



				Zirconia				
Property		ASTM Method	Units	MSZ (Magnesia Stabilized) MSZ-200	MSZ (Magnesia Stabilized) MSZ-300	YTZP 2000 (Yttria Stabilized)	YTZP 4000 (Yttria Stabilized)	CSZ (Cerium Stabilized)
General	Crystal Size (Average)	Thin Section	Microns	30	30	1	1	3
	Color	--	--	Ivory	Yellow	Ivory	Ivory	Yellow
	Gas Permeability	--	atms-cc/sec	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰
	Water Absorption	C 20-97	%	0	0	0	0	0
Mechanical	Density	C 20-97	g/cc	5.72	5.72	6.02	6.07	6.20
	Hardness	Vickers 500 gm	GPa (kg/mm ²)	11.7 (1200)	11.7 (1200)	12.5 (1250)	12.5 (1250)	11.7 (1200)
	Hardness	--	R45N	78	78	80	80	78
	Fracture Toughness	Notched Beam	MPam ^{1/2}	12	12	10	10	12
	Flexural Strength (MOR) (3 point) @ RT°	F417-87	MPa (psi x 10 ³)	620 (90)	586 (85)	951 (138)	1380 (200)	551 (80)
	Tensile Strength @ RT°	--	MPa (psi x 10 ³)	310 (45)	310 (45)	550 (80)	690 (100)	337 (49)
	Compressive Strength @ RT°	--	MPa (psi x 10 ³)	1862 (270)	1862 (270)	2485 (360)	2485 (360)	2000 (290)
	Elastic Modulus	C848	GPa (psi x 10 ⁶)	206 (29.8)	206 (29.8)	210 (30)	210 (30)	200 (29)
	Poisson's Ratio	C848	--	0.28	0.28	0.30	0.30	0.25
Thermal	C.T.E. 25 - 100° C	C 372-96	x 10 ⁻⁶ /C	8.9	8.9	6.9	6.9	6.9
	C.T.E. 25 - 300° C	C 372-96	x 10 ⁻⁶ /C	9.7	9.7	8.1	8.1	8.1
	C.T.E. 25 - 600° C	C 372-96	x 10 ⁻⁶ /C	10.0	10.0	10.5	10.5	10.5
	Thermal Conductivity @ RT°	C 408	W/m K	3	3	2.2	2.2	3.5
	Max Use Temp (non-loading) (at high strength)	--	Fahrenheit (°F)	2200	2200	932	932	1000
	--	Celsius (°C)	1200	1200	500	500	537	
Electrical	Dielectric Strength (.125" Thick)	D 149-97A	V/mil	300	300	240	240	250
	Dielectric Constant @ 1 MHz	D 150-98	--	22.7	22.7	30.0	30.0	30.0
	Dielectric Constant	D 2520-95	--	29.2	29.2	--	--	--
	@ Gigahertz			6.2	6.2	--	--	--
	Dielectric Loss @ 1 MHz	D 150-98	--	0.0016	0.0016	0.0010	0.0010	0.0010
	Dielectric Loss	D 2520-95	--	0.0018	0.0018	--	--	--
	@ Gigahertz			6.2	6.2	--	--	--
	Volume Resistivity, 25°C	D 257	ohms-cm	> 1 x 10 ¹³	> 1 x 10 ¹³	> 1 x 10 ¹³	> 1 x 10 ¹³	> 1 x 10 ¹³
	Volume Resistivity, 300° C	D 1829	ohms-cm	5 x 10 ⁷	5 x 10 ⁷	1 x 10 ¹⁰	1 x 10 ¹⁰	1 x 10 ¹⁰
	Volume Resistivity, 500° C	D 1829	ohms-cm	1 x 10 ⁷	1 x 10 ⁷	1 x 10 ⁶	1 x 10 ⁶	1 x 10 ⁶
	Volume Resistivity, 700° C	D 1829	ohms-cm	2 x 10 ⁶	2 x 10 ⁶	5 x 10 ³	5 x 10 ³	5 x 10 ³
Volume Resistivity, 1000° C	D 1829	ohms-cm	--	--	--	--	--	

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	Property	ASTM Method	Units	Nitrides		Carbides	Steatite	
				Aluminum Nitride (AlN)	Silicon Nitride (Si ₃ N ₄)	Silicon Carbide (SiC) Alpha	L-4	L-5
General	Crystal Size (Average)	Thin Section	Microns	< 6	4	< 7	7	7
	Color	--	--	Gray	Black	Black	Tan	Gray-Green
	Gas Permeability	--	atms-cc/sec	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	--	--
	Water Absorption	C 20-97	%	0	0	0	0	0
Mechanical	Density	C 20-97	g/cc	3.20	3.25	3.15	2.65	2.75
	Hardness	Vickers 500 gm	GPa (kg/mm ²)	11.2 (1142)	15 (1529)	26 (2650)	4.9 (500)	4.9 (500)
	Hardness	--	R45N	79	83	> 90	57	57
	Fracture Toughness	Notched Beam	MPam ^{1/2}	3	6	4	--	--
	Flexural Strength (MOR) (3 point) @ RT°	F417-87	MPa (psi x 10 ³)	241 (35)	900 (130)	483 (70)	117 (17)	138 (20)
	Tensile Strength @ RT°	--	MPa (psi x 10 ³)	139 (20)	537 (78)	241 (35)	103 (15)	103 (15)
	Compressive Strength @ RT°	--	MPa (psi x 10 ³)	2100 (304)	2500 (362)	3306 (480)	551 (80)	586 (85)
	Elastic Modulus	C848	GPa (psi x 10 ⁶)	310 (45)	300 (44)	448 (65)	103 (15)	103 (15)
Poisson's Ratio	C848	--	0.24	0.28	0.17	0.24	0.24	
Thermal	C.T.E. 25 - 100° C	C 372-96	x 10 ⁻⁶ /C	--	--	3.7	7.3	8.5
	C.T.E. 25 - 300° C	C 372-96	x 10 ⁻⁶ /C	4.3	--	--	7.4	8.6
	C.T.E. 25 - 600° C	C 372-96	x 10 ⁻⁶ /C	5.0	2.9	4.0	7.5	8.6
	Thermal Conductivity @ RT°	C 408	W/m K	160	29	150	3	3
	Max Use Temp (non-loading) (at high strength)	--	Fahrenheit (°F)	2912	2552	2912	2350	2350
		--	Celcius (°C)	1600	1400	1600	1290	1290
Electrical	Dielectric Strength (.125" Thick)	D 149-97A	V/mil	355	330	--	260	270
	Dielectric Constant @ 1 MHz	D 150-98	--	8.6	9.2	10.2	5.6	5.7
	Dielectric Constant @ Gigahertz	D 2520-95	--	--	--	--	5.6	5.8
			--	--	--	9.2	12.5	
	Dielectric Loss @ 1 MHz	D 150-98	--	0.0026	--	--	0.003	0.0014
	Dielectric Loss @ Gigahertz	D 2520-95	--	--	--	--	0.005	0.0017
			--	--	--	--	9.2	12.5
	Volume Resistivity, 25° C	D 257	ohms-cm	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ⁵	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴
	Volume Resistivity, 300° C	D 1829	ohms-cm	--	--	1 x 10 ⁴	2 x 10 ¹⁰	1 x 10 ¹¹
	Volume Resistivity, 500° C	D 1829	ohms-cm	--	--	1 x 10 ³	1 x 10 ⁹	4 x 10 ¹⁰
	Volume Resistivity, 700° C	D 1829	ohms-cm	--	--	--	2 x 10 ⁸	1 x 10 ⁹
Volume Resistivity, 1000° C	D 1829	ohms-cm	--	--	--	--	--	

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			Alumina					
			AL74 74%	AL95 95%	AL96 96%	AL96P 95.5%	AL98 98%	
	Property	ASTM Method	Units					
General	Crystal Size (Average)	Thin Section	Microns	13	11	8	9	7
	Color	--	--	White	Ivory	White	Purple	White
	Gas Permeability	--	atms-cc/sec	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰
	Water Absorption	C 20-97	%	0	0	0	0	0
Mechanical	Density	C 20-97	g/cc	3.03	3.65	3.71	3.68	3.78
	Hardness	Vickers 500 gm	GPa (kg/mm ²)	10.5 (1075)	11.5 (1175)	12.7 (1300)	12.7 (1300)	12.7 (1300)
	Hardness	--	R45N	78	79	81	81	81
	Fracture Toughness	Notched Beam	MPam ^{1/2}	2 - 5	3 - 4	4 - 5	4 - 5	4 - 5
	Flexural Strength (MOR) (3 point) @ RT°	F417-87	MPa (psi x 10 ³)	241 (35)	310 (45)	358 (52)	331 (48)	393 (57)
	Tensile Strength @ RT°	--	MPa (psi x 10 ³)	117 (17)	151 (22)	200 (29)	159 (23)	221 (32)
	Compressive Strength @ RT°	--	MPa (psi x 10 ³)	1378 (200)	1827 (265)	2068 (300)	1965 (285)	2241 (325)
	Elastic Modulus	C848	GPa (psi x 10 ⁶)	172 (25)	303 (44)	310 (45)	310 (45)	345 (50)
	Poisson's Ratio	C848	--	0.22	0.22	0.22	0.22	0.23
Thermal	C.T.E. 25 - 100° C	C 372-96	x 10 ⁻⁶ /C	5.5	6.1	6.0	6.3	6.2
	C.T.E. 25 - 300° C	C 372-96	x 10 ⁻⁶ /C	5.8	7.0	6.8	6.9	6.8
	C.T.E. 25 - 600° C	C 372-96	x 10 ⁻⁶ /C	6.3	7.7	7.5	7.6	7.6
	Thermal Conductivity @ RT°	C 408	W/m K	4	19	23	21	29
	Max Use Temp (non-loading) (at high strength)	--	Fahrenheit (°F)	2800	3000	3100	3100	3100
--		Celcius (°C)	1540	1650	1700	1700	1700	
Electrical	Dielectric Strength (.125" Thick)	D 149-97A	V/mil	225	250	250	250	260
	Dielectric Constant @ 1 MHz	D 150-98	--	7.0	9.0	9.1	9.0	9.5
	Dielectric Constant @ Gigahertz	D 2520-95	--	--	9.2	9.1	8.9	9.4
				--	11.0	10.9	10.8	9.8
	Dielectric Loss @ 1 MHz	D 150-98	--	0.0012	0.0006	0.0004	0.0006	0.0006
	Dielectric Loss @ Gigahertz	D 2520-95	--	--	0.0009	0.0007	0.0006	0.0005
				--	12.5	10.9	10.8	9.8
	Volume Resistivity, 25°C	D 257	ohms-cm	> 1 x 10 ¹³	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹³	> 1 x 10 ¹⁴
	Volume Resistivity, 300° C	D 1829	ohms-cm	4 x 10 ¹⁰	5 x 10 ¹²	3 x 10 ¹²	1 x 10 ¹¹	8 x 10 ¹¹
	Volume Resistivity, 500° C	D 1829	ohms-cm	3 x 10 ⁷	3 x 10 ⁹	7 x 10 ⁹	5 x 10 ⁹	2 x 10 ⁹
	Volume Resistivity, 700° C	D 1829	ohms-cm	2 x 10 ⁶	3 x 10 ⁸	4 x 10 ⁸	4 x 10 ⁸	2 x 10 ⁸
Volume Resistivity, 1000° C	D 1829	ohms-cm	--	--	--	--	--	

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			Alumina				
			AL995 99.5%	AL998 NSF51 Certified 99.8%	AL9980 99.8%	AL999 99.9%	
	Property	ASTM Method	Units				
General	Crystal Size (Average)	Thin Section	Microns	6	6	6	2
	Color	--	--	Ivory-White	Ivory	Ivory	Off White/ Blush
	Gas Permeability	--	atms-cc/sec	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰
	Water Absorption	C 20-97	%	0	0	0	0
Mechanical	Density	C 20-97	g/cc	3.88	3.91	3.91	3.93
	Hardness	Vickers 500 gm	GPa (kg/mm ²)	14.3 (1459)	15 (1530)	15 (1530)	19.6 (2000)
	Hardness	--	R45N	82	86	86	90
	Fracture Toughness	Notched Beam	MPam ^{1/2}	4 - 5	3 - 4	3 - 4	5 - 6
	Flexural Strength (MOR) (3 point) @ RT°	F417-87	MPa (psi x 10 ³)	338 (49)	379 (55)	379 (55)	455 (66)
	Tensile Strength @ RT°	--	MPa (psi x 10 ³)	172 (25)	200 (29)	200 (29)	275 (40)
	Compressive Strength @ RT°	--	MPa (psi x 10 ³)	2137 (310)	2240 (325)	2240 (325)	2413 (350)
	Elastic Modulus	C848	GPa (psi x 10 ⁹)	379 (55)	379 (55)	379 (55)	393 (57)
Poisson's Ratio	C848	--	0.23	0.23	0.23	0.23	
Thermal	C.T.E. 25 - 100° C	C 372-96	x 10 ⁻⁶ /C	6.3	6.5	6.5	6.5
	C.T.E. 25 - 300° C	C 372-96	x 10 ⁻⁶ /C	6.9	7.9	7.9	7.9
	C.T.E. 25 - 600° C	C 372-96	x 10 ⁻⁶ /C	7.6	8.1	8.1	8.2
	Thermal Conductivity @ RT°	C 408	W/m K	30	30	30	35
	Max Use Temp (non-loading) (at high strength)	--	Fahrenheit (°F)	3047	3047	3047	3100
	--	Celsius (°C)	1675	1675	1675	1700	
Electrical	Dielectric Strength (.125" Thick)	D 149-97A	V/mil	270	290	290	422
	Dielectric Constant @ 1 MHz	D 150-98	--	9.8	9.8	9.8	9.9
	Dielectric Constant @ Gigahertz	D 2520-95	--	9.7	10	10	--
	Dielectric Loss @ 1 MHz	D 150-98	--	0.0002	< .0001	< .0001	< .0001
	Dielectric Loss @ Gigahertz	D 2520-95	--	< .0001	< .0001	< .0001	--
	Volume Resistivity, 25°C	D 257	ohms-cm	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴
	Volume Resistivity, 300° C	D 1829	ohms-cm	1 x 10 ¹²	3 x 10 ¹²	3 x 10 ¹²	1 x 10 ¹³
	Volume Resistivity, 500° C	D 1829	ohms-cm	5 x 10 ¹⁰	6 x 10 ¹⁰	6 x 10 ¹⁰	5 x 10 ¹²
	Volume Resistivity, 700° C	D 1829	ohms-cm	2 x 10 ⁹	6 x 10 ⁹	6 x 10 ⁹	1 x 10 ¹²
	Volume Resistivity, 1000° C	D 1829	ohms-cm	--	--	--	--

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				Zirconia Toughened Alumina			
		Property	ASTM Method	Units	ZTA-02 US Patent 8679995	ZTA-14	ZTA-20
General	Crystal Size (Average)	Thin Section	Microns	< 2	6	3	
	Color	--	--	Off White	White	White	
	Gas Permeability	--	atms-cc/sec	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	gas tight <10 ⁻¹⁰	
	Water Absorption	C 20-97	%	0	0	0	
Mechanical	Density	C 20-97	g/cc	3.96	4.17	4.30	
	Hardness	Vickers 500 gm	GPa (kg/mm ²)	14 (1440)	14.5 (1478)	14.4 (1470)	
	Hardness	--	R45N	81	82	82	
	Fracture Toughness	Notched Beam	MPam ^{1/2}	5	6	6	
	Flexural Strength (MOR) (3 point) @ RT°	F417-87	MPa (psi x 10 ³)	448 (65)	586 (85)	621 (90)	
	Tensile Strength @ RT°	--	MPa (psi x 10 ³)	259 (38)	344 (50)	350 (51)	
	Compressive Strength @ RT°	--	MPa (psi x 10 ³)	2413 (350)	2758 (400)	2758 (400)	
	Elastic Modulus	C848	GPa (psi x 10 ⁶)	358 (52)	338 (49)	338 (49)	
	Poisson's Ratio	C848	--	0.23	0.23	0.23	
Thermal	C.T.E. 25 - 100° C	C 372-96	x 10 ⁻⁶ /C	6.7	6.0	6.0	
	C.T.E. 25 - 300° C	C 372-96	x 10 ⁻⁶ /C	8.1	7.0	7.0	
	C.T.E. 25 - 600° C	C 372-96	x 10 ⁻⁶ /C	8.3	7.1	7.1	
	Thermal Conductivity @ RT°	C 408	W/m K	27	24	24	
	Max Use Temp (non-loading) (at high strength)	--	Fahrenheit (°F)	2732	2730	2730	
		--	Celcius (°C)	1500	1500	1500	
Electrical	Dielectric Strength (.125" Thick)	D 149-97A	V/mil	230	250	250	
	Dielectric Constant @ 1 MHz	D 150-98	--	10.5	12.5	12.5	
	Dielectric Constant @ Gigahertz	D 2520-95	--	--	--	12.4	
				--	--	9.4	
	Dielectric Loss @ 1 MHz	D 150-98	--	0.0003	0.0006	0.0006	
	Dielectric Loss @ Gigahertz	D 2520-95	--	--	0.0005	0.0005	
				--	9.4	9.4	
	Volume Resistivity, 25°C	D 257	ohms-cm	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	
	Volume Resistivity, 300° C	D 1829	ohms-cm	3 x 10 ¹²	1 x 10 ¹⁰	1 x 10 ¹⁰	
	Volume Resistivity, 500° C	D 1829	ohms-cm	6 x 10 ¹⁰	2 x 10 ⁹	2 x 10 ⁹	
	Volume Resistivity, 700° C	D 1829	ohms-cm	6 x 10 ⁹	2 x 10 ⁸	4 x 10 ⁸	
Volume Resistivity, 1000° C	D 1829	ohms-cm	--	--	--		

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	Property	ASTM Method	Units	Cordierite	Mullite	Forsterite	Lava Grade A Fired
General	Crystal Size (Average)	Thin Section	Microns	--	7	7	--
	Color	--	--	Orange-Tan	Gray-Tan	Orange-Tan	Gray-Tan
	Gas Permeability	--	atms-cc/sec	Porous	--	gas tight <10 ⁻⁵	Porous
	Water Absorption	C 20-97	%	10	0	0	3
Mechanical	Density	C 20-97	g/cc	2.00	3.00	3.16	2.30
	Hardness	Vickers 500 gm	GPa (kg/mm ²)	5.8 (590)	10 (1000)	6 (611)	4.4 (450)
	Hardness	--	R45N	50	78	60	42
	Fracture Toughness	Notched Beam	MPam ^{1/2}	--	3	2	--
	Flexural Strength (MOR) (3 point) @ RT°	F417-87	MPa (psi x 10 ³)	66 (9.5)	206 (30)	103 (15)	69 (10)
	Tensile Strength @ RT°	--	MPa (psi x 10 ³)	19 (2.7)	138 (20)	--	21 (3)
	Compressive Strength @ RT°	--	MPa (psi x 10 ³)	165 (24)	1034 (150)	--	172 (25)
	Elastic Modulus	C848	GPa (psi x 10 ⁶)	103 (15)	179 (26)	150 (21)	--
Poisson's Ratio	C848	--	0.31	0.24	0.24	--	
Thermal	C.T.E. 25 - 100° C	C 372-96	x 10 ⁻⁶ /C	2.1	3.6	--	2.9
	C.T.E. 25 - 300° C	C 372-96	x 10 ⁻⁶ /C	2.5	4.1	--	3.3
	C.T.E. 25 - 600° C	C 372-96	x 10 ⁻⁶ /C	3.0	4.8	10.5	3.6
	Thermal Conductivity @ RT°	C 408	W/m K	3	4	5	2
	Max Use Temp (non-loading) (at high strength)	--	Fahrenheit (°F)	2350	3100	1472	2000
		--	Celcius (°C)	1290	1700	800	1100
Electrical	Dielectric Strength (.125" Thick)	D 149-97A	V/mil	120	250	330	100
	Dielectric Constant @ 1 MHz	D 150-98	--	5.5	6.7	6.5	5.3
	Dielectric Constant @ Gigahertz	D 2520-95	--	--	6.7	--	--
			--	--	11.4	--	--
	Dielectric Loss @ 1 MHz	D 150-98	--	--	0.003	0.003	--
	Dielectric Loss @ Gigahertz	D 2520-95	--	--	0.003	--	--
			--	--	11.4	--	--
	Volume Resistivity, 25°C	D 257	ohms-cm	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	> 1 x 10 ¹⁴	--
	Volume Resistivity, 300° C	D 1829	ohms-cm	--	4 x 10 ¹⁰	1 x 10 ⁹	--
	Volume Resistivity, 500° C	D 1829	ohms-cm	--	1 x 10 ⁹	--	--
	Volume Resistivity, 700° C	D 1829	ohms-cm	--	--	--	--
Volume Resistivity, 1000° C	D 1829	ohms-cm	--	--	--	--	

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