



Amazing Solutions.®

### Ceramic Properties Standard

				Alumina									
				Porcelain	Mullite	AD-85	AD-90	AD-94	AD-96	FG-995	AD-995	AD-998	PlasmaPure-UC™ Alumina
						Nom. 85% Al <sub>2</sub> O <sub>3</sub>	Nom. 90% Al <sub>2</sub> O <sub>3</sub>	Nom. 94% Al <sub>2</sub> O <sub>3</sub>	Nom. 96% Al <sub>2</sub> O <sub>3</sub>	Nom. 98.5% Al <sub>2</sub> O <sub>3</sub>	Nom. 99.5% Al <sub>2</sub> O <sub>3</sub>	Min. 99.8% Al <sub>2</sub> O <sub>3</sub>	Min. 99.9% Al <sub>2</sub> O <sub>3</sub>
Properties*		Units	Test										
Density		gm/cc	ASTM-C20	2.40	2.80	3.42	3.60	3.70	3.72	3.80	3.90	3.92	3.92
Crystal Size	Average	MICRONS	THIN-SECTION	–	10	6	4	12	6	6	6	6	3
Water Absorption		%	ASTM-373	0	0	0	0	0	0	0	0	0	0
Gas Permeability		–	–	–	0	0	0	0	0	0	0	0	0
Color		–	–	WHITE	TAN	WHITE	WHITE	WHITE	WHITE	WHITE	IVORY	IVORY	IVORY
Flexural Strength (MOR)	20° C	MPa (psi x 10 <sup>3</sup> )	ASTM-F417	130 (19)	170 (25)	296 (43)	338 (49)	352 (51)	358 (52)	375 (54)	379 (55)	375 (54)	400 (58)
Elastic Modulus	20° C	GPa (psi x 10 <sup>6</sup> )	ASTM-C848	104 (15)	150 (22)	221 (32)	276 (40)	303 (44)	303 (44)	350 (51)	370 (54)	370 (54)	386(56)
Poisson's Ratio	20° C	–	ASTM-C848	–	–	0.22	0.22	0.21	0.21	0.22	0.22	0.22	0.22
Compressive Strength	20° C	MPa (psi x 10 <sup>3</sup> )	ASTM-C773	590 (86)	550 (80)	1930 (280)	2482 (360)	2103 (305)	2068 (300)	2500 (363)	2600 (377)	2500 (363)	2700 (392)
Hardness		GPa (kg/mm <sup>2</sup> )	KNOOP 1000 gm	5.9 (600)	7.4 (750)	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	60	70	73	75	78	78	82	83	83	86
Tensile Strength	25° C	MPa (psi x 10 <sup>3</sup> )	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 <sup>1/2</sup>	NOTCHED BEAM	2	2	3 - 4	3 - 4	4 - 5	4 - 5	4 - 5	4 - 5	4 - 5	4 - 5
Thermal Conductivity	20° C	W/m K	ASTM-C408	5.0	3.5	16.0	16.7	22.4	24.7	27.5	30.0	30.0	35.0
Coefficient of Thermal Expansion	25-1000° C	1X 10 <sup>-6</sup> /°C	ASTM-C372	4.9	5.3	7.2	8.1	8.2	8.2	8.2	8.2	8.2	8.1
Specific Heat	100° C	J/kg*K	ASTM-E1269	–	950	920	920	880	880	880	880	880	870
Thermal Shock Resistance	ΔTc	°C	NOTE 3	–	300	300	250	250	250	200	200	200	200
Maximum Use Temperature		°C	NO-LOAD COND.	1400	1700	1400	1500	1700	1700	1700	1750	1750	1750
Dielectric Strength		ac-kV/mm (ac V/mil)	ASTM-D116	–	9.8 (248)	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	5.9	6.0	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	0.0024	0.002	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 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>15</sup>
	500° C	ohm-cm	ASTM-D1829	–	5 x 10 <sup>12</sup>	4 x 10 <sup>8</sup>	4 x 10 <sup>8</sup>	4 x 10 <sup>9</sup>	4 x 10 <sup>9</sup>	2 x 10 <sup>10</sup>	2 x 10 <sup>10</sup>	2 x 10 <sup>10</sup>	1 x 10 <sup>12</sup>
	1000° C	ohm-cm	ASTM-D1829	–	3 x 10 <sup>5</sup>	–	5 x 10 <sup>5</sup>	5 x 10 <sup>5</sup>	1 x 10 <sup>6</sup>	2 x 10 <sup>6</sup>	2 x 10 <sup>6</sup>	2 x 10 <sup>7</sup>	1 x 10 <sup>7</sup>
Impingement		–	NOTE 4	–	–	1.00	0.45	0.52	0.50	0.48	0.47	0.47	0.47
Rubbing		–	NOTE 4	–	–	1.00	0.36	–	0.60	–	–	–	–

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				Zirconia					
				Porcelain	Mullite	ZTA	DURA-Z™ (TTZ)	YTZP (Sintered)	YTZP (HIPed)
						Zirconia-Toughened Alumina	MgO Partially Stabilized Zirconia	Y <sub>2</sub> O <sub>3</sub> Partially Stabilized Zirconia	Y <sub>2</sub> O <sub>3</sub> Partially Stabilized Zirconia
Properties*		Units	Test						
Density		gm/cc	ASTM-C20	2.40	2.80	4.01	5.72	6.02	6.07
Crystal Size	Average	MICRONS	THIN-SECTION	–	10	2	35	1	1
Water Absorption		%	ASTM-373	0	0	0	0	0	0
Gas Permeability		–	–	–	0	0	0	0	0
Color		–	–	WHITE	TAN	WHITE	IVORY	IVORY	GREY
Flexural Strength (MOR)	20° C	MPa (psi x 10 <sup>3</sup> )	ASTM-F417	130 (19)	170 (25)	450 (65)	900 (130)	1240 (180)	1720 (250)
Elastic Modulus	20° C	GPa (psi x 10 <sup>6</sup> )	ASTM-C848	104 (15)	150 (22)	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 <sup>3</sup> )	ASTM-C773	590 (86)	550 (80)	2900 (421)	1750 (254)	2500 (363)	2500 (363)
Hardness		GPa (kg/mm <sup>2</sup> )	KNOOP 1000 gm	5.9 (600)	7.4 (750)	14.4 (1475)	11.8 (1200)	12.7 (1300)	12.7 (1300)
		R45N	ROCKWELL 45 N	60	70	85	77	81	81
Tensile Strength	25° C	MPa (psi x 10 <sup>3</sup> )	ACMA TEST #4	–	–	290 (42)	483 (70)	–	–
Fracture Toughness	K(I c)	Mpa m <sup>1/2</sup>	NOTCHED BEAM	2	2	5 - 6	11	13	13
Thermal Conductivity	20° C	W/m K	ASTM-C408	5.0	3.5	27.0	2.2	2.2	2.2
Coefficient of Thermal Expansion	25-1000° C	1X 10 <sup>-6</sup> /°C	ASTM-C372	4.9	5.3	8.3	10.2	10.3	10.3
Specific Heat	100° C	J/kg*K	ASTM-E1269	–	950	885	400	400	400
Thermal Shock Resistance	Δ Tc	°C	NOTE 3	–	300	300	350	350	350
Maximum Use Temperature		°C	NO-LOAD COND.	1400	1700	1500	500	1500	1500
Dielectric Strength		ac-kV/mm (ac V/mil)	ASTM-D116	–	9.8 (248)	9.0 (228)	9.4 (240)	9.0 (228)	9.0 (228)
Dielectric Constant	1 MHz	25° C	ASTM-D150	5.9	6.0	10.6	28.0	29.0	29.0
Dielectric Loss (tan delta)	1 MHz	25° C	ASTM-D150	0.0024	0.002	0.0005	0.001	0.001	0.001
Volume Resistivity	25° C	ohm-cm	ASTM-D1829	–	> 10 <sup>14</sup>	> 10 <sup>14</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>	> 10 <sup>13</sup>
	500° C	ohm-cm	ASTM-D1829	–	5 x 10 <sup>12</sup>	2 x 10 <sup>9</sup>	2 x 10 <sup>5</sup>	2 x 10 <sup>4</sup>	2 x 10 <sup>4</sup>
	1000° C	ohm-cm	ASTM-D1829	–	3 x 10 <sup>5</sup>	3 x 10 <sup>6</sup>	< 10 <sup>3</sup>	< 10 <sup>3</sup>	< 10 <sup>3</sup>
Impingement		–	NOTE 4	–	–	0.41	0.63	0.20	0.20
Rubbing		–	NOTE 4	–	–	0.49	0.57	0.20	0.20

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				Carbides						
				Porcelain	Mullite	SC-RB (SC-2)	UltraSiC™ (SC-30)	WC	PureSiC® HR	PureSiC® LR
						Reaction Bonded Silicon Carbide	Direct Sintered Silicon Carbide	Tungsten Carbide	CVD Silicon Carbide > 99.9995%	CVD Silicon Carbide > 99.9995%
Properties*		Units	Test							
Density		gm/cc	ASTM-C20	2.40	2.80	3.10	3.15	14.90	3.21	3.21
Crystal Size	Average	MICRONS	THIN-SECTION	–	10	12	5	2	3 - 10	3 - 10
Water Absorption		%	ASTM-373	0	0	0	0	0	0	0
Gas Permeability		–	–	–	0	0	0	0	0	0
Color		–	–	WHITE	TAN	BLACK	BLACK	GRAY	BLACK	BLACK
Flexural Strength (MOR)	20° C	MPa (psi x 10 <sup>3</sup> )	ASTM-F417	130 (19)	170 (25)	462 (67)	480 (70)	1550 (225)	468 (68)	517 (75)
Elastic Modulus	20° C	GPa (psi x 10 <sup>6</sup> )	ASTM-C848	104 (15)	150 (22)	393 (57)	410 (59)	627 (91)	462 (67)	434 (63)
Poisson's Ratio	20° C	–	ASTM-C848	–	–	0.20	0.21	–	0.21	0.21
Compressive Strength	20° C	MPa (psi x 10 <sup>3</sup> )	ASTM-C773	590 (86)	550 (80)	2700 (363)	3500 (507)	5000 (725)	–	–
Hardness		GPa (kg/mm <sup>2</sup> )	KNOOP 1000 gm	5.9 (600)	7.4 (750)	26 (2500)	26 (2800)	16 (1630)	27 (2750)	27 (2750)
		R45N	ROCKWELL 45 N	60	70	–	–	–	–	–
Tensile Strength	25° C	MPa (psi x 10 <sup>3</sup> )	ACMA TEST #4	–	–	307 (44.5)	–	–	–	–
Fracture Toughness	K(I c)	Mpa m <sup>1/2</sup>	NOTCHED BEAM	2	2	4	4	> 6	3.5	3.5
Thermal Conductivity	20° C	W/m K	ASTM-C408	5.0	3.5	125.0	150.0	100.0	115.0	115.0
Coefficient of Thermal Expansion	25-1000° C	1X 10 <sup>-6</sup> /°C	ASTM-C372	4.9	5.3	4.3	4.4	5.1	4.6	4.6
Specific Heat	100° C	J/kg*K	ASTM-E1269	–	950	800	800	–	665	665
Thermal Shock Resistance	Δ Tc	°C	NOTE 3	–	300	400	300	–	–	–
Maximum Use Temperature		°C	NO-LOAD COND.	1400	1700	1000	1600	1000	1600	1600
ELECTRICAL	Dielectric Strength	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 500° C 1000° C	ohm-cm	ASTM-D1829	–	> 10 <sup>14</sup>	< 10 <sup>3</sup>	< 10 <sup>5</sup>	< 10 <sup>3</sup>	> 10 <sup>6</sup>
		ohm-cm	ASTM-D1829	–	5 x 10 <sup>12</sup>	< 10 <sup>3</sup>	< 10 <sup>3</sup>	< 10 <sup>3</sup>	–	–
		ohm-cm	ASTM-D1829	–	3 x 10 <sup>5</sup>	< 10 <sup>3</sup>	< 10 <sup>3</sup>	< 10 <sup>3</sup>	–	–
WEAR	Impingement	–	NOTE 4	–	–	0.14	0.12	0.12	0.03	0.02
	Rubbing	–	NOTE 4	–	–	–	–	–	–	–

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The chart is intended to illustrate typical properties. Engineering data is representative. Property values vary somewhat with method of manufacture, size, and shape of part. Any suggested applications are not made as a representation or warranty that the material will ultimately be suitable for such applications. The customer is ultimately responsible for all design and material suitability decisions. Data contained herein is not to be construed as absolute and does not constitute a representation or warranty for which CoorsTek assumes legal responsibility. Any warranty or representation for which CoorsTek is responsible shall be subject to a separately negotiated agreement.

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Notes:

1. Data Measurements – All data measurements are typical and made at room temperature unless otherwise noted.

2. Composition Control – all CoorsTek ceramic compositions are controlled using modern chemical, spectrographic, and X-ray fluorescent methods.

3. 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.

4. 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.

5. Dielectric Strength numbers represent measurements on samples that were 0.25" thick.

\*Ceramic property values vary somewhat with method of manufacture, size, and shape of part. Close control of values of most properties can be maintained if specified.