Material Specifications

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

Properties	Polished High Density 996 Aluminum Oxide	Asfired Superstrate 996 Aluminum Oxide	Superstrate TPS	Beryllium Oxide	Aluminum Nitride	Fused Silica Quartz	Z-Cut Quartz	Sapphire (Crystalline)	Polished Titanates	Ferrites & Garnets
Chemical Composition	Al_2O_3	Al_2O_3	Al_2O_3	BeO	AlN	SiO_2	SiO_2	A/C plane–Al_2O_3		
Purity	99.6%	99.6%	99.6%	99.5%	98%	100%	100%	100%		
Color	White	White	White	White	Tan	Transparent	Transparent	Transparent	Cream	Gray
Nominal Density	3.87g/cm^3	3.87g/cm^3	3.95g/cm^3	2.85g/cm^3	3.28g/cm^3	2.2g/cm^3	2.65g/cm^3	3.97g/cm^3		
Surface Finish (Polished) CLA	< 1.0µ" (25nm)		< 1.0µ" (25nm)	2.0–4.0µ" (50–100nm)	< 2.0µ" (50nm)	60/40 Optical	60/40 Optical	< 1.0µ" (25nm) CLA	< 3.0µ" (76nm)	< 16.0µ" (400nm)
Surface Finish (Asfired) CLA		3–4µ" (76–101nm)								
Camber	0.0003–0.0005" (76nm / 152nm)	0.002" (0.0508mm)		0.0003–0.0005" (76nm / 152nm)	0.0003–0.0005" (76nm / 152nm)	0.0003–0.0005" (76nm / 152nm)	0.0003–0.0005" (76nm / 152nm)	0.0003–0.0005" (76nm / 152nm)	0.002" (0.0508mm)	0.002" (0.0508mm)
Thickness	0.004–0.080" (0.100–2.0mm)	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)	0.004–0.025"* (0.100–0.635mm)	0.005–0.025"* (0.127–0.635mm)	0.010–0.025" (0.254–0.635mm)
Thickness Tolerance	±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)	±0.0005" (±0.0127mm)
Process Sizes (L&W)	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)	1.0–3.00" (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)	7.0–8.3 x 10^6 (25–1000°C)	7.0–8.3 x 10^6 (25–1000°C)	8.2 x 10^6 (25–1000°C)	9.0 x 10^6 (25–1000°C)	4.6 x 10^6 (25–300°C)	0.55 x 10^6 (20–320°C)		A plane @ 25°C–5.3		
Thermal Conductivity	26.9 Watts/m°K	26.9 Watts/m°K	35 Watts/m°K	270 Watts/m°K 325 Watts/m°K	170 Watts/m°K 200 Watts/m°K	1.38 Watts/m°K		42 Watts/m°K		
Dielectric Constant (k)	9.9 @ 1 MHz	9.9 @ 1 MHz	10.0 @ 1 MHz	6.5 @ 1 MHz	8.6 @ 1 MHz	3.826 @ 1 MHz	4.6 parallel 4.5 perpendicular	11.5/9.3 @ 1 MHz †	36–180 @ 1 MHz	14.5–17.6 @ 1 MHz
Dissipation Factor (Loss Tangent)	0.0001 @ 1 MHz	0.0001 @ 1 MHz	0.0001 @ 1 MHz	0.0004 @ 1 MHz	0.001 @ 1 MHz	0.000015 @ 1 MHz		0.00086/0.0003 @ 1 MHz †		
Dissipation Factor (Loss Tangent)	0.0002 @ >10 GHz	0.0002 @ >10 GHz	0.0001 @ >10 GHz		0.002 @ >10 GHz					
Q	5000 @ 1 GHz	5000 @ 1 GHz	5000 @ 1 GHz		5000 @ 1 GHz					
Hardness (Rockwell)	87	87	87	45		7 Mohs	7 Mohs	1800/2200A Knoop		
Flexural Strength	90 x 10^3 K lbs/in^2	90 x 10^3 K lbs/in^2	99 x 10^3 K lbs/in^2	35 x 10^3 K lbs/in^2 (3 pt. bend)	59 x 10^3 K lbs/in^2 (4 pt. bend)	25 x 10^3 K lbs/in^2		60 x 10^3 K lbs/in^2		
Compressive Strength	54 x 10^3 M lbs/in^2	54 x 10^3 M lbs/in^2				161 x 10^3 M lbs/in^2		350 x 10^3 M lbs/in^2		
Grain Size	< 1.0µm	< 1.0µm	< 1.0µm	9–16µm	5–7µm	Amorphous	single crystal	single crystal		

* Additional thicknesses and tolerances available upon request.

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

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