

## Material Specifications

Specifications are offered as an assistance to Engineers and Purchasing professionals in the design and procurement of thin-film circuit substrates.

Properties	Units	Polished High Density 996 Aluminum Oxide	Asfired Superstrate 996 Aluminum Oxide	Beryllium Oxide	Aluminum Nitride	Fused Silica Quartz	Sapphire (Crystalline)	Polished Titanates	Ferrites & Garnets
Chemical Composition		Al <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	BeO	AlN	SiO <sub>2</sub>	A/C plane—Al <sub>2</sub> O <sub>3</sub>		
Purity	%	99.6	99.6	99.5	98	100	100		
Color		White	White	White	Tan	Transparent	Transparent	Cream	Gray
Nominal Density	g/cm <sup>3</sup>	3.87	3.87	2.85	3.28	2.2	3.97		
Surface Finish (Polished) CLA	μ-inches (nm)	< 1.0 (25nm)	n/a	2.0-4.0 (50-100nm)	< 2.0 (50nm)	60/40 Optical	< 1.0μ-inch (25nm) CLA	< 3.0 (76nm)	< 16.0 (400nm)
Surface Finish (Asfired) CLA	μ-inches (nm)	n/a	3-4 (76-101 nm)	n/a	n/a	n/a	n/a	n/a	n/a
Camber	inch / inch	0.0003"-0.0005"	0.002"	0.0003"-0.0005"	.00003"-0.0005"	0.0003"-0.0005"	0.0003"-0.0005"	0.002"	0.002"
Camber	nm / nm	76nm / 152nm	0.0508mm	76nm / 152nm	76nm / 152nm	76nm / 152nm	76nm / 152nm	0.0508mm	0.0508mm
Thickness	inches (mm)	0.004"-0.080" (.100-2.0mm)	0.005"-0.025"* (0.127-0.635mm)	0.005"-0.025"* (0.127-0.635mm)	0.004"-0.080" (0.100-2.0mm)	0.004"-0.025"* (0.100-0.635mm)	0.004"-0.025"* (0.100-0.635mm)	0.005"-0.025"* (0.127-0.635mm)	0.010"-0.025" (0.254-0.635mm)
Thickness Tolerance (±)	inches (nm)	0.0005 (0.0127mm)	0.001 (0.0254mm)	0.0005 (0.0127mm)	0.0005 (0.0127mm)	0.0005 (0.0127mm)	0.0005 (0.0127mm)	0.0005 (0.0127mm)	0.0005 (0.0127mm)
Process Sizes (L&W)	inches (mm)	1.0"-4.0" (25.4-101.6mm)	1.0"-6.0" (25.4-152.4mm)	1.0"-4.00" (25.4-101.6mm)	1.0"-4.00" (25.4-101.6mm)	1.0"-3.00" (25.4-76.2mm)	1.0"-2.25" (25.4-57.15mm)	1.0"-2.25" (25.4-57.15mm)	1.0"-2.25" (25.4-57.15mm)
Coefficient of Thermal Expansion (CTE)	10-6	7.0-8.3 (25-1000°C)	7.0-8.3 (25-1000°C)	9.0 (25-1000°C)	4.6 (25-300°C)	0.55 (20-320°C)	A plane @ 25°C-5.3		
Thermal Conductivity	Watts/m <sup>2</sup> K	26.9	26.9	270	170	n/a	n/a		
Dielectric Constant (k)	@ 1 MHz	9.9 ± 0.1	9.9 ± 0.1	6.5	8.6	3.826	11.5/9.3†	36-180	14.5-17.6
Dielectric Constant (k)	@ 4 GHz	9.9	9.9						
Dielectric Constant (k)	@ 10 GHz	9.7	9.7						
Dissipation Factor (Loss Tangent)	@ 1 MHz	0.0001	0.0001	0.0004	0.001	0.000015	0.00086/0.0003†		
Dissipation Factor (Loss Tangent)	@ 10 GHz	0.0002	0.0002						
Q	@ 1 GHz	5000	5000		5000				
Hardness	Rockwell	87	87	45	n/a	7 Mohs	1800/2200A Knoop		
Flexural Strength	K(10-3) lbs/in <sup>2</sup>	90	90	35 (3 pt. bend)	59 (4 pt. bend)	25	60		
Compressive Strength	M(10-3) lbs/in <sup>2</sup>	54	54	n/a	n/a	161	350		
Grain Size	μm (microns)	< 1.0	< 1.0	9-16	5-7	Amorphous	single crystal		

\* Additional thicknesses and tolerances available upon request.

† Value varies with orientation ("A" plane / "C" plane)