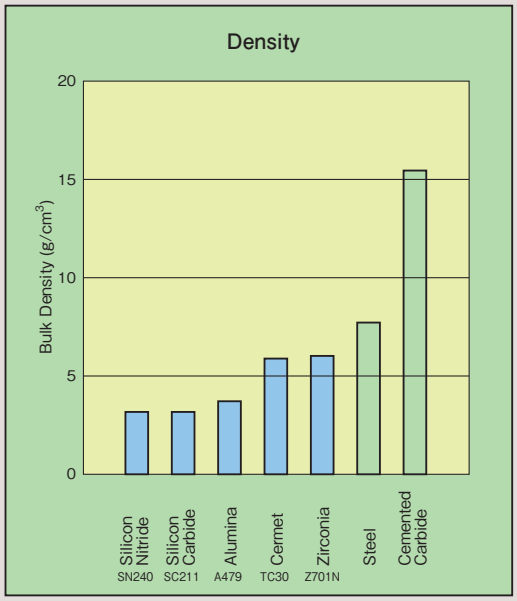
THE NEW VALUE FRONTIER

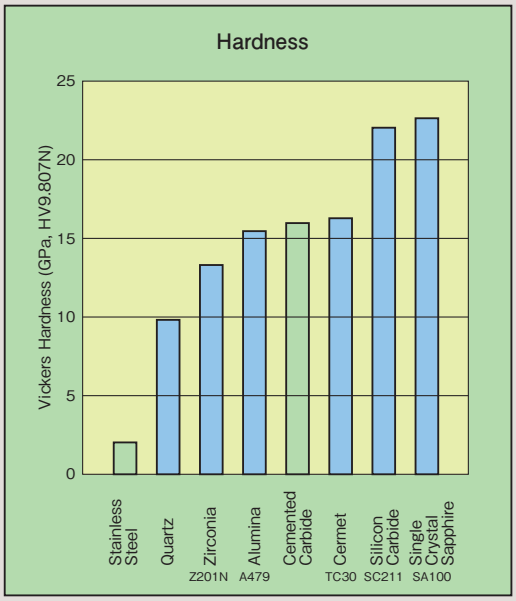
KYOCERA

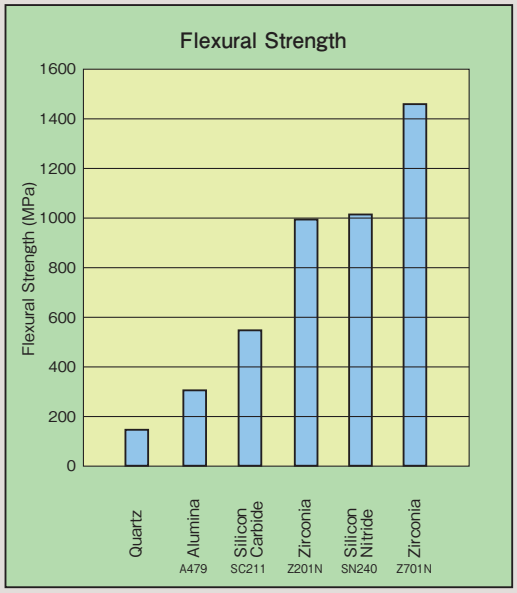
CHARACTERISTICS OF KYOCERA FINE CERAMICS

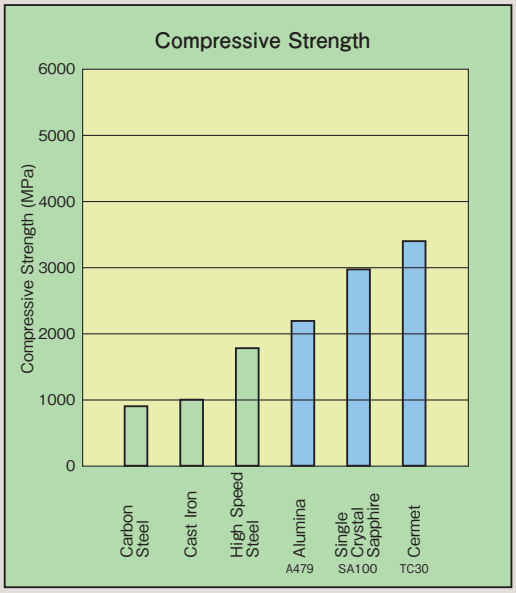
KYOCERA

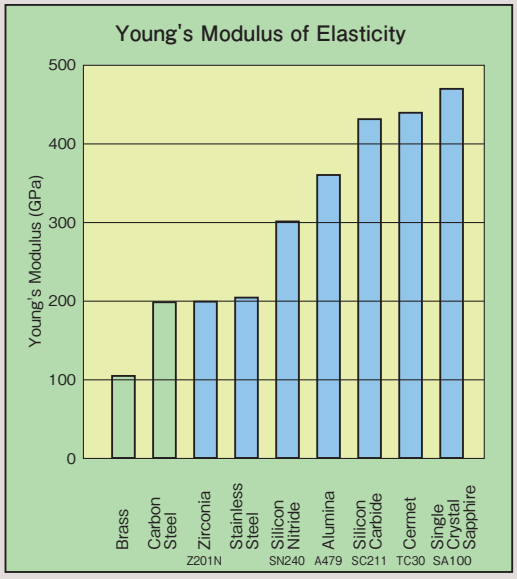
MATERIAL COMPARISON CHARTS

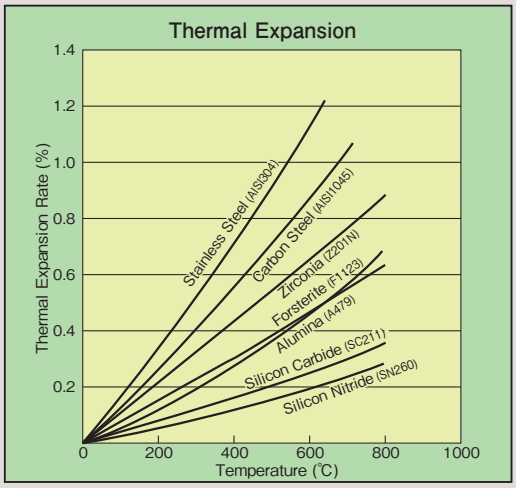


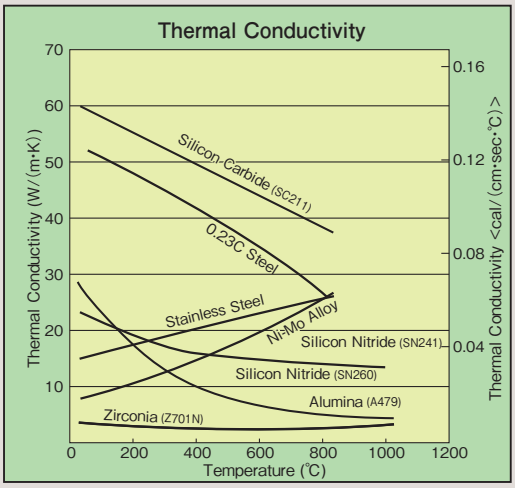


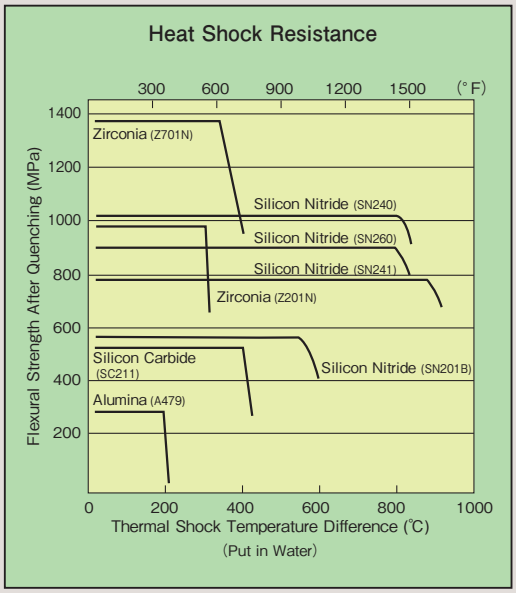


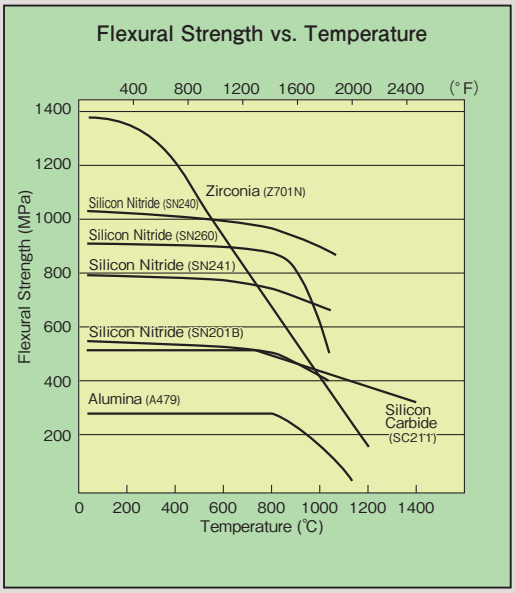


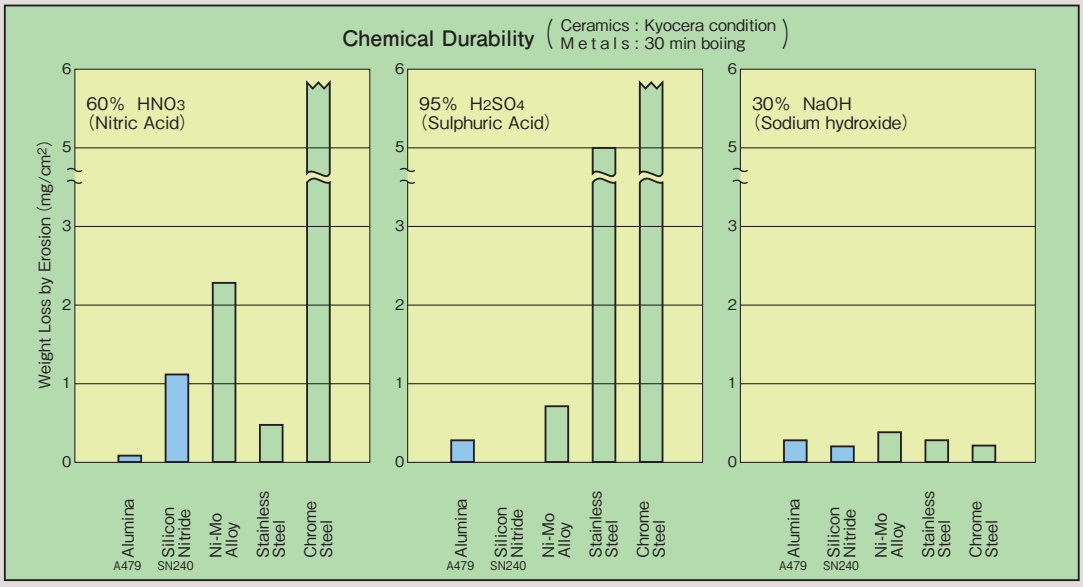












Unit Conversion Table

■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

KYOCERA

CHARACTERISTICS of Kyocera Fine Ceramics (1)

Item \ Material				ALUMINA (Al_2O_3)								
Kyocera No.				A482R	A459	A445	A471	A473	A484	A476	A479	A479S
Appearance				Porous	Dense							
Color				Pink	Russet	Dark Brown	White	White	White	White	White	Ivory
Content			(%)	$A\ell_2O_3$ 76	89	90	92	92	92	96	99	99.5
Main Characteristics				High Mechanical Strength, High Temperature Resistance, High Frequency Insulation, Hig								
				● 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
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
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
Water Absorption			%	JIS C 2141	0.6	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
	Flexural Strength 3 P.B.		MPa	JIS R 1601	120	310	320	390	340	370	350	310	360
	Compressive Strength		MPa	JIS R 1608	—	—	—	—	2,300	—	—	2,160	2,350
	Young's Modulus of Elasticity		GPa	JIS R 1602	160	280	320	280	280	280	320	360	370
	Poisson's Ratio		—		0.17	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	Fracture Toughness (SEPB)		MPa・m$^{1/2}$	JIS R 1607	—	—	—	—	—	—	—	3 ~ 4	4
Thermal Characteristics	Coefficient of Linear Thermal Expansion	40 — 400℃	× 10^{-6}/K	JIS R 1618	7.1	7.0	7.3	7.1	6.9	6.8	7.2	7.2	7.2
		40 — 800℃			7.5	7.9	8.1	7.9	7.8	7.7	7.9	8.0	8.0
	Thermal Conductivity	20℃	W/(m・K)	JIS R 1611	8	14	12	16	18	17	24	29	32
	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
	Thermal Shock Temperature Difference (Put in Water, Relative Method)		℃	JIS R 1648	320	—	—	200	200	200	200	200	250
Electrical Characteristics	Dielectric Strength		kV/mm	JIS C 2141	12	15	12	16	16	14	15	15	15
	Volume Resistivity	20℃	Ω・cm		> 10^{14}	> 10^{14}	10^{11}	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{14}
		300℃			10^{10}	10^{10}	10^{7}	10^{12}	10^{12}	10^{10}	10^{10}	10^{10}	10^{13}
		500℃			10^{8}	10^{8}	10^{5}	10^{9}	10^{10}	10^{8}	10^{8}	10^{8}	10^{10}
	Dielectric Constant	(1MHz)	—		8.4	8.8	9.8	8.9	9.0	8.9	9.4	9.9	9.9
	Dielectric Loss Angle	(1MHz)	(× 10^{-4})		180	6	20	6	6	9	4	2	1
	Loss Factor		(× 10^{-4})		1,500	52	190	53	54	80	38	20	10
Chemical Characteristics	Nitric Acid (60%) 90℃,24H		(Weight Loss) mg/cm^2	—	—	—	—	—	0.32	0.14	—	0.10	0.07
	Sulphuric Acid (95%) 95℃,24H				—	—	—	—	0.65	0.34	—	0.33	0.25
	Sodium Hydroxide (30%) 80℃,24H				—	—	—	—	0.91	0.95	—	0.26	0.05

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	MULLITE ($3Al_2O_3 \cdot 2SiO_2$)	CORDIERITE ($2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$)		STEATITE ($MgO \cdot SiO_2$)		FORSTERITE ($2MgO \cdot SiO_2$)		
A479M A479G	A480S	A601D A601L	SA100	ML652	CO220	CO720	S210	S211	F1120	F1023	FC112M
			Dense	Dense	Dense	Dense	Dense		Dense		
Ivory	Ivory	Ivory	Transparent	Dark Brown	Gray	Gray	White	Dark Brown	Light Yellow		Black
99.5	99.7	99.9	99.99	—	—	—	—	—	—	—	—
gh Chemical Resistance			Single Crystal	• Low Thermal Expansion	• Very Low Thermal Expansion • Light Weight		• Thermal Insulator	• Good Light Shield	• Good Surface Finish	• High Thermal Expansion	• Electro Static Ossipation • Less Voids
• High Chemical Resistance,	• Good Anti-Plasma, • Wear Resistance • High Purity		• High Heat Resistance, • High Chemical Resistance			• Void Less					
• Wear Resistant Parts • Chemically Ressitant Parts • Semiconductor Processing Equipment Parts			• Thin Film Substarates, • Windows, • Chemically Resistant Parts	• IC Packages	• Lithography Stage Component • Wafer Inspection Stage Component • SEM/TEM		• Various Circuit Parts		• Substrate For Resistor • Core For Resistor		• HDD Parts
3.9	3.9	3.9	3.97	3.2	2.5	2.5	2.8	3.1	3.0	3.0	3.6
0	0	0	0	0	0	0	0	0	0	0	0
15.7	17.2	17.5	Surface a 22.5	10.8	8	8.5	5.8	6.7	7.3	5.9	8.7
370	380	400	Surface a Axis c 690	280	190	200	190	220	180	160	210
—	—	—	2,940	—	—	—	—	—	—	—	—
370	380	380	470	210	140	145	120	130	150	150	190
0.23	0.23	0.23	—	0.27	0.31	0.31	0.22	0.22	0.24	0.24	0.27
—	—	5 ~ 6	—	—	1 ~ 1.5	1 ~ 1.5	—	—	—	—	1 ~ 2
7.2	7.2	7.2	Parallel to Axis c 7.7	5.0	1.5 (40℃~ 400℃) 2.1 (40℃~ 800℃)	1.5 (40℃~ 400℃) 2.1 (40℃~ 800℃)	7.7	9.2	9.7	10.1	10.5
8.0	8.0	8.0	Vertical to Axis c 7.0	5.8	< | 0.05 | (23℃) < | 0.02 | (22℃)	< | 0.05 | (23℃) < | 0.02 | (22℃)	8.0	10.4	—	—	12.0
32	32	34	41	5	4	4	2	3	5	5	4
0.78	0.79	0.78	0.75	0.75	0.71	—	0.75	0.72	0.78	0.75	0.77
—	—	—	—	—	—	400	—	—	—	—	—
15	15	15	48	15	19.1	19.3	18	14	17	13	—
$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$	$>10^{14}$	$> 10^{14}$	$> 10^{13}$	$> 10^{14}$	$> 10^{14}$	10^4
10^{13}	10^{13}	10^{13}	—	10^{12}	10^{12}	10^{12}	10^{10}	10^9	10^{13}	10^9	—
10^{10}	10^{10}	10^{10}	10^{11}	10^9	10^{10}	10^{10}	10^7	10^7	10^{10}	10^9	—
9.9	9.9	9.9	Parallel to Axis c 11.5 Vertical to Axis c 9.3	7.4	4.9	4.9	6	8	6.5	6.5	—
1	1	1	< 1	18	9	8.5	18	750	3	5	—
10	10	10	—	148	—	—	108	6,000	20	30	—
—	0.05	0.03	≒ 0.00	—	—	—	—	—	—	—	—
—	0.22	0.19	≒ 0.00	—	—	—	—	—	—	—	—
—	0.04	0.03	≒ 0.00	—	—	—	—	—	—	—	—

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

CHARACTERISTICS of Kyocera Fine Ceramics (2)

Item \ Material				YTTRIA (Y_2O_3)	TITANIA			SILICON CARBIDE (SiC)		
Kyocera No.				YO100A	T716	T716H	T792H	SC211	SC1000	SN201B
Appearance				Dense	Dense			Dense		
Color				White	Light Brown	Light Brown	Grayish Yellow	Black	Black	Black
Alumina 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
	Flexural Strength 3 P.B.		MPa	JIS R 1601	130	320	320	230	540	450	580
	Compressive Strength		MPa	JIS R 1608	–	–	–	–	–	–	–
	Young's Modulus of Elasticity		GPa	JIS R 1602	160	260	270	180	430	440	290
	Poisson's Ratio		–		–	–	–	–	0.16	0.17	0.28
	Fracture Toughness (SEPB)		MPa·m$^{1/2}$	JIS R 1607	1.1	–	–	–	4 ~ 5	2 ~ 3	4 ~ 5
Thermal Characteristics	Coefficient of Linear Thermal Expansion	40 – 400℃	× 10^{-6}/K	JIS R 1618	7.2	11.5	11.5	9.6	3.7	3.7	2.4
		40 – 800℃			7.6	12.1	12.1	–	4.4	4.4	3.2
	Thermal Conductivity	20℃	W/(m · K)	JIS R 1611	14	4	4	2	60	200	25
	Specific Heat Capacity		J/(g · K)	JIS R 1611	0.45	0.71	0.71	0.59	0.67	0.67	0.64
	Thermal Shock Temperature Difference	(Put in Water, Relative Method)	℃	JIS R 1648	–	–	–	–	400	–	550
Electrical Characteristics	Dielectric Strength		kV/mm	JIS C 2141	11	–	–	–	–	–	–
	Volume Resistivity	20℃	Ω · cm		>10^{13}	10^{12}	10^{12}	10^{12}	10^5	10^8	>10^{14}
		300℃			10^{10}	–	–	–	10^4	10^4	10^{12}
		500℃			10^7	–	–	–	10^3	10^3	10^{10}
	Dielectric Constant	(1MHz)	–		11	–	–	–	–	–	–
	Dielectric Loss Angle	(1MHz)	(× 10^{-4})		5	–	–	–	–	–	–
	Loss Factor		(× 10^{-4})		55	–	–	–	–	–	–
Chemical Characteristics	Nitric Acid (60%) 90℃ ,24H		(Weight Loss) mg/cm^2	–	–	–	–	–	0.04	≒ 0.00	–
	Sulphuric Acid (95%) 95℃ ,24H				–	–	–	–	0.01	≒ 0.00	–
	Caustic Soda (30%) 80℃ ,24H				–	–	–	–	≒ 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.
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SILICON NITRIDE (Si_3N_4)			ALUMINIUM NITRIDE (AlN)		ZIRCONIA (ZrO_2)				CERMET	
SN260	SN240	SN241	AN216A	AN2000	Z220	Z201N	Z701N	Z21H04	TC30	TC50
Dense			Dense		Dense				Dense	
Black	Black	Black	Gray	Ivory	Yellow	Ivory	Ash Black	Black	Silver	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	
●Rare Earth Free	●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	
3.1	3.3	3.2	3.4	3.2	5.6	6.0	6.0	5.6	6.0	7.7
0	0	0	0	0	0	0	0	0	0	0
12.7	14.0	13.8	10.4	11.2	10.7	12.3	12.7	10.8	16.2	14.2
900	1,020	790	310	220	750	1,000	1,470	710	1,470	1,860
—	—	—	—	—	—	—	—	—	3,430	3,430
270	300	290	320	310	200	200	220	210	440	410
0.28	0.28	0.28	0.24	0.24	0.31	0.31	0.31	—	0.21	0.23
6 ～ 7	7	6 ～ 7	—	—	7 ～ 8	4 ～ 5	4 ～ 5	3 ～ 4	—	—
2.8	2.8	2.9	4.6	4.6	10	10.5	10.8	10.3	7.4	7.8
3.4	3.3	3.5	5.3	5.2	10.5	11.0	11.3	11.4	8.3	—
23	27	54	150	67	3	3	3	3	17	13
0.66	0.65	0.66	0.71	0.72	0.46	0.46	0.46	0.48	—	—
800	800	900	—	—	450	300	350	—	310	360
12	13	12	14	16	13	11	—	—	—	—
$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	10^{13}	—	10^{8}	10^{-4}	10^{-4}
10^{13}	10^{12}	10^{12}	10^{10}	10^{11}	10^{6}	10^{6}	—	—	—	—
10^{11}	10^{10}	10^{10}	10^{8}	10^{9}	10^{4}	10^{3}	—	—	—	—
8.3	9.6	9.6	8.6	8.5	28	33	—	—	—	—
5	19	18	3	2	17	16	—	—	—	—
—	—	—	26	17	476	520	—	—	—	—
1.02	1.11	0.18	—	—	—	≒ 0.00	≒ 0.00	—	6.0	2.6
0.01	0	0	—	—	—	0.04	0.04	—	0.26	0.73
0.49	0.22	0.07	—	—	—	0.08	0.08	—	0.02	0.03

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

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