Material Specifications

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

(76nm / Thickness 0.004-0.1 (0.100-2)	6 V V V V V V V V V V V V V V V V V V V	3-4μ" (76-101nm) 0.002" (0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.001" (±0.0254mm) 1.0-6.0" (25.4-152.4mm)	Al2O3 99.6% White 3.95g/cm³ < 1.0µ" (25nm)	Be0 99.5% White 2.85g/cm³ 2.0–4.0μ" (50–100nm) 0.0003–0.0005" (76nm / 152nm) 0.005–0.025"* (0.127–0.635mm) ±0.0005" (±0.0127mm) 1.0–4.00" (25.4–101.6mm)	AIN 98% Tan 3.28g/cm³ < 2.0µ" (50nm) 0.0003-0.0005" (76nm / 152nm) 0.004-0.080" (0.100-2.0mm) ±0.0005" (±0.0127mm) 1.0-4.00"	\$i02 100% Transparent 2.2g/cm³ 60/40 Optical 0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005" (±0.0127mm) 1.0-3.00"	\$i02 100% Transparent 2.65g/cm³ 60/40 Optical 0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005" (±0.0127mm)	A/C plane-Al ₂ O ₃ 100% Transparent 3.97g/cm ³ <1.0µ" (25nm) CLA 0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005" (±0.0127mm)	Cream < 3.0µ" (76nm) 0.002" (0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.0005" (±0.0127mm)	Gray <16.0µ" (400nm) 0.002" (0.0508mm) 0.010-0.025" (0.254-0.635mm) ±0.0005" (±0.0127mm)
Color White Nominal Density 3.87g/cm Surface Finish (Polished) CLA (25nm) Surface Finish (Asfired) CLA Camber 0.0003-C (76nm / Thickness ±0.005* Tolerance ±0.0127 Process Sizes (L&W) (25.4-10 Coefficient of Thermal Expansion (CTE) Thermal 26.9 Wat Conductivity Dielectric Constant (k) Dissipation Factor (Loss Tangent) Dissipation Factor 0.0002 @	e V g/cm³ 3 Dµ" m) (03-0.0005" 0 m / 152nm) (4-0.080" (10-2.0mm) (005" 2 1-101.6mm) 1 8.3 x 106 7	3.87g/cm ³ 3.4µ" (76–101nm) 0.002" (0.0508mm) 0.005–0.025"* (0.127–0.635mm) ±0.001" (±0.0254mm) 1.0–6.0" (25.4–152.4mm)	White 3.95g/cm ³ <1.0μ"	White 2.85g/cm³ 2.0-4.0µ" (50-100nm) 0.0003-0.0005" (76nm / 152nm) 0.005-0.025"* (0.127-0.635mm) ±0.0005" (±0.0127mm) 1.0-4.00"	Tan 3.28g/cm³ < 2.0µ" (50nm) 0.0003-0.0005" (76nm / 152nm) 0.004-0.080" (0.100-2.0mm) ±0.0005" (±0.0127mm)	Transparent 2.2g/cm³ 60/40 Optical 0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005" (±0.0127mm)	Transparent 2.65g/cm³ 60/40 Optical 0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005"	Transparent 3.97g/cm ³ <1.0μ" (25nm) CLA 0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005"	<3.0µ" (76nm) 0.002" (0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.0005"	<16.0µ" (400nm) 0.002" (0.0508mm) 0.010-0.025" (0.254-0.635mm) ±0.0005"
Nominal Density 3.87g/cm Surface Finish (Polished) CLA (25nm) Surface Finish (Asfired) CLA (25nm) Surface Finish (Asfired) CLA (76nm / 70nm	g/cm³ 3 Dµ" m) (0 03-0.0005" 0 m / 152nm) (1 0-2.0mm) (2 005" 0 0127mm) (4 0" 1 1-101.6mm) (6 8.3 x 106 7	3.87g/cm³ 3-4µ" (76-101nm) 0.002" (0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.001" (±0.0254mm) 1.0-6.0" (25.4-152.4mm)	3.95g/cm ³ < 1.0µ"	2.85g/cm ³ 2.0-4.0µ" (50-100nm) 0.0003-0.0005" (76nm / 152nm) 0.005-0.025"* (0.127-0.635mm) ±0.0005" (±0.0127mm) 1.0-4.00"	3.28g/cm ³ < 2.0µ" (50nm) 0.0003-0.0005" (76nm / 152nm) 0.004-0.080" (0.100-2.0mm) ±0.0005" (±0.0127mm)	2.2g/cm ³ 60/40 Optical 0.0003-0.0005'' (76nm / 152nm) 0.004-0.025''* (0.100-0.635mm) ±0.0005'' (±0.0127mm)	2.65g/cm ³ 60/40 Optical 0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005"	3.97g/cm ³ <1.0µ" (25nm) CLA 0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005"	<3.0µ" (76nm) 0.002" (0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.0005"	<16.0µ" (400nm) 0.002" (0.0508mm) 0.010-0.025" (0.254-0.635mm) ±0.0005"
Surface Finish (Polished) CLA (25nm) Surface Finish (Asfired) CLA (25nm) Surface Finish (Asfired) CLA (25nm) Thickness 0.0004-0.1 (0.100-2 Thickness ±0.0005* Tolerance ±0.0005* Tolerance (±0.0127 Process Sizes (1.0-4.0" (25.4-10 Coefficient of Thermal Expansion (CTE) Thermal 26.9 Wat Conductivity 26.9 Wat Conductivity 9.9 @ 1 (k) Dissipation Factor (Loss Tangent) 0.0001 @ 1.00011 @ 1.0	Dμ" m) ((23–0.0005" μ / 152nm) ((24–0.080" μ / 10–2.0mm) ((24–0.027mm)	3-4µ" (76-101nm) 0.002" (0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.001" (±0.0254mm) 1.0-6.0" (25.4-152.4mm)	< 1.0µ"	2.0-4.0µ" (50-100nm) 0.0003-0.0005" (76nm / 152nm) 0.005-0.025"* (0.127-0.635mm) ±0.0005" (±0.0127mm) 1.0-4.00"	<2.0μ" (50nm) 0.0003-0.0005" (76nm / 152nm) 0.004-0.080" (0.100-2.0mm) ±0.0005" (±0.0127mm)	0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005" (±0.0127mm)	0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005"	<1.0μ" (25nm) CLA 0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005"	(76nm) 0.002" (0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.0005"	(400nm) 0.002" (0.0508mm) 0.010-0.025" (0.254-0.635mm) ±0.0005"
(Polished) CLA (25nm) Surface Finish (Asfired) CLA (25nm) Camber 0.0003-0 (76nm / Thickness 0.004-0.1 (0.100-2 Thickness ±0.0005' Tolerance (±0.0127' Process Sizes (L&W) 1.0-4.0" Coefficient of Thermal Expansion (CTE) 7.0-8.3 x (25-1000' Thermal Expansion (CTE) 26.9 Wat Conductivity Dielectric Constant (k) 9.9 @ 1 0.0001 @ Dissipation Factor (Loss Tangent) 0.0001 @ Dissipation Factor (Loss Tangent) 0.0002 @	(033-0.0005" C (077 152nm) (152nm) (15	(76-101nm) 0.002" (0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.001" (±0.0254mm) 1.0-6.0" (25.4-152.4mm)		(50–100nm) 0.0003–0.0005" (76nm / 152nm) 0.005–0.025"* (0.127–0.635mm) ±0.0005" (±0.0127mm) 1.0–4.00"	(50nm) 0.0003-0.0005" (76nm / 152nm) 0.004-0.080" (0.100-2.0mm) ±0.0005" (±0.0127mm)	0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005" (±0.0127mm)	0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005"	(25nm) CLA 0.0003-0.0005" (76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005"	(76nm) 0.002" (0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.0005"	(400nm) 0.002" (0.0508mm) 0.010-0.025" (0.254-0.635mm) ±0.0005"
(Asfired) CLA Camber	(103-0.0005" C	(76-101nm) 0.002" (0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.001" (±0.0254mm) 1.0-6.0" (25.4-152.4mm)		(76nm / 152nm) 0.005-0.025"* (0.127-0.635mm) ±0.0005" (±0.0127mm) 1.0-4.00"	(76nm / 152nm) 0.004- 0.080" (0.100-2.0mm) ±0.0005" (±0.0127mm)	(76nm / 152nm) 0.004–0.025"* (0.100–0.635mm) ±0.0005" (±0.0127mm)	(76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005"	(76nm / 152nm) 0.004- 0.025''* (0.100- 0.635mm) ±0.0005''	(0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.0005"	(0.0508mm) 0.010-0.025" (0.254-0.635mm) ±0.0005"
(76nm / 17 Thickness 0.004-0.1 (0.100-2 17 17 17 17 17 17 17 1	m / 152nm) (4-0.080" 0 0-2.0mm) (005" ± 0127mm) (4.0" 1 1-101.6mm) (8.3 x 106 7	(0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.001" (±0.0254mm) 1.0-6.0" (25.4-152.4mm)		(76nm / 152nm) 0.005-0.025"* (0.127-0.635mm) ±0.0005" (±0.0127mm) 1.0-4.00"	(76nm / 152nm) 0.004- 0.080" (0.100-2.0mm) ±0.0005" (±0.0127mm)	(76nm / 152nm) 0.004–0.025"* (0.100–0.635mm) ±0.0005" (±0.0127mm)	(76nm / 152nm) 0.004-0.025"* (0.100-0.635mm) ±0.0005"	(76nm / 152nm) 0.004- 0.025''* (0.100- 0.635mm) ±0.0005''	(0.0508mm) 0.005-0.025"* (0.127-0.635mm) ±0.0005"	(0.0508mm) 0.010-0.025" (0.254-0.635mm) ±0.0005"
(0.100 – 2 Thickness	00-2.0mm) (005''	(0.127–0.635mm) ±0.001" (±0.0254mm) 1.0–6.0" (25.4–152.4mm)		(0.127-0.635mm) ±0.0005" (±0.0127mm) 1.0-4.00"	(0.100 – 2.0mm) ±0.0005" (±0.0127mm)	(0.100-0.635mm) ±0.0005" (±0.0127mm)	(0.100-0.635mm) ±0.0005"	(0.100-0.635mm) ±0.0005"	(0.127-0.635mm) ±0.0005"	(0.254-0.635mm) ±0.0005"
Tolerance (±0.0127 Process Sizes (L&W) (25.4-10 Coefficient of Thermal Expansion (CTE) Thermal Conductivity Dielectric Constant (k) Dissipation Factor (Loss Tangent) Dissipation Factor 0.0002 @	0127mm) (4.0'' 1 4-101.6mm) (8.3 x 10 ⁶ 7	(±0.0254mm) 1.0–6.0'' (25.4–152.4mm)		(±0.0127mm) 1.0-4.00"	(±0.0127mm)	(±0.0127mm)				
(L&W) (25.4–10 Coefficient of Thermal Expansion (25–1000 (CTE) Thermal Conductivity Dielectric Constant (k) Dissipation Factor (Loss Tangent) Dissipation Factor 0.0002 @	1–101.6mm) (8.3 x 10 ⁶	(25.4-152.4mm)			1.0-4.00"	1.0. 2.00!!				
Thermal Expansion (25–1000 (CTE) Thermal Conductivity Dielectric Constant (k) Dissipation Factor (Loss Tangent) Dissipation Factor 0.0001 @		70.00106		(23.4-101.011111)	(25.4-101.6mm)	(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)
Conductivity Dielectric Constant (k) Dissipation Factor (Loss Tangent) Dissipation Factor 0.0002 @	-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		
(k) Dissipation Factor (Loss Tangent) Dissipation Factor 0.0001 ©	Watts/m°K 2	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		
(Loss Tangent) Dissipation Factor 0.0002 @	@ 1 MHz 9	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
	01 @ 1 MHz 0	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 †		
(Loss Tangent) >10 GHz		0.0002 @ >10 GHz	0.0001 @ >10 GHz		0.002 @ >10 GHz					
Q 5000 @	0 @ 1 GHz 5	5000 @ 1 GHz	5000 @ 1 GHz		5000 @ 1 GHz					
Hardness (Rockwell) 87	3	87	87	45		7 Mohs	7 Mohs	1800/2200A Knoop		
Flexural Strength 90 x 10 ³ l	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 54 x 10 ³ I Strength	10 ³ M lbs/in ² 5	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										

^{*} Additional thicknesses and tolerances available upon request.

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

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