.05mm)

Standard Depth (Inch (mm))

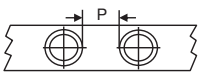
Substrate Thickness (t)	Scribe Line Depth
.015" (0.381)	.0051″ (0.13)
.020″ (0.508)	.0067″ (0.17)
.025″ (0.635)	.0082″ (0.21)
.030″ (0.762)	.0098″ (0.25)
.032″ (0.813)	.0102″ (0.26)
.035″ (0.889)	.0114″ (0.29)
.040″ (1.016)	.0130″ (0.33)
.047″ (1.194)	.0157″ (0.40)



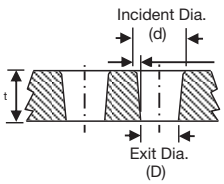
Through-Hole



Through-Hole Diameter (D)	Dimensional Tolerance
D ≦ Ø.030" (0.762mm)	±.002" (±0.050mm)
.030" ~ .100" (0.762mm) (2.54mm)	±.003" (±0.076mm)
D>.100" (2.54mm)	±.005" (±0.127mm)

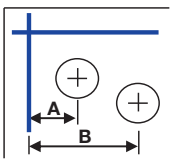


P ≧ t
(more than substrate thickness to process)



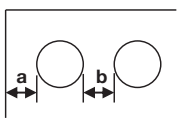
d-D= ≦ 10% of substrate thickness

■ Dimensional Tolerance from Scribe Line to Center of Through-hole

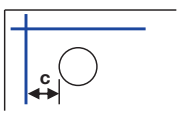


A,B: ±.002"
(±0.050mm)

■ Locational Condition of Through-hole



a or b > Substrate Thickness



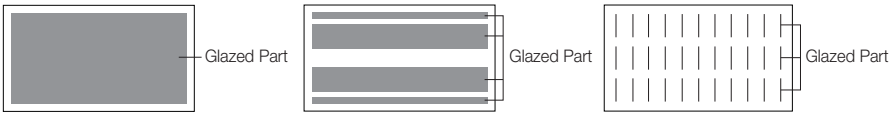
c > Substrate Thickness

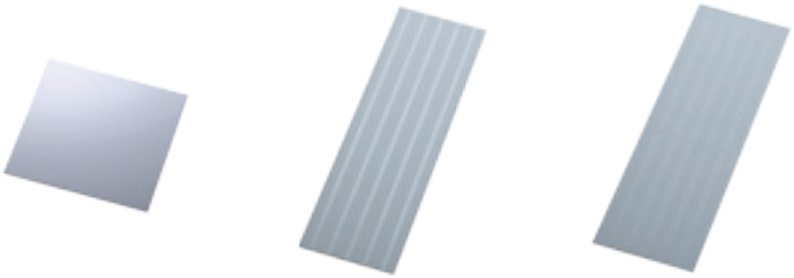
Optional

Glazing

Minimized surface defects enable precision thin film printing

• Full Glazing • Partial Glazing • Serial Glazing





Standard Glazing Specifications

		Full Glazing	Partial Glazing
Standard Thickness		45~80μm	30~60μm
Tolerance	Standard	±15μm	±10μm
	Premium	±10μm	±7μm

Material Characteristics

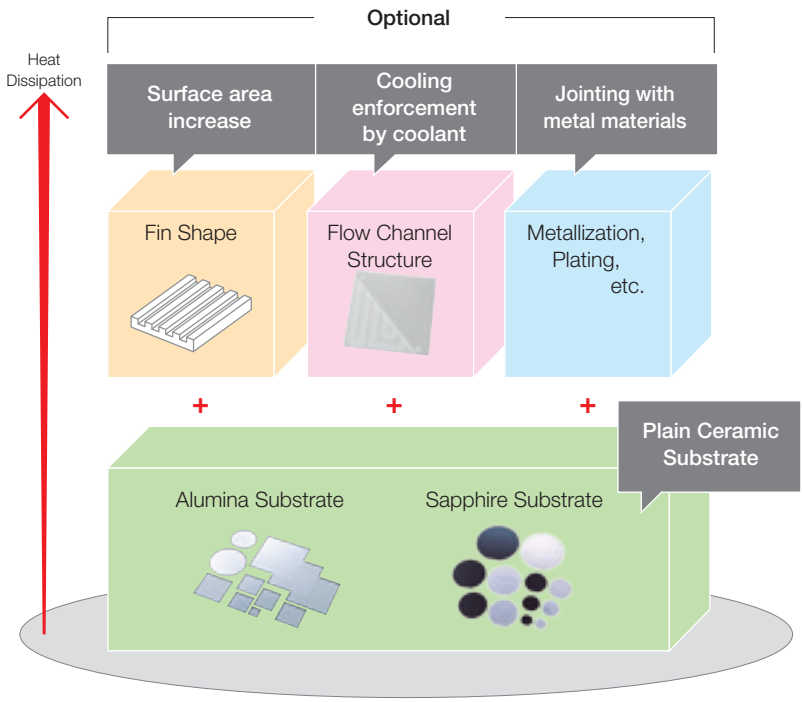
* Values are typical data from test pieces

Item	Unit	Condition	GS-5	GS-71
Glass Transition Temperature	°C	DTA*	670	685
Glass Softening Temperature	°C	DTA*	865	870
Coefficient of Linear Thermal Expansion	1/°C	R.T.to 400°C	6.6×10^{-6}	6.8×10^{-6}
Thermal Conductivity	W/(m•K)	20°C	0.837	0.754
Volume Resistivity	Ω ·cm	20°C 300°C 500°C	$>10^{14}$ $>10^{14}$ 2.8×10^{10}	$>10^{14}$ $>10^{14}$ 2.1×10^{10}
Dielectric Constant	–	1MHz	7.2	8.7
Dielectric Loss Tangent	–	1MHz	14.6×10^{-4}	10.0×10^{-4}
Surface Roughness	Ra μm		<0.02	<0.02

*DTA: Differential Thermal Analysis

Heat Dissipation Substrates

Thermal management is increasingly important as electronic devices evolve to realize further downsizing and improved functionality. Kyocera offers heat dissipation substrates to meet customers' needs by developing high thermal conductive materials, metal jointing technologies, or substrate configurations to improve dissipation efficiency.

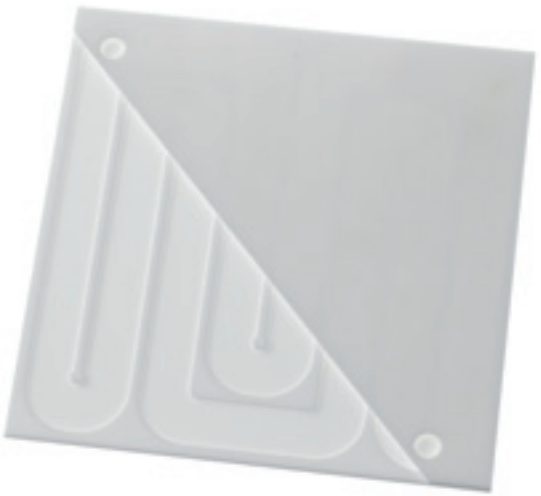


Heat Dissipation Structure Ceramic Substrates

Monolithic ceramic structure with no bonding material for long-term reliability

Features

- Cooling or heat exchanging components made of light weight ceramic with low heat capacity provide a more efficient, energy saving system compared to metal
- Design possibility for thin wall or complex structure
- Long term, efficient cooling and temperature control
- Low maintenance cost due to superior chemical durability
- Applicational exploitation other than cooling or temperature control

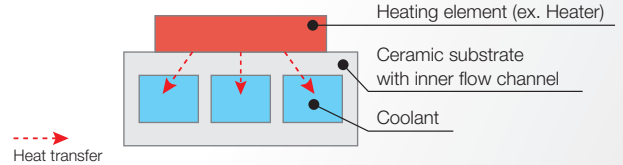


Applications

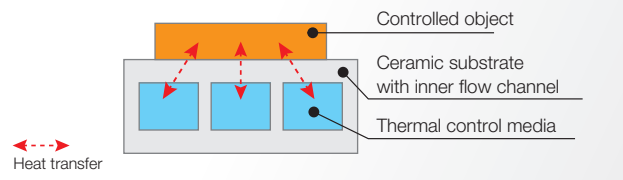
- Heat element coolers / Thermal control components
- Heat exchanger components
- Manifolds
- Micro reactors
- Thermal insulation components

Product Examples

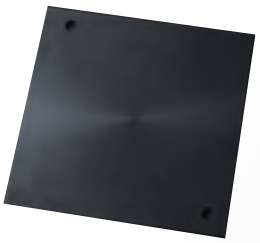
Heat Element Cooler



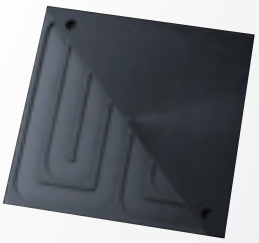
Thermal Control Component



Product Structure Example



Appearance



Product Cut Model

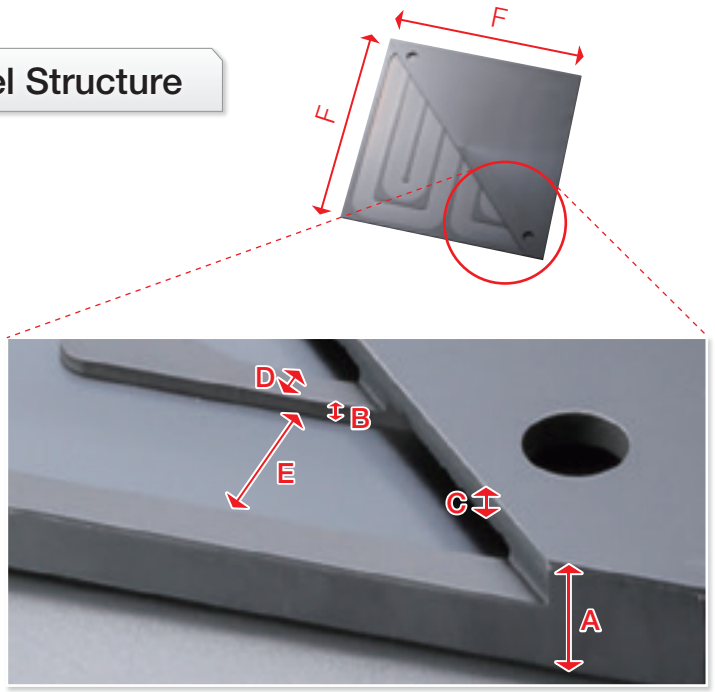
Design Guideline for Flow Channel Structure

Standard Product Dimensions

(Unit: mm)

		Minimum	Maximum
A	Product Thickness	2	15
B	Channel Height	0.5	10
C	Lid Plate Thickness	0.5	–
D	Channel Wall Thickness	2	–
E	Channel Width	1	12
D/E	Line & Space	>0.2	
B/D	Aspect Ratio	<2.5	
F	Maximum Size	600sq.	

* Please contact us for more information



Material Characteristics

* Values are typical data from test pieces

			Unit	AO476T	AO479T	SC140A
Color			–	White	White	Black
Content			wt%	96	99.5	–
Bulk Density			–	3.7	3.9	3.1
Mechanical Characteristics	Vickers Hardness		GPa	13.9	16.3	23
	Flexural Strength (3-point Bending)		MPa	380	470	450 (4-point Bending)
	Young's Modules of Elasticity		GPa	340	380	430
	Poisson's Ratio		–	0.23	0.23	0.17
Thermal Characteristics	Thermal Conductivity		W/(m·K)	26	30	180
	Specific Heat Capacity		J/(g·K)	0.78	0.79	0.67
	Coefficient of Linear Thermal Expansion	40-400°C	ppm/K	7	7.6	3.7
Electrical Characteristics	Dielectric Strength		kV/mm	15	18	–
	Volume Resistivity	RT	Ω·cm	$>10^{14}$	$>10^{14}$	–
		300°C		1.0×10^{10}	4.9×10^{10}	–
		500°C		1.1×10^{8}	3.5×10^{8}	–
	Dielectric Loss Tangent		1MHz	3.0×10^{-4}	1.0×10^{-4}	–
	Dielectric Constant		1MHz	9.6	10.2	–

*Other materials can also be considered upon request from prototyping

Functional Materials

Inductor Cores

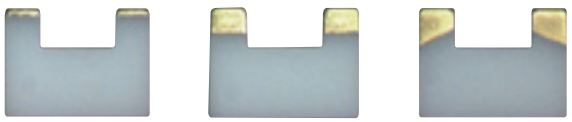
Optimal materials and electrode patterns for customized applications and surface mounting processes

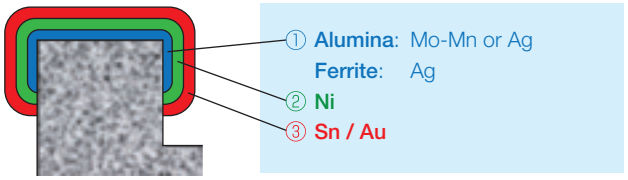
Features

- Core material either in alumina or in ferrite
- Flexible material selections for customized needs (ex. Magnetic permeability, Saturation magnetic flux density, Curie temperature, etc.)
- Accommodation to highly precise, miniaturized designs
- Electrode patterns adjustable to surface mounting process

Electrode Pattern Examples

Top surface only	Top + side	Top + side (tapered)





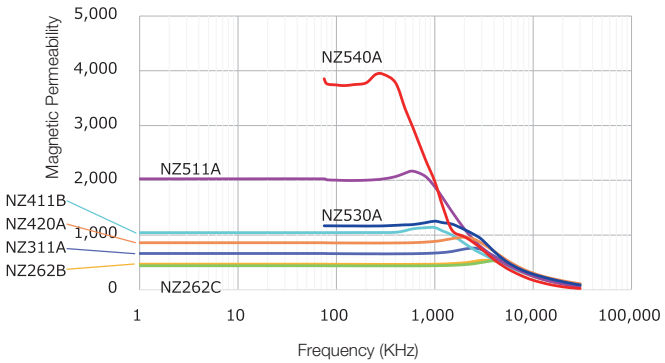
*Other patterns can also be considered upon request

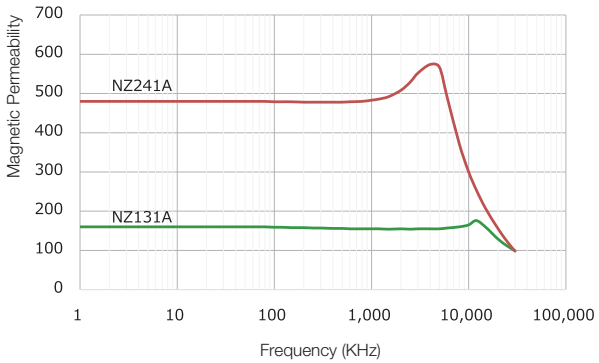
Material Characteristics

Material Code		AO476X	NZ021A	NZ112H	NZ112A	NZ131A	NZ262C	NZ241A	NZ312B	NZ262B
Magnetic Permeability	100KHz	1	7	60	65	160	400	480	490	500
	1MHz	1	7	58	65	160	400	480	500	500
	10MHz	1	7	58	65	160	250	300	260	220
Relative Loss Factor (tanδ/μ)	100KHz ($\times10^{-6}$)	–	26000	335	200	150	15	15	15	20
	1MHz ($\times10^{-6}$)	–	3600	625	130	80	30	30	60	50
	10MHz ($\times10^{-6}$)	–	1300	1375	180	280	4000	2700	3200	5000
Relative Temperature Coefficient (α μγ)	-25-20°C ($\times10^{-6}$)	–	35	15	0	50	12	15	0	14
	20-80°C ($\times10^{-6}$)	–	35	8	0	35	17	7	-1	10
Saturation Magnetic Flux Density (mT)		–	140	360	380	370	470	350	290	430
Residual Magnetic Flux Density (mT)		–	60	150	230	160	300	120	110	150
Curie Temperature (°C)		–	≧300	≧300	≧300	240	300	150	90	220
Volume Resistivity (Ω·cm)		>1014	108	108	108	108	108	108	108	108

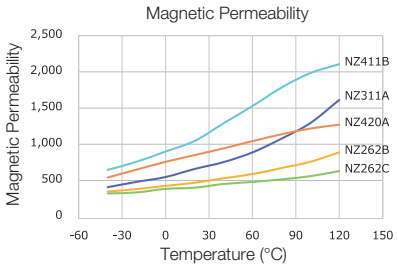
* If desired material is not on the list, please feel free to contact us.

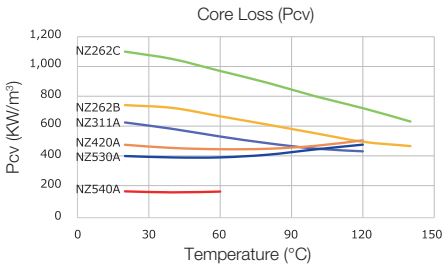
Magnetic Permeability vs Frequency

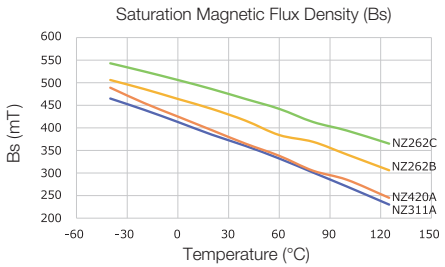




Magnetic Permeability / Core Loss (Pcv) / Saturation Magnetic Flux Density (Bs) vs Temperature







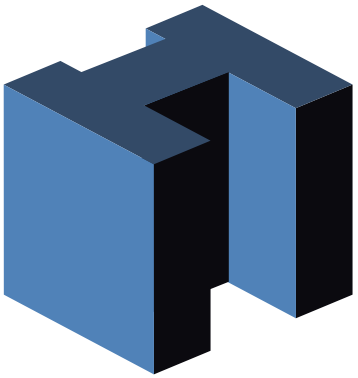
* Values are typical data from test pieces

	NZ350A	NZ301B	NZ311A	NZ420A	NZ411B	NZ511A	NZ530A	NZ540A	NZ550A
	535	570	650	860	1100	2000	1150	3700	2000
	550	600	650	880	1200	1500	1250	2000	(2000)
	250	280	270	280	250	240	285	180	(250)
	20	15	20	10	15	15	10	14	15
	100	80	55	45	120	360	70	450	(250)
	3400	3500	4500	4400	5300	9600	5350	180000	(7000)
	2	0	20	5	15	7	8	3	–
	-2	2	10	9	6	2	4	8	–
	340	340	390	390	380	320	375	260	320
	55	110	210	70	170	100	50	180	220
	125	125	160	180	120	80	150	90	115
	108	108	108	108	108	108	108	108	108

Inductor Core Shape Examples

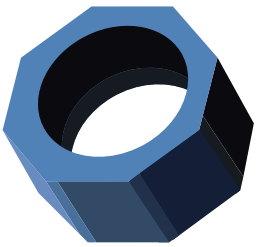
SQUARE CORE

- Available in both alumina and ferrite materials
- Suitable for complex shape with tight tolerance
- Edged shape for high speed surface mounting



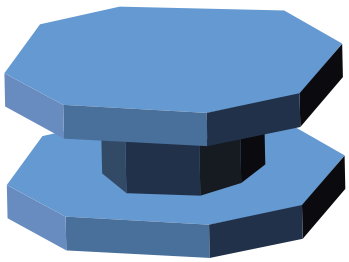
CAP CORE

- Thin wall cap shape suitable for shielded core
- Edged shape for high speed surface mounting
- Low height design possibility together with Push-pin Core
- Please contact us for possible combinations among OD, height, bottom thickness, and wall thickness.



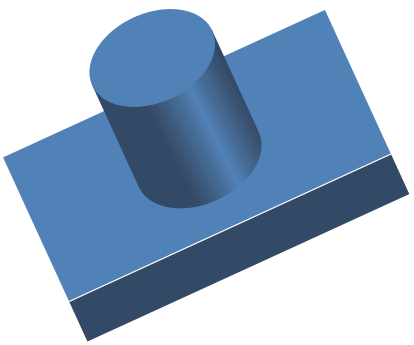
DR CORE (Edged sleeves & winding core type)

- Available in both alumina and ferrite materials
- Please contact us for possible combinations among OD, core diameter, height, machinable width, and sleeve thickness.



PUSHPIN CORE

- One side sleeve shape suitable for shielded core
- Low height design possibility together with Cap Core



* Tooling structure for volume production may require some design restrictions.
Please contact us to finalize feasible dimensions and tolerances.

Piezoelectric PZT Substrates

PZT: Lead Zirconate Titanate Pb (Zr,Ti) O_3

Piezoelectric ceramic substrate with stable characteristics

Features

- Low voltage actuation with high piezoelectric constant
- High coercive electric field to mitigate piezoelectrical deterioration during high voltage actuation
- Excellent machinability (fine grains / minimal voids)

Applications

- Actuator components (positioning control)
- Various sensors

Design Guideline (mm)

MAX size: 120 × 90
MIN size: 30 × 30
Thickness: 0.1 - 9.0

* Please contact us for more details

Material Characteristics

* Values are typical data from test pieces

Item	Unit	PZ0750	PZ0801
Bulk Density	–	7.9	7.9
Piezoelectric Constant (d15)	10^{-12} m/V	750	900
Piezoelectric Constant (d31)	10^{-12} m/V	-230	-190
Piezoelectric Constant (d33)	10^{-12} m/V	450	400
Dielectric Constant ($\varepsilon_{11}^{T}/\varepsilon_0$)	–	2400	3000
Dielectric Constant ($\varepsilon_{33}^{T}/\varepsilon_0$)	–	1950	2280
Curie Temperature	°C	310	260
Coercive Electric Field	V/mm	1100	970

Device Peripherals

Sapphire Cover Plates

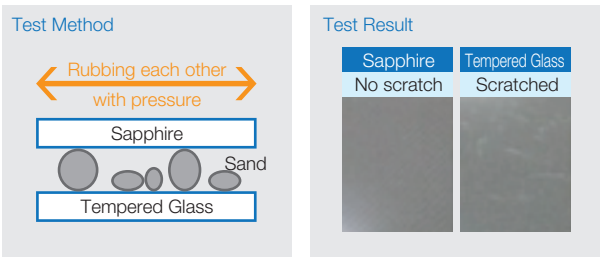
Surface protection from mechanical stress or friction for display and transparency

The LCD panel or reading indicator of an inspection stage requires a scratch-free protection plate with high optical transparency. Our unique design and polishing capabilities make our single-crystal sapphire into a thin, high-quality cover plate with remarkable hardness and stiffness.

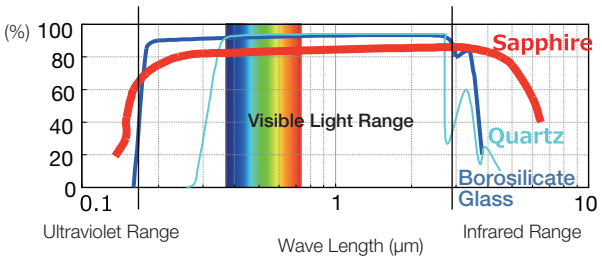
Features

- Scratch-free hardness
- Excellent optical transparency
- Bonding technology with glass (sapphire on glass) for large, rigid substrates
- Assembly capability with surface coating or printing

Scratch Resistance Test

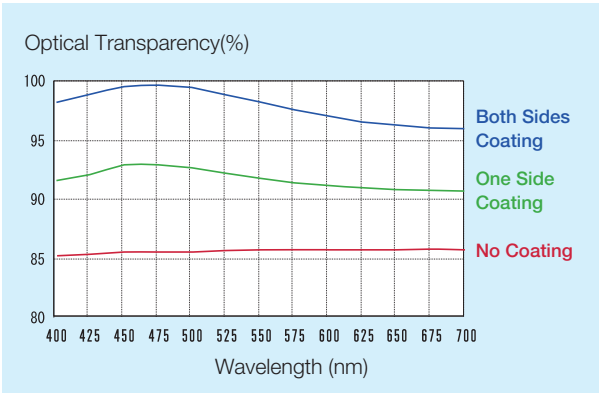


Optical Transparency



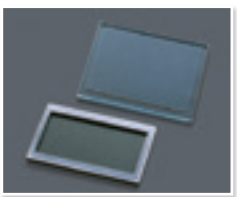
Options

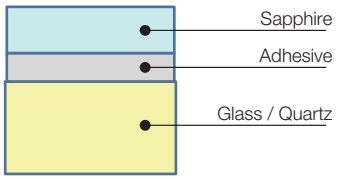
Anti-Reflection Coating (AR Coating)



SOG (Sapphire on Glass)

Sapphire-on-Glass bonding structure makes the plate both shock-resistant and shatter-resistant.





* Please contact us for available sizes.
* Values are typical properties of each material, and may vary depending on product configurations or manufacturing processes. For more details, please feel to contact us.

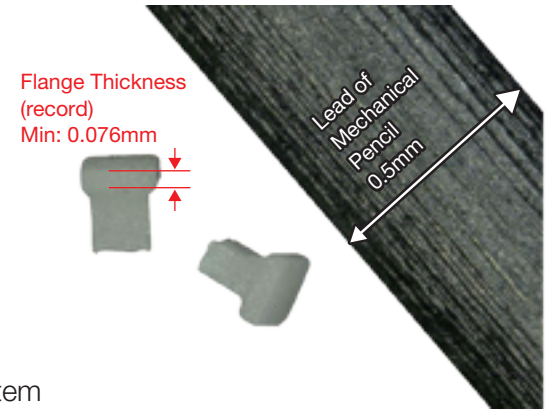
Volume Production Components for Various Electronics

Volume production capability of customized product, in monthly quantity of hundreds of millions per item

Features

- Variety of product configurations
  - Technology to optimize density balance in forming process enables multi-cavity shapes or ultra small components
- Wide selection of ceramics materials
  - Alumina / Silicon Carbide / Ferrite / etc.
- Volume production capability
  - Experience in monthly quantity of hundreds of millions per item
- Please contact us for any specific requirement

■ Ultra Small Component Example



Applications

- Insulators for downsized electronic components, or ceramic parts to minimize magnetic / dielectric losses

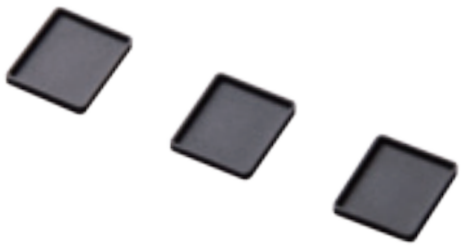
(ex.: Used in or as fuses, thermostats, inductor cores, filters for base tranceiver stations, etc.)

Ultra Thin Ceramic Caps

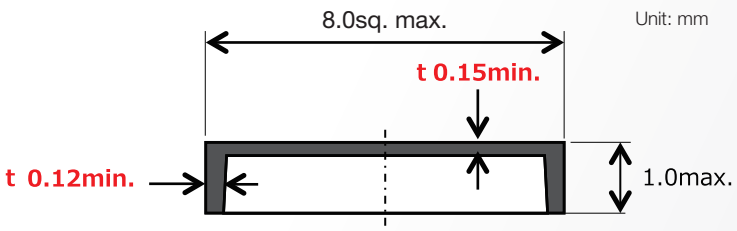
Ultra thin, enabling devices to become smaller in size, lower in height

Features

- Cap in ceramic for smaller size and lower height
- Ultra thin walls, based on Kyocera's unique material / forming technology



- New Ceramic Cap Size

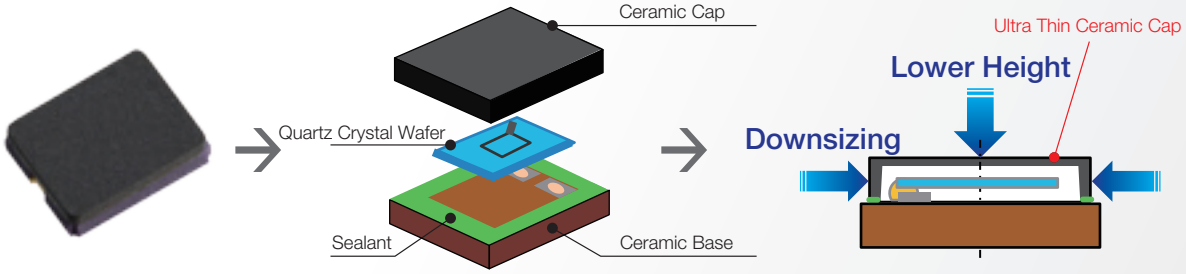


Minimum Wall Thickness Comparison (Compared to our company's product)

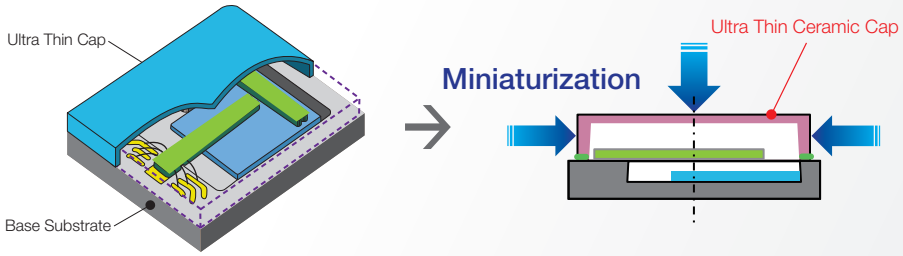
	Conventional Technology	New Technology
Side Wall Thickness	0.24mm	0.12mm
Top Wall Thickness	0.20mm	0.15mm

* Please contact us for any other sizes.

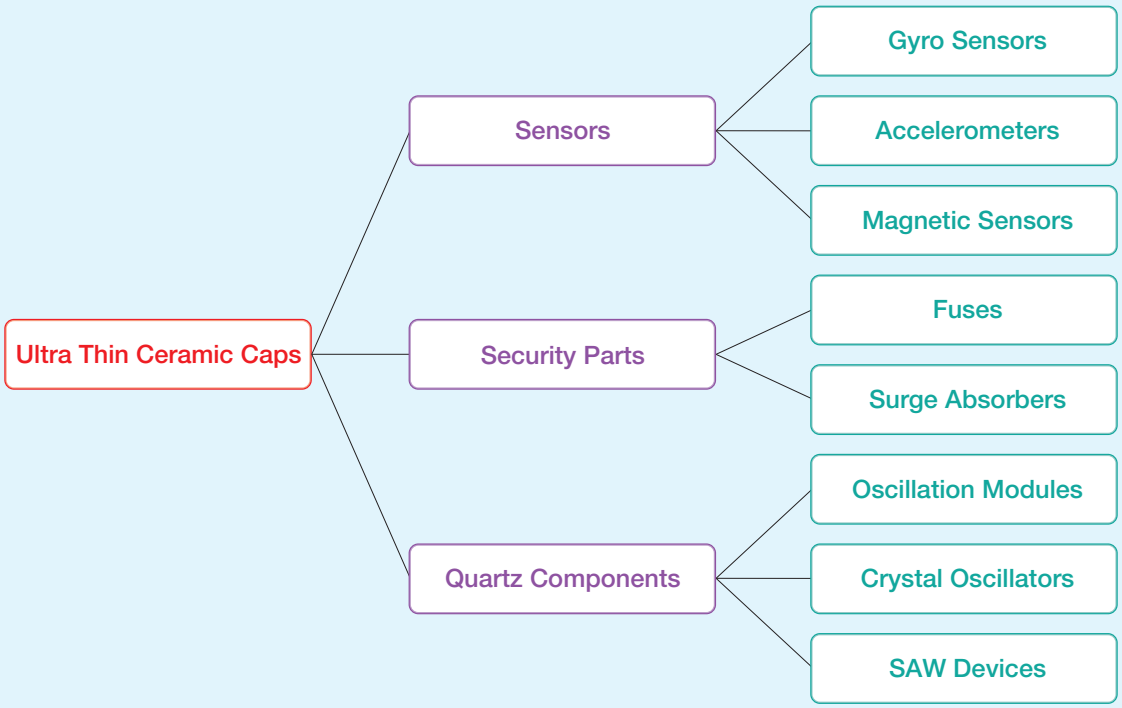
• Application Example in Crystal Oscillator



• Application Example in Gyro Sensor



• Market for Ultra Thin Ceramic Caps



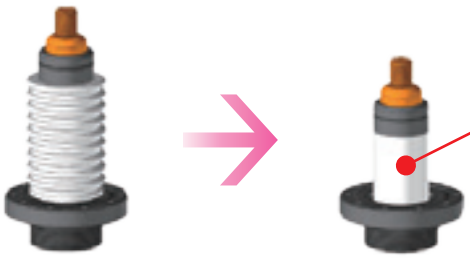
High Voltage-resistant Alumina Ceramic (AH100A)

Possibility of 50% downsizing, with 1.6 times higher voltage resistance than conventional ceramic (based on Kyocera simulation)

Features

- Improvement of dielectric strength / creeping voltage resistance in vacuum atmosphere
- Conditioning time reduction at high voltage operation
- Ripple reduction
- 50% downsizing from conventional alumina (based on Kyocera simulation)

■ Design Image of Size Reduction

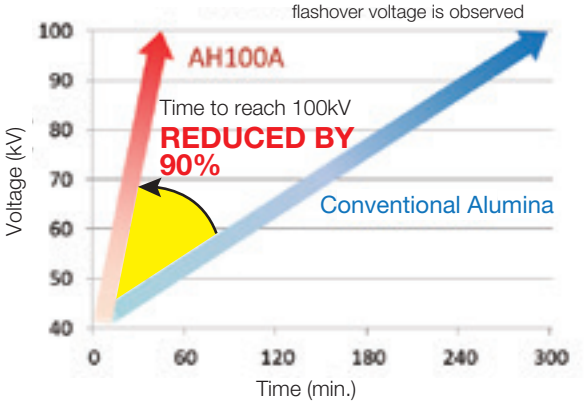


Applications

- High Voltage Accelerators (Analysis Equipment)
- Ultra High Vacuum Feedthroughs (Semiconductor Processing Tools)
- Electron Beam Generators (Medical or Industrial X-ray Tubes)

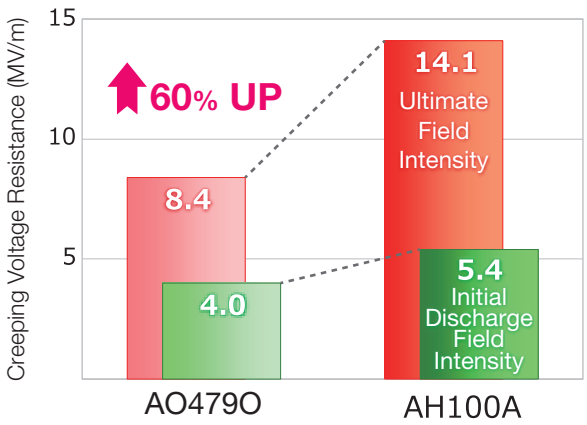
Conditioning Time

Measuring Conditions: Pressure ≦ 10^{-3}Pa
Voltage Increase 1kV/min.
Restarted from 0V every time flashover voltage is observed



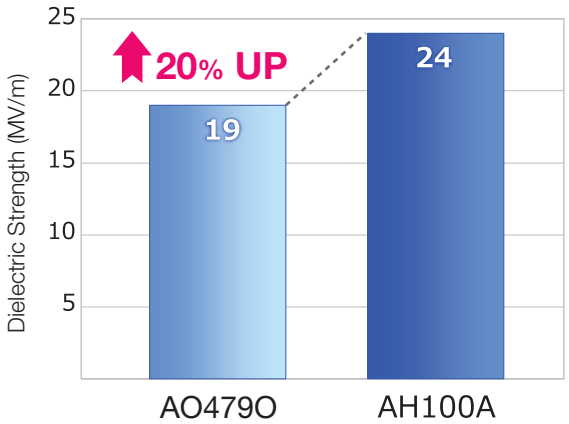
Creeping Voltage Resistance (in a vacuum)

Surface Distance 2mm
Degree of Vacuum ≦ 10^{-4}Pa
Others per Kyocera testing set-up



Dielectric Strength

Bulk Ceramic Thickness 1mm
Others based on JIS C 2141 standard



Material Characteristics & Measurement Comparison

(Reference Data)

Item		Unit	AO479O (Conventional Alumina)	AH100A (High Voltage Resistant Alumina)
Electrical Characteristics	Ultimate Field Intensity	MV/m	8.4 (ave.)	14.1 (ave.)
	Dielectric Strength	MV/m	19	24
	Volume Resistivity	Ω·cm	≧ 1×10^{14}	≧ 1×10^{14}
	Dielectric Constant (1MHz)	–	9.9	10.2
	Dielectric Loss Tangent (1MHz)	–	2×10^{-4}	< 1×10^{-4}
Mechanical Characteristics	Average Strength ASTM D2442 TYPE3	MPa	310	330
	Young's Modulus of Elasticity	GPa	360	380
	Poisson's Ratio	–	0.23	0.25
	Fracture Toughness	MPa·$m^{1/2}$	3~4	5
Thermal Characteristics	Thermal Conductivity	W/(m·K)	29	24
	Coefficient of Linear Thermal Expansion (RT-800°C)	ppm/°C	8.0	8.2

Characteristics of Kyocera's Fine Ceramics

The term "Fine Ceramics" is interchangeable with "advanced ceramics," "technical ceramics" and "engineered ceramics." Use varies by region and industry.

Item \ Material				Aluminum Oxide (Al_2O_3)							
Material Code (New)				AO459K	AO445O	AO473O	AO476O	AO479O	AO479S	AO479M/AO479G	AO480S
Material Code (Old)				A459	A445	A473	A476	A479	A479S	A479M / A479G	A480S
Appearance				Dense							
Color				Russet	Dark Brown	White	White	White	Ivory	Ivory	Ivory
Content			(%)	89	90	92	96	99	99.5	99.5	99.7
Main Characteristics				•High Frequency Insulation •High Mechanical Strength •Wear Resistant •High Corrosion Resistance •High Temperature Resistance							
				•Good for Metallizing	•Intercepting •High Heat Dissipation	•Metallizing •High Mechanical Strength	•Excellent Surface Finish •Excellent Printability	•High Hardness •High Corrosion Resistance	•High Hardness •High Corrosion Resistance •High Wear Resistance	•High Hardness •High Corrosion Resistance •High Wear Resistance	•High Purity •High Corrosion Resistance •Good Plasma Resistance •High Wear Resistance
Main Applications				•Magnetron	•IC Packages	•IC Multilayer Packages •Electron-tube Housing •Wear Resistant Parts	•Hybrid IC Substrates	•Heat, Corrosion and Wear Resistant Parts	•Corrosion and Wear Resistant Parts	•Corrosion and Wear Resistant Parts •Semiconductor Processing Equipment	•Corrosion and Wear Resistant Parts •Semiconductor Processing Equipment
Density			g/cm^3	JIS R1634	3.6	3.8	3.6	3.7	3.8	3.9	3.9	3.9
Water Absorption			%	JIS C2141	0	0	0	0	0	0	0	0
Mechanical Characteristics	Vickers Hardness HV9.807N		GPa	JIS R1610	12.1	12.7	12.3	13.7	15.2	16.0	15.7	17.2
	Flexural Strength 3 P.B.		MPa	JIS R1601	310	320	340	350	310	400	370	480
	Compressive Strength		MPa	JIS R1608	-	2,430	2,300	2,992	2,160	2,350	2,984	2,900
	Young's Modulus of Elasticity		GPa	JIS R1602	280	320	280	320	360	370	370	380
	Poisson's Ratio		-	JIS R1602	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	Fracture Toughness (SEPB)		$MPa \cdot m^{1/2}$	JIS R1607	-	4.1	3.5	2.9	3 - 4	4	4.3	4.3
Thermal Characteristics	Coefficient of Linear Thermal Expansion	40 - 400°C	$x10^{-6}/K$	JIS R1618	7.0	7.3	6.9	7.2	7.2	7.2	7.2	7.2
		40 - 800°C			7.9	8.1	7.8	7.9	8.0	8.0	8.0	8.0
	Thermal Conductivity	20°C	W/(m·K)	JIS R1611	14	12	18	24	29	32	32	32
	Specific Heat Capacity		J/(g·K)	JIS R1611	0.75	0.75	0.78	0.78	0.79	0.78	0.78	0.79
	Thermal Shock Temperature Difference (Put in Water, Relative Method)		°C	JIS R1648	-	150	150	150	150	180	180	180
Electrical Characteristics	Dielectric Strength		KV/mm	JIS C2141	15	12	16	15	15	15	15	15
	Volume Resistivity	20°C	Ω·cm		$>10^{14}$	10^{11}	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$
		300°C			10^{10}	10^{7}	10^{12}	10^{10}	10^{10}	10^{13}	10^{13}	10^{13}
		500°C			10^{8}	10^{5}	10^{10}	10^{8}	10^{8}	10^{10}	10^{10}	10^{10}
	Dielectric Constant	(1MHz)	-		8.8	9.8	9.0	9.4	9.9	9.9	9.9	9.9
	Dielectric Loss Tangent	(1MHz)	$(x10^{-4})$		6	20	6	4	2	1	1	1
	Loss Factor		$(x10^{-4})$		52	190	54	38	20	10	10	10
Chemical Characteristics	Nitric Acid	(60%) 90°C,24H	(Weight Loss) mg/cm^2	-	-	1.17	0.32	0.02	0.10	0.00	0.01	0.05
	Sulphuric Acid	(95%) 95°C,24H			-	0.33	0.65	0.01	0.33	0.00	0.00	0.22
	Caustic Soda	(30%) 80°C,24H			-	0.58	0.91	0.86	0.26	0.00	0.00	0.04

*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.

	Sapphire (Al_2O_3)	Steatite (MgO·SiO2)		Forsterite ($2MgO·SiO_2$)		Silicon Nitride (Si_3N_4)		Aluminum Nitride (AlN)		Zirconia (ZrO_2)
	SA100	SO210O	SO211O	F1120O	F1023O	SN201B	SN240O	AN216A	AN2000	ZO201N
	SA100	S210	S211	F1120	F1023	SN201B	SN240	AN216A	AN2000	Z201N
	Dense	Dense		Dense		Dense		Dense		Dense
	Transparent	White	Dark Brown	Light Yellow		Black		Gray	Ivory	Ivory
	99.99	-		-		-		-	99.9	-
	Single Crystal					•High Temperature Strength •Wear Resistance •Excellent Thermal Shock Resistance •Light Weight		•Insulation Property •High Thermal Conductivity •Lower Thermal Expansion		•High Mechanical Strength •High Fracture Toughness •Excellent Sliding Properties •Excellent Surface Finish
	•Optical Transparency •High Heat Resistance •High Frequency Insulation •High Chemical Resistance	•Good Insulation Property	•Good Light Shield	•Good Surface Finish	•High Thermal Expansion		•High Strength, High Temperature Durability		•High Purity •Good Plasma Resistance	
	•Thin Film Substrates •Windows •Chemically Resistant Parts	•Various Circuit Parts		•Resistor Cores •Substrates for Resistors		•Anti Wear Liner •Pulverizer •Molten Metal Parts •Metal Forming Tool		•Heat Uniformity Parts •High Temperature Treatment Fixtures •Semiconductor Processing Equipment		•Industrial Cutlery •Pump Parts •Dies •Knives •Scissors •Wear Resistant Parts
	3.97	2.8	3.1	3.0	3.0	3.2	3.3	3.4	3.2	6.0
	0	0	0	0	0	0	0	0	0	0
	a Plane 22.5	5.8	6.7	7.3	5.9	13.9	14.0	10.4	11.2	12.3
	a Plane / c Axis 690	190	220	180	160	580	1,020	310	220	1,000
	2,940	1,305	-	-	-	3,160	3,551	3,200	2,900	3,000
	470	120	130	150	150	290	300	320	310	200
	Parallel to Axis c / Vertical to Axis c 0.18	0.22	0.22	0.24	0.24	0.28	0.28	0.24	0.24	0.31
	2.1	1.9	-	-	-	4 - 5	7	3.2	2.5	6
	Parallel to Axis c 7.7 / Vertical to Axis c 7.0	7.7	9.2	9.7	10.1	2.4	2.8	4.6	4.6	10.5
	Parallel to Axis c 8.8 / Vertical to Axis c 7.9	8.0	10.4	-	-	3.2	3.3	5.3	5.2	11.0
	42	2	3	5	5	25	27	150	67	3
	0.75	0.75	0.72	0.78	0.75	0.64	0.65	0.71	0.72	0.46
	180	150	-	-	-	550	800	250	200	300
	48	18	14	17	13	9.7	13	14	16	11
	$>10^{14}$	$>10^{14}$	$>10^{13}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	10^{13}
	10^{12}	10^{10}	10^{9}	10^{13}	10^{9}	10^{12}	10^{12}	10^{10}	10^{11}	10^{6}
	10^{11}	10^{7}	10^{7}	10^{10}	10^{9}	10^{10}	10^{10}	10^{8}	10^{9}	10^{3}
	Parallel to Axis c 11.5 / Vertical to Axis c 9.3	6	8	6.5	6.5	8.9	9.6	8.6	8.5	33.0
	<1	18	750	3	5	17.0	19	3	2	16
	-	108	6,000	20	30	-	-	26	17	520
	≒0.00	0.01	-	-	-	-	1.11	-	-	≒0.00
	≒0.00	0.00	-	-	-	-	0	-	-	0.04
	≒0.00	15.35	-	-	-	-	0.22	-	-	0.08

1kgf/mm^2=9.807MPa

KYOCERA

KYOCERA Corporation

Corporate Fine Ceramics Group

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

Kyocera Fine Ceramics

Product Inquiries→

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