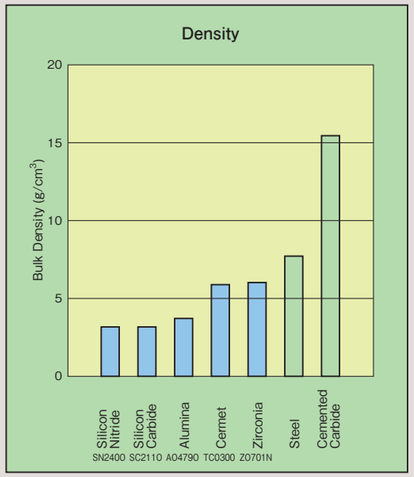
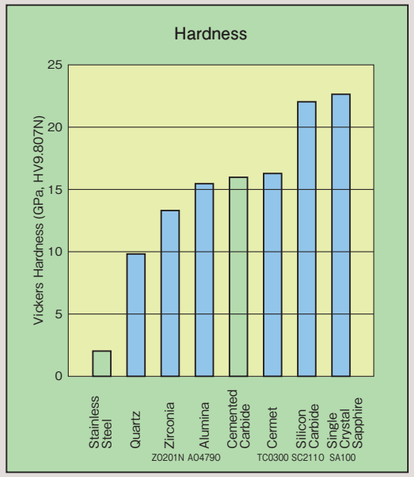
THE NEW VALUE FRONTIER

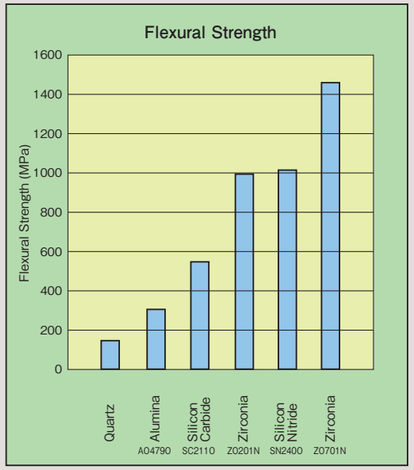
KYOCERA

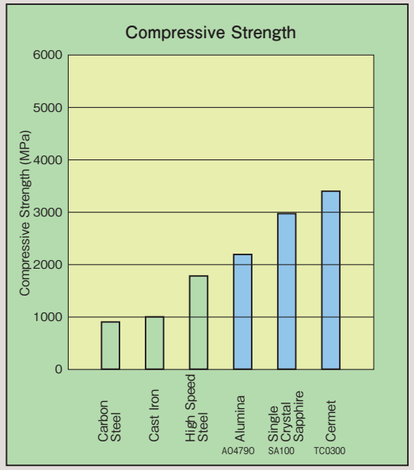
CHARACTERISTICS OF KYOCERA FINE CERAMICS

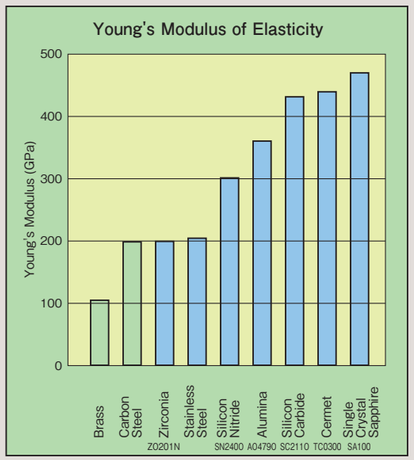
MATERIAL COMPARISON CHARTS

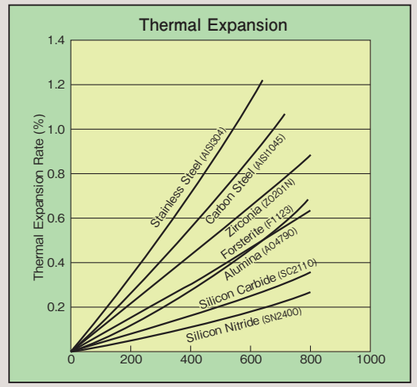


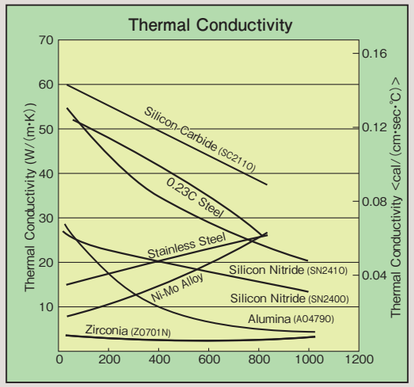


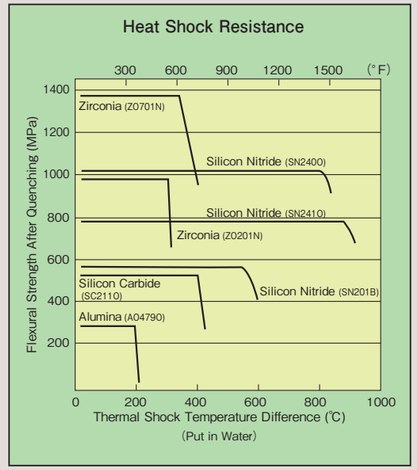


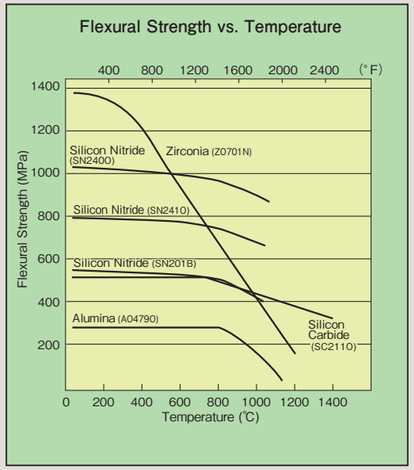


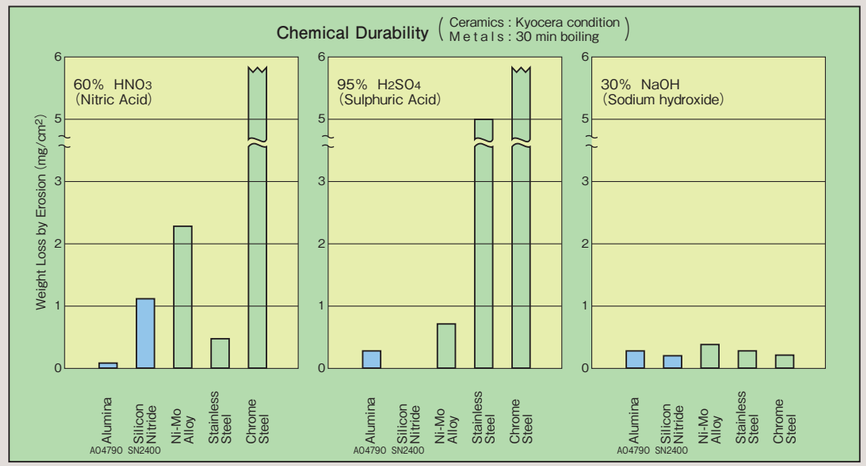












Unit Conversion Table

■Stress

MPa or N/mm²	kgf/mm²	psi(=lbf/in²)
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 of Kyocera Fine Ceramics (1)

Item \ Material			ALUMINA (Al_2O_3)											SAPPHIRE	CORDIERITE ($2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$)		STEATITE ($MgO \cdot SiO_2$)		FORSTERITE ($2MgO \cdot SiO_2$)	
Material Code (Old)			A482R	A459	A445	A471	A473	A484	A476	A479	A479S	A479M A479G	A480S	A601D A601L	SA100	CO220	CO720	S210	S211	F1120	F1023
Material Code (New)			AO482R	AO459K	AO445O	AO471O	AO473O	AO484O	AO476O	AO479O	AO479S	AO479M AO479G	AO480S	AO601D AO601L	SA100	CO220O	CO720O	SO210O	SO211O	F1120O	F1023O
Appearance			Porous	Dense											Dense	Dense	Dense	Dense		Dense	
Color			Pink	Russet	Dark Brown	White	White	White	White	White	Ivory	Ivory	Ivory	Ivory	Transparent	Gray	Gray	White	Dark Brown	Light Yellow	
Content		(%)	Al_2O_3 76	89	90	92	92	92	96	99	99.5	99.5	99.7	99.9	99.99	–	–	–	–	–	–
Main Characteristics			High Mechanical Strength, High Temperature Resistance, High Frequency Insulation, High Chemical Resistance												Single Crystal	● Very Low Thermal Expansion ● Light Weight	● Void Less	● Thermal Insulator	● Good Light Shield	● Good Surface Finish	● High Thermal Expansion
			● High Heat Resistance	● Good for Metallizing	● Light Intercepting, ● High Heat Dissipation	● Wear Resistant	● Good for Metallizing, ● Mechani-cally Strong	● Wear Resistant	● Good Surface Smoothness	● Hard and Chemically Stable	● 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						
Main Applications			● Welding Nozzle, ● Nozzle for Glass Fiber Manufac-turing	● 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	● Pump ● Shafts	● Wear Resistant Parts ● Chemically Ressitant Parts ● Semiconductor Processing Equipment Parts			● Thin Film Substarates, ● Windows, ● Chemically Resistant Parts	● Lithography Stage Component ● Wafer Inspection Stage Component ● SEM/TEM		● Various Circuit Parts		● Substrate For Resistor ● Core For Resistor	
Density (*1)		g/cm^3	JIS R 1634	3.6	3.6	3.8	3.6	3.6	3.6	3.7	3.8	3.9	3.9	3.9	3.9	3.97		2.5	2.5	2.8	3.1	3.0	3.0
Water Absorption		%	JIS C 2141	0.6	0	0	0	0	0	0	0	0	0	0	0	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	16.0	15.7	17.2	17.5	Surface a	22.5	8	8.5	5.8	6.7	7.3	5.9
	Flexural Strength 3 P.B.	MPa	JIS R 1601	120	310	320	390	340	370	350	310	360	370	380	400	Surface a / Axis c	690	190	200	190	220	180	160
	Compressive Strength	MPa	JIS R 1608	–	–	–	–	2,300	–	–	2,160	2,350	–	–	–	2,940		–	–	–	–	–	–
	Young's Modulus of Elasticity	GPa	JIS R 1602	160	280	320	280	280	280	320	360	370	370	380	380	470		140	145	120	130	150	150
	Poisson's Ratio	–		0.17	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	–		0.31	0.31	0.22	0.22	0.24	0.24
	Fracture Toughness (SEPB)	$MPa \cdot m^{1/2}$	JIS R 1607	–	–	–	–	–	–	–	3 ~ 4	4	–	–	5 ~ 6	–		1 ~ 1.5	1 ~ 1.5	–	–	–	–
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	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
	Coefficient of Linear Thermal Expansion 40 – 800℃			7.5	7.9	8.1	7.9	7.8	7.7	7.9	8.0	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	–	–
	Thermal Conductivity 20℃	W/(m・K)	JIS R 1611	8	14	12	16	18	17	24	29	32	32	32	34	41		4	4	2	3	5	5
	Specific Heat Capacity	J/(g・K)	JIS R 1611	0.75	0.75	0.75	0.79	0.78	0.78	0.78	0.79	0.78	0.78	0.79	0.78	0.75		0.71	–	0.75	0.72	0.78	0.75
	Thermal Shock Temperature Difference (Put in Water, Relative Method)	℃	JIS R 1648	320	–	–	200	200	200	200	200	250	–	–	–	–		–	400	–	–	–	–
Electrical Characteristics	Dielectric Strength	kV/mm	JIS C 2141	12	15	12	16	16	14	15	15	15	15	15	15	48		19.1	19.3	18	14	17	13
	Volume Resistivity 20℃	Ω・cm		$> 10^{14}$	$> 10^{14}$	10^{11}	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$		$> 10^{14}$	$>10^{14}$	$> 10^{14}$	$> 10^{13}$	$> 10^{14}$	$> 10^{14}$
	Volume Resistivity 300℃			10^{10}	10^{10}	10^{7}	10^{12}	10^{12}	10^{10}	10^{10}	10^{10}	10^{13}	10^{13}	10^{13}	10^{13}	–		10^{12}	10^{12}	10^{10}	10^{9}	10^{13}	10^{9}
	Volume Resistivity 500℃			10^{8}	10^{8}	10^{5}	10^{9}	10^{10}	10^{8}	10^{8}	10^{8}	10^{10}	10^{10}	10^{10}	10^{10}	10^{11}		10^{10}	10^{10}	10^{7}	10^{7}	10^{10}	10^{9}
	Dielectric Constant (1MHz)	–		8.4	8.8	9.8	8.9	9.0	8.9	9.4	9.9	9.9	9.9	9.9	9.9	Parallel to Axis c	11.5	4.9	4.9	6	8	6.5	6.5
																Vertical to Axis c	9.3						
	Dielectric Loss Angle (1MHz)	($\times 10^{-4}$)		180	6	20	6	6	9	4	2	1	1	1	1	< 1		9	8.5	18	750	3	5
	Loss Factor	($\times 10^{-4}$)		1,500	52	190	53	54	80	38	20	10	10	10	10	–		–	–	108	6,000	20	30
Chemical Characteristics	Nitric Acid (60%) 90℃,24H	(Weight Loss) mg/cm^2	–	–	–	–	–	0.32	0.14	–	0.10	0.07	–	0.05	0.03	≒ 0.00		–	–	–	–	–	–
	Sulphuric Acid (95%) 95℃,24H			–	–	–	–	0.65	0.34	–	0.33	0.25	–	0.22	0.19	≒ 0.00		–	–	–	–	–	–
	Sodium Hydroxide (30%) 80℃,24H			–	–	–	–	0.91	0.95	–	0.26	0.05	–	0.04	0.03	≒ 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.

$1kgf/mm^2 = 9.807MPa$

$1cal/(cm \cdot sec \cdot ℃) = 418.6W/(m \cdot K)$

*1: All values for apparent density and bulk density are the same, except for A482R which lists apparent density only.

KYOCERA

CHARACTERISTICS of Kyocera Fine Ceramics (2)

Item \ Material			YTTRIA (Y_2O_3)	TITANIA			SILICON CARBIDE (SiC)		SILICON NITRIDE (Si_3N_4)			ALUMINIUM NITRIDE (AlN)		ZIRCONIA (ZrO_2)				CERMET
Material Code (Old)			YO100A	T716	T716H	T792H	SC211	SC1000	SN201B	SN240	SN241	AN216A	AN2000	Z220	Z201N	Z701N	Z21H04	TC30
Material Code (New)			YO100A	TO716O	TO716H	TO792H	SC211O	SC1000	SN201B	SN240O	SN241O	AN216A	AN2000	ZO220O	ZO201N	ZO701N	Z21H04	TC0300
Appearance			Dense	Dense			Dense		Dense			Dense		Dense				Dense
Color			White	Light Brown	Light Brown	Grayish Yellow	Black	Black	Black	Black	Black	Gray	Ivory	Yellow	Ivory	Ash Black	Black	Silver
Alumina Content		(%)	–	–	–	–	–	–	–	–	–	–	AlN 99.9	–	–	–	–	–
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	●High Temperature Strength ●Wear Resistant ●Excellent Thermal Shock Resistance ●Light Weight ●Haigh Strength, High Temperature Durability		●High Thermal Conductivity	●High Electrical Insulation, ●High Thermal Conductivity ●Excellent Thermal ●Conductivity	●High Purity, ●Good Plasma Resistance	●High Mechanical Strength, ●Excellent Wear Resistance, ●Good Surface Finish, ●High Fracture Toughness				●High Mechanical Strength, ●Excellent Wear Resistance, ●High Heat Shock Resistance, ●Electrical Conductivity
Main Applications			●SPE Parts	●Slider Pads for Disk Drive Heads			●Mechanical Seal, ●High Temperature Resistance Parts		●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
Density (*1)		g/cm^3 JIS R 1634	4.9	3.9	4.0	4.5	3.2	3.16	3.2	3.3	3.2	3.4	3.2	5.6	6.0	6.0	5.6	6.0
Water Absorption		% JIS C 2141	0	0	0	0	0	0	0	0	0	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	14.0	13.8	10.4	11.2	10.7	12.3	12.7	10.8	16.2
	Flexural Strength 3 P.B.	MPa JIS R 1601	130	320	320	230	540	450	580	1,020	790	310	220	750	1,000	1,470	710	1,470
	Compressive Strength	MPa JIS R 1608	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3,430
	Young's Modulus of Elasticity	GPa JIS R 1602	160	260	270	180	430	440	290	300	290	320	310	200	200	220	210	440
	Poisson's Ratio	– JIS R 1602	–	–	–	–	0.16	0.17	0.28	0.28	0.28	0.24	0.24	0.31	0.31	0.31	–	0.21
	Fracture Toughness (SEPB)	$MPa \cdot m^{1/2}$ JIS R 1607	1.1	–	–	–	4 ~ 5	2 ~ 3	4 ~ 5	7	6 ~ 7	–	–	7 ~ 8	4 ~ 5	4 ~ 5	3 ~ 4	–
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	2.8	2.9	4.6	4.6	10	10.5	10.8	10.3	7.4
	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	3.3	3.5	5.3	5.2	10.5	11.0	11.3	11.4	8.3
	Thermal Conductivity 20℃	W/(m・K) JIS R 1611	14	4	4	2	60	200	25	27	54	150	67	3	3	3	3	17
	Specific Heat Capacity	J/(g・K) JIS R 1611	0.45	0.71	0.71	0.59	0.67	0.67	0.64	0.65	0.66	0.71	0.72	0.46	0.46	0.46	0.48	–
	Thermal Shock Temperature Difference (Put in Water, Relative Method)	℃ JIS R 1648	–	–	–	–	400	–	550	800	900	–	–	450	300	350	–	310
Electrical Characteristics	Dielectric Strength	kV/mm JIS C 2141	11	–	–	–	–	–	–	13	12	14	16	13	11	–	–	–
	Volume Resistivity 20℃	Ω・cm JIS C 2141	$>10^{13}$	10^{12}	10^{12}	10^{12}	10^{5}	10^{8}	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	10^{13}	–	10^{8}	10^{-4}
	Volume Resistivity 300℃	Ω・cm JIS C 2141	10^{10}	–	–	–	10^{4}	10^{4}	10^{12}	10^{12}	10^{12}	10^{10}	10^{11}	10^{6}	10^{6}	–	–	–
	Volume Resistivity 500℃	Ω・cm JIS C 2141	10^{7}	–	–	–	10^{3}	10^{3}	10^{10}	10^{10}	10^{10}	10^{8}	10^{9}	10^{4}	10^{3}	–	–	–
	Dielectric Constant (1MHz)	– JIS C 2141	11	–	–	–	–	–	–	9.6	9.6	8.6	8.5	28	33	–	–	–
	Dielectric Loss Angle (1MHz)	($\times 10^{-4}$) JIS C 2141	5	–	–	–	–	–	–	19	18	3	2	17	16	–	–	–
	Loss Factor	($\times 10^{-4}$) JIS C 2141	55	–	–	–	–	–	–	–	–	26	17	476	520	–	–	–
Chemical Characteristics	Nitric Acid (60%) 90℃ ,24H	(Weight Loss) mg/cm^2 –	–	–	–	–	0.04	≒ 0.00	–	1.11	0.18	–	–	–	≒ 0.00	≒ 0.00	–	6.0
	Sulphuric Acid (95%) 95℃ ,24H	(Weight Loss) mg/cm^2 –	–	–	–	–	0.01	≒ 0.00	–	0	0	–	–	–	0.04	0.04	–	0.26
	Caustic Soda (30%) 80℃ ,24H	(Weight Loss) mg/cm^2 –	–	–	–	–	≒ 0.00	≒ 0.00	–	0.22	0.07	–	–	–	0.08	0.08	–	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.

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

*1: All values for apparent density and bulk density are the same, except for A482R which lists apparent density only.

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008/019/2001
Printed in Japan