

# Ceramic Material Properties Table 1

Material			Fine ceramics										
			Alumina	Alumina	Alumina	Alumina	Zirconia	Silicon nitride	Aluminum nitride	Boron nitride	Silicon carbide	Boron carbide	
Data	Unit		Al <sub>2</sub> O <sub>3</sub> : 99.5%	Al <sub>2</sub> O <sub>3</sub> : 99.7%	Al <sub>2</sub> O <sub>3</sub> : 99.8%	Al <sub>2</sub> O <sub>3</sub> : 99.99%	ZrO <sub>2</sub>	Si <sub>3</sub> N <sub>4</sub>	AlN: 99.0% and above	BN: 99.5% and above binderless	SiC	B <sub>4</sub> C: 98.5%	
Main component amount [%]													
Other component or binder													
General properties	Color	-	White	Beige	Light yellow	White	Milky white	Dark grey	Grey beige	White	Black		
	Density	[g/cm <sup>3</sup> ]	3.9	3.9	3.9 and above	3.9	6.0	3.2	3.3	1.8	3.1	2.5	
	Water absorption	[%]	0	0	0	0	0	0	0	0	0		
Machining properties	Hardness (HV)	[GPa]	18	15	16	18	13	16	13	0.8 12 (HS)	24	34	
	Flexural rigidity	20°C	[MPa] <small>(impact bending 0.5-0.7)</small>	450	340	400	480	1000	750	350	30	500	550
		1000°C	[MPa]							330			
		1200°C	[MPa]	300			300	350	550	250		600	
	Compressive strength	[MPa]	2350	2900		2450							2000
	Fracture toughness	[MPa <sup>m<sup>1/2</sup></sup> ]	4		4	4	6	6	3		3		
	Young's modulus	[GPa]	390	350	390	400	200	300	320	10	410	450	
Poisson's ratio	-	0.24	0.23		0.24	0.32	0.28	0.29		0.16			
Thermal properties	Max. use temp	Oxidizing atmosphere	[°C]	1300	1500		1500				950		2450 (melting point)
		Non-oxidizing atmosphere	[°C]								2200(inactive) 2000(in vacuo)		
	Thermal expansion coefficient	RT~200°C	[*10 <sup>-6</sup> /°C]	5.4	6.5	5.7	5.3	7.7	1.5	2.4		2.9	
		RT~400°C	[*10 <sup>-6</sup> /°C]		7.0					3.9(300°C)	-1.8		
		RT~600°C	[*10 <sup>-6</sup> /°C]	7.3(500°C)	7.5		7.5(500°C)	10.0(500°C)	3.1(500°C)	4.0(500°C)	-1.5	4.6(500°C)	
		RT~800°C	[*10 <sup>-6</sup> /°C]	8.5(1000°C)	7.9		8.6(1000°C)	11.0(1000°C)	3.7(1000°C)	5.2(1000°C)	-1.4(1000°C)	5.0(1000°C)	4.5
	Thermal conductivity	20°C	[W/(m·K)]	30		28	33	3	13	160	63	150	20
		400°C	[W/(m·K)]								45		
		800°C	[W/(m·K)]								30		
	Specific heat	RT	[J/(kg·K)]	800		920	800	470	680	740	800	660	960
400°C		[J/(kg·K)]								1500			
800°C		[J/(kg·K)]											
Impact resistance (ΔT)	[°C]	200		200	200	280	650	400	1500	450			
Electrical characteristics	Dielectric strength	[kV/mm]	> 30	> 10	12	> 30	> 10	> 30	> 30	25			
	Volume resistivity	20°C	[Ω·cm]	> 10 <sup>14</sup>	1*10 <sup>15</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>12</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	10*10 <sup>15</sup>	> 10 <sup>6</sup>	0.3~0.8
		500°C	[Ω·cm]		60*10 <sup>9</sup>						10 <sup>6</sup> (1200°C)		
	Dielectric constant	1MHz	-	10	10.0	10.2	10	35	8	9	4.5		
		3GHz	-	10			10	40	8	8			
Dielectric loss	1MHz	[*10 <sup>-1</sup> ]	30	4	82	7	20	30	10	9			
	3GHz	[*10 <sup>-1</sup> ]	4				10	30	130				
Anti-corrosion properties	Chemical resistance	hydrochloric acid	WT loss [mg/cm <sup>2</sup> /day]	-0.3μm (20%-72hr)			-0.3μm (20%-72hr)	0.0μm (20%-72hr)	-2.8μm (20%-72hr)	erosion μm (20%-72hr)		0.0μm (20%-72hr)	
		hydrochloric acid	WT loss [mg/cm <sup>2</sup> /day]	0.0μm (20%-24hr)			0.0μm (20%-24hr)	0.0μm (20%-24hr)	0.0μm (20%-24hr)	-0.6μm (20%-24hr)		0.0μm (20%-24hr)	
		sulfuric acid	WT loss [mg/cm <sup>2</sup> /day]	-0.3μm (20%-72hr)			0.0μm (20%-72hr)	0.0μm (20%-72hr)	-5.3μm (20%-72hr)	erosion μm (20%-72hr)		0.0μm (20%-72hr)	
		sulfuric acid	WT loss [mg/cm <sup>2</sup> /day]	0.0μm (20%-24hr)			0.0μm (20%-24hr)	0.0μm (20%-24hr)	-0.3μm (20%-24hr)	-0.9μm (20%-24hr)		0.0μm (20%-24hr)	
		nitric acid	WT loss [mg/cm <sup>2</sup> /day]	0.0μm (61%-72hr)			0.0μm (61%-72hr)	0.0μm (61%-72hr)	-1.9μm (61%-72hr)	erosion μm (61%-72hr)		0.0μm (61%-72hr)	
		nitric acid	WT loss [mg/cm <sup>2</sup> /day]	0.0μm (61%-24hr)			0.0μm (61%-24hr)	0.0μm (61%-24hr)	0.0μm (61%-24hr)	-0.6μm (61%-24hr)		0.0μm (61%-24hr)	
		phosphoric acid	WT loss [mg/cm <sup>2</sup> /day]	erosion μm (85%-72hr)			-0.3μm (85%-72hr)	-3.2μm (85%-72hr)	-1.3μm (85%-72hr)	erosion μm (85%-72hr)		0.0μm (85%-72hr)	
		phosphoric acid	WT loss [mg/cm <sup>2</sup> /day]	0.0μm (85%-24hr)			0.0μm (85%-24hr)	0.0μm (85%-24hr)	0.0μm (85%-24hr)	-1.8μm (85%-24hr)		0.0μm (85%-24hr)	
		caustic soda (sodium hydroxide)	WT loss [mg/cm <sup>2</sup> /day]	0.0μm (20%-72hr)			0.0μm (20%-72hr)	0.0μm (20%-72hr)	-0.3μm (20%-72hr)	erosion μm (20%-72hr)		0.0μm (20%-72hr)	
		caustic soda (sodium hydroxide)	WT loss [mg/cm <sup>2</sup> /day]	0.0μm (20%-24hr)			0.0μm (20%-24hr)	0.0μm (20%-24hr)	-1.5μm (20%-24hr)	0.0μm (20%-24hr)		0.0μm (20%-24hr)	
		hydrogen fluoride	WT loss [mg/cm <sup>2</sup> /day]	erosion μm (47%-72hr)			-0.5μm (47%-72hr)	erosion μm (47%-72hr)	-0.9μm (47%-72hr)	-3.6μm (47%-72hr)		0.0μm (47%-72hr)	
		Abrasiveness	Blast abrasion amount	[μm]	2.1			1.0	0.5	0.6			1.6
Features & applications			High intensity Wear resistance Thermal resistance Large shape possible Relatively low price		High intensity Wear resistance Thermal resistance Large shape possible Relatively low price	High tenacity High intensity Wear resistance	High intensity Wear resistance Thermal shock resistance	High thermal conductivity	High temperature insulator Sinter for firing ceramics Jig for semi-conductor manufacturing equipment Jig for glass casts Crucible for melting Heat exchanger	High hardness High stiffness High thermal conductivity	Wear resistance Light weight		
Remarks				CIP	mold								