

				Porcelain	Steatite	Cordierite	Mullite	
	Properties*	Units	Test					
	MECHANICAL	Density	gm/cc	ASTM-C20	2.40	2.78	2.05	2.80
Crystal Size		Average	MICRONS	THIN-SECTION	–	–	–	10
Water Absorption			%	ASTM-373	0	0	9.50	0
Gas Permeability			–	–	0	0	–	0
Color			–	–	WHITE	BEIGE	YELLOW	TAN
Flexural Strength (MOR)		20° C	MPa (psi x 10 ³)	ASTM-F417	130 (19)	140	55	170 (25)
Elastic Modulus		20° C	GPa (psi x 10 ⁶)	ASTM-C848	104 (15)	110	40	150 (22)
Poisson's Ratio		20° C	–	ASTM-C848	–	–	–	–
Compressive Strength		20° C	MPa (psi x 10 ³)	ASTM-C773	590 (86)	–	–	550 (80)
Hardness			GPa (kg/mm ²)	KNOOP 1000 gm	5.9 (600)	–	–	7.4 (750)
		R45N	ROCKWELL 45 N	60	57	–	70	
Tensile Strength	25° C	MPa (psi x 10 ³)	ACMA TEST #4	–	–	–	–	
Fracture Toughness	K(I c)	Mpa m ^{1/2}	NOTCHED BEAM	2	–	–	2	
THERMAL	Thermal Conductivity	20° C	W/m K	ASTM-C408	5.0	2.5	1.6	3.5
	Coefficient of Thermal Expansion	25-1000° C	1X 10 ⁻⁶ /°C	ASTM-C372	4.9	9	3.4	5.3
	Specific Heat	100° C	J/kg*K	ASTM-E1269	–	–	–	950
	Thermal Shock Resistance	ΔTc	°C	①	–	100	350	300
	Maximum Use Temperature		°C	NO-LOAD COND.	1400	1200	1200	1700
ELECTRICAL	Dielectric Strength	6.35mm	ac-kV/mm (ac V/mil)	ASTM-D116	–	–	–	9.8 (248)
	Dielectric Constant	1 MHz	25° C	ASTM-D150	5.9	–	–	6.0
	Dielectric Loss (tan delta)	1 MHz	25° C	ASTM-D150	0.0024	–	–	0.002
	Volume Resistivity	25° C	ohm-cm	ASTM-D1829	–	10 ¹³	10 ¹²	> 10 ¹⁴
500° C		ohm-cm	ASTM-D1829	–	10 ⁸	10 ⁶	4 x 10 ⁵	
1000° C		ohm-cm	ASTM-D1829	–	–	–	–	
WEAR	Impingement		②	–	–	–	–	
	Rubbing		②	–	–	–	–	

Notes:

- ① Thermal Shock Resistance – Tests are run by quenching samples into water from various elevated temperatures. The change in temperature where a sharp decrease in flexural strength is observed is listed as ΔTc.
 - ② Wear Resistance – Impingement tests are run using a dry fused alumina abrasive. Rubbing tests are run using a dry 240 grit fused alumina abrasive. The indices in the chart are calculated by dividing the material volume loss by the volume loss of an AD-85 alumina control. The lower in the index, the better the wear resistance.
 - ③ 100 gm load
 - ④ Four point bend modulus of rupture
- *Ceramic property values vary somewhat with method of manufacture, size, and shape of part.
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			Alumina									
			AD-85	AD-90	AD-94	AD-96	FG-995	AD-995	AD-998	PlasmaPure-UC™ Alumina	ESD Alumina	
			Nom. 85% Al ₂ O ₃	Nom. 90% Al ₂ O ₃	Nom. 94% Al ₂ O ₃	Nom. 96% Al ₂ O ₃	Nom. 98.5% Al ₂ O ₃	Nom. 99.5% Al ₂ O ₃	Min. 99.8% Al ₂ O ₃	Min. 99.9% Al ₂ O ₃		
Properties*		Units	Test									
Density		gm/cc	ASTM-C20	3.42	3.60	3.70	3.72	3.80	3.90	3.92	3.92	3.85
Crystal Size	Average	MICRONS	THIN-SECTION	6	4	12	6	6	6	6	3	6
Water Absorption		%	ASTM-373	0	0	0	0	0	0	0	0	0
Gas Permeability		–	–	0	0	0	0	0	0	0	0	0
Color		–	–	WHITE	WHITE	WHITE	WHITE	WHITE	IVORY	IVORY	IVORY	BLACK
Flexural Strength (MOR)	20° C	MPa (psi x 10 ³)	ASTM-F417	296 (43)	338 (49)	352 (51)	358 (52)	375 (54)	379 (55)	375 (54)	400 (58)	300
Elastic Modulus	20° C	GPa (psi x 10 ⁹)	ASTM-C848	221 (32)	276 (40)	303 (44)	303 (44)	350 (51)	370 (54)	370 (54)	386(56)	370
Poisson's Ratio	20° C	–	ASTM-C848	0.22	0.22	0.21	0.21	0.22	0.22	0.22	0.22	0.22
Compressive Strength	20° C	MPa (psi x 10 ³)	ASTM-C773	1930 (280)	2482 (360)	2103 (305)	2068 (300)	2500 (363)	2600 (377)	2500 (363)	2700 (392)	1975 (287)
Hardness		GPa (kg/mm ²)	KNOOP 1000 gm	9.4 (960)	10.4 (1058)	11.5 (1175)	11.5 (1175)	13.7 (1400)	14.1 (1440)	14.1 (1440)	14.5 (1480)	–
		R45N	ROCKWELL 45 N	73	75	78	78	82	83	83	86	78
Tensile Strength	25° C	MPa (psi x 10 ³)	ACMA TEST #4	155 (22)	221 (32)	193 (28)	221 (32)	248 (36)	262 (38)	248 (36)	283 (41)	–
Fracture Toughness	K(I c)	Mpa m ^{1/2}	NOTCHED BEAM	3 - 4	3 - 4	4 - 5	4 - 5	4 - 5	4 - 5	4 - 5	4 - 5	3 - 4
Thermal Conductivity	20° C	W/m K	ASTM-C408	16.0	16.7	22.4	24.7	27.5	30.0	30.0	35.0	25
Coefficient of Thermal Expansion	25-1000° C	1X 10 ⁻⁶ /°C	ASTM-C372	7.2	8.1	8.2	8.2	8.2	8.2	8.2	8.1	8
Specific Heat	100° C	J/kg*K	ASTM-E1269	920	920	880	880	880	880	880	870	–
Thermal Shock Resistance	ΔTc	°C	①	300	250	250	250	200	200	200	200	–
Maximum Use Temperature		°C	NO-LOAD COND.	1400	1500	1700	1700	1700	1750	1750	1750	800
Dielectric Strength	6.35mm	ac-kV/mm (ac V/mil)	ASTM-D116	9.4 (240)	8.3 (210)	8.3 (210)	8.3 (210)	8.7 (220)	8.7 (220)	8.7 (220)	8.7 (220)	–
Dielectric Constant	1 MHz	25° C	ASTM-D150	8.2	8.8	9.1	9	9.6	9.7	9.8	9.8	–
Dielectric Loss (tan delta)	1 MHz	25° C	ASTM-D150	0.0009	0.0004	0.0004	0.0002	0.0002	0.0001	< 0.0001	<0.0001	–
Volume Resistivity	25° C	ohm-cm	ASTM-D1829	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁵	10 ⁹ - 10 ¹⁰
	500° C	ohm-cm	ASTM-D1829	4 x 10 ⁸	4 x 10 ⁸	4 x 10 ⁹	4 x 10 ⁹	2 x 10 ¹⁰	2 x 10 ¹⁰	2 x 10 ¹⁰	1 x 10 ¹²	–
	1000° C	ohm-cm	ASTM-D1829	–	5 x 10 ⁵	5 x 10 ⁵	1 x 10 ⁶	2 x 10 ⁶	2 x 10 ⁶	2 x 10 ⁷	1 x 10 ⁷	–
Impingement		–	②	1.00	0.45	0.52	0.50	0.48	0.47	0.47	0.47	–
Rubbing		–	②	1.00	0.36	–	0.60	–	–	–	–	–

Notes:

- ① Thermal Shock Resistance – Tests are run by quenching samples into water from various elevated temperatures. The change in temperature where a sharp decrease in flexural strength is observed is listed as DTc.
 - ② Wear Resistance – Impingement tests are run using a dry fused alumina abrasive. Rubbing tests are run using a dry 240 grit fused alumina abrasive. The indices in the chart are calculated by dividing the material volume loss by the volume loss of an AD-85 alumina control. The lower in the index, the better the wear resistance.
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				Zirconia					
				ZTA 10%	DURA-Z™ (TTZ)	YTZP (Sintered)	YTZP (HIPed)		
				Zirconia-Toughened Alumina	MgO Partially Stabilized Zirconia	Y ₂ O ₃ Partially Stabilized Zirconia	Y ₂ O ₃ Partially Stabilized Zirconia		
Properties*		Units	Test						
Density		gm/cc	ASTM-C20	4.01	5.72	6.02	6.07		
Crystal Size	Average	MICRONS	THIN-SECTION	2	35	1	1		
Water Absorption		%	ASTM-373	0	0	0	0		
Gas Permeability		–	–	0	0	0	0		
Color		–	–	WHITE	IVORY	IVORY	GRAY		
MECHANICAL	Flexural Strength (MOR)	20° C	MPa (psi x 10 ³)	ASTM-F417	450 (65)	900 (130)	1240 (180)	1720 (250)	
	Elastic Modulus	20° C	GPa (psi x 10 ⁹)	ASTM-C848	360 (52)	200 (29)	210 (30)	210 (30)	
	Poisson's Ratio	20° C	–	ASTM-C848	0.23	0.30	0.23	0.23	
	Compressive Strength	20° C	MPa (psi x 10 ³)	ASTM-C773	2900 (421)	1750 (254)	2500 (363)	2500 (363)	
	Hardness		GPa (kg/mm ²)	KNOOP 1000 gm	14.4 (1475)	11.8 (1200)	12.7 (1300)	12.7 (1300)	
			R45N	ROCKWELL 45 N	85	77	81	81	
	Tensile Strength	25° C	MPa (psi x 10 ³)	ACMA TEST #4	290 (42)	483 (70)	–	–	
	Fracture Toughness	K(I c)	Mpa m ^{1/2}	NOTCHED BEAM	5 - 6	11	13	13	
	THERMAL	Thermal Conductivity	20° C	W/m K	ASTM-C408	27.0	2.2	2.2	2.2
		Coefficient of Thermal Expansion	25-1000° C	1X 10 ⁻⁶ /°C	ASTM-C372	8.3	10.2	10.3	10.3
		Specific Heat	100° C	J/kg*K	ASTM-E1269	885	400	400	400
		Thermal Shock Resistance	Δ Tc	°C	①	300	350	350	350
Maximum Use Temperature			°C	NO-LOAD COND.	1500	500	1500	1500	
ELECTRICAL	Dielectric Strength	6.35mm	ac-kV/mm (ac V/mil)	ASTM-D116	9.0 (228)	9.4 (240)	9.0 (228)	9.0 (228)	
	Dielectric Constant	1 MHz	25° C	ASTM-D150	10.6	28.0	29.0	29.0	
	Dielectric Loss (tan delta)	1 MHz	25° C	ASTM-D150	0.0005	0.001	0.001	0.001	
	Volume Resistivity	25° C	ohm-cm	ASTM-D1829	> 10 ¹⁴	> 10 ¹³	> 10 ¹³	> 10 ¹³	
500° C		ohm-cm	ASTM-D1829	2 x 10 ⁹	2 x 10 ⁵	2 x 10 ⁴	2 x 10 ⁴		
1000° C		ohm-cm	ASTM-D1829	3 x 10 ⁵	< 10 ³	< 10 ³	< 10 ³		
WEAR	Impingement		–	②	0.41	0.63	0.20	0.20	
	Rubbing		–	②	0.49	0.57	0.20	0.20	

Notes:

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				Carbides							
				SC-RB (SC-2)	UltraSiC™ (SC-30)	PureSiC®	RBB4C	HPB4C	WC		
				Reaction Bonded Silicon Carbide	Direct Sintered Silicon Carbide	CVD Silicon Carbide > 99.9995%	Reaction Bonded Boron Carbide	Hot Pressed Boron Carbide	Tungsten Carbide		
Properties*		Units	Test								
Density		gm/cc	ASTM-C20	3.10	3.15	3.21	2.65	2.5	14.90		
Crystal Size	Average	MICRONS	THIN-SECTION	12	3 - 10	3 - 10	–	15	2		
Water Absorption		%	ASTM-373	0	0	0	0	0	0		
Gas Permeability		–	–	0	0	0	0	0	0		
Color		–	–	BLACK	BLACK	BLACK	–	BLACK	GRAY		
MECHANICAL	Flexural Strength (MOR)	20° C	MPa (psi x 10 ³)	ASTM-F417	462 (67)	480 (70)	470-520	250 (36)	410	1550 (225)	
	Elastic Modulus	20° C	GPa (psi x 10 ⁶)	ASTM-C848	393 (57)	410 (59)	435-460	379 (55)	460	627 (91)	
	Poisson's Ratio	20° C	–	ASTM-C848	0.20	0.21	0.21	0.18	0.17	–	
	Compressive Strength	20° C	MPa (psi x 10 ³)	ASTM-C773	2700 (363)	3500 (507)	–	1721 (250)	–	5000 (725)	
	Hardness		GPa (kg/mm ²)	KNOOP 1000 gm	26 (2500) ③	26 (2800) ③	27 (2750) ③	25.5 (2600) ③	(3200) ③	16 (1630)	
			R45N	ROCKWELL 45 N	–	–	–	–	–	–	
	Tensile Strength	25° C	MPa (psi x 10 ³)	ACMA TEST #4	307 (44.5)	–	–	–	–	–	
	Fracture Toughness	K(I c)	Mpa m ^{1/2}	NOTCHED BEAM	4	4	3.5	3-4	2.5	> 6	
	THERMAL	Thermal Conductivity	20° C	W/m K	ASTM-C408	125.0	150.0	115.0	50.0	90	100.0
		Coefficient of Thermal Expansion	25-1000° C	1X 10 ⁻⁶ /°C	ASTM-C372	4.3	4.4	4.6	4.5	5.6	5.1
		Specific Heat	100° C	J/kg*K	ASTM-E1269	800	800	665	–	–	–
		Thermal Shock Resistance	ΔTc	°C	①	400	300	–	–	–	–
Maximum Use Temperature			°C	NO-LOAD COND.	1000	1600	1600	1000	2000	1000	
ELECTRICAL	Dielectric Strength	6.35mm	ac-kV/mm (ac V/mil)	ASTM-D116	–	–	–	–	–	–	
	Dielectric Constant	1 MHz	25° C	ASTM-D150	–	–	–	–	–	–	
	Dielectric Loss (tan delta)	1 MHz	25° C	ASTM-D150	–	–	–	–	–	–	
	Volume Resistivity	25° C	ohm-cm	ASTM-D1829	< 10 ³	< 10 ³	< 0.10 - > 10 ⁶	< 10 ³	10 ²	< 10 ³	
500° C		ohm-cm	ASTM-D1829	< 10 ³	< 10 ³	–	< 10 ³	–	< 10 ³		
1000° C		ohm-cm	ASTM-D1829	< 10 ³	< 10 ³	–	< 10 ³	–	< 10 ³		
WEAR	Impingement	–	②	0.14	0.12	0.03	–	–	0.12		
	Rubbing	–	②	–	–	–	–	–	–		

Notes:

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 - ② Wear Resistance – Impingement tests are run using a dry fused alumina abrasive. Rubbing tests are run using a dry 240 grit fused alumina abrasive. The indices in the chart are calculated by dividing the material volume loss by the volume loss of an AD-85 alumina control. The lower in the index, the better the wear resistance.
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Properties*			Nitrides					Steel	
			HP AlN	SN 101C	NBD-200	NT 154	Kersit 303		
			Hot Pressed Aluminum Nitride	Silicon Nitride (Glass HIPed)	Silicon Nitride (Glass HIPed)	High Temp Silicon Nitride (Glass HIPed)	Silicon Nitride (GPS)		
Units	Test								
Density		gm/cc	ASTM-C20	3.26	3.21	3.16	3.22	3.20	7.5-8.0
Crystal Size	Average	MICRONS	THIN-SECTION	3	–	–	–	–	–
Water Absorption		%	ASTM-373	0	0	0	0	0	0
Gas Permeability		–	–	0	0	0	0	0	0
Color		–	–	GRAY	GRAY	GRAY	GRAY	GRAY	GRAY
Flexural Strength (MOR)	20° C	MPa (psi x 10 ³)	ASTM-F417	340 ④	1000	900	900 ④	900	–
Elastic Modulus	20° C	GPa (psi x 10 ⁶)	ASTM-C848	330	310	320	310	315	210-235 (30-34)
Poisson's Ratio	20° C	–	ASTM-C848	0.25	0.27	0.26	0.27	–	0.29
Compressive Strength	20° C	MPa (psi x 10 ³)	ASTM-C773	–	2500	2500	–	2500	1000-2000 (145-290)
Hardness		GPa (kg/mm ²)	KNOOP 1000 gm	11	16	15	16	16	6.4-8.8 (650-900)
			ROCKWELL 45 N	–	–	–	–	–	55-80
Tensile Strength	25° C	MPa (psi x 10 ³)	ACMA TEST #4	–	–	–	630	–	1110 (103)
Fracture Toughness	K(I c)	Mpa m ^{1/2}	NOTCHED BEAM	3	6.5	5.5	6.0	7.5	50-80
Thermal Conductivity	20° C	W/m K	ASTM-C408	80.0	34	29	38	19	35-55
Coefficient of Thermal Expansion	25-1000° C	1X 10 ⁻⁶ /°C	ASTM-C372	5.0	3.7	2.9	3.1	3.1	12
Specific Heat	100° C	J/kg*K	ASTM-E1269	740	–	–	724	800	475
Thermal Shock Resistance	ΔTc	°C	①	–	–	–	–	–	–
Maximum Use Temperature		°C	NO-LOAD COND.	800	1400	1400	1400	1400	800
Dielectric Strength	6.35mm	ac-kV/mm (ac V/mil)	ASTM-D116	17	–	–	–	15	–
Dielectric Constant	1 MHz	25° C	ASTM-D150	9	8	8	–	–	–
Dielectric Loss (tan delta)	1 MHz	25° C	ASTM-D150	< 0.001	–	–	–	–	–
Volume Resistivity	25° C	ohm-cm	ASTM-D1829	> 10 ¹³	10 ¹⁴	10 ¹⁴	–	10 ¹⁰	10 ⁵
	500° C	ohm-cm	ASTM-D1829	> 10 ⁵	–	–	–	–	–
	1000° C	ohm-cm	ASTM-D1829	> 10 ³	–	–	–	–	–
Impingement		–	②	–	–	–	–	–	–
Rubbing		–	②	–	–	–	–	–	–

Notes:

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