

The World's Leading OEMs Trust CoorsTek for Superior Results.



We are the largest technical ceramics manufacturer in the world with facilities across 3 continents. This means we have the scale, selection of materials, and capabilities to ensure superior component fit and function, and optimal product life to keep our customers on the road to next-generation technology.

CoorsTek has a highly qualified staff to assist with material selection and product design. Please contact us today at +1.303.271.7100 or info@coorstek.com for more information. For general information about CoorsTek, please visit our website at www.coorstek.com.

Scope and Intent

Alumina, an ideal material for thin-film ceramic substrates, offers a smooth surface finish, high flexural strength, and controlled electrical properties. CoorsTek offers four thin-film alumina substrate materials: SuperStrate® 996, SuperStrate TPS, ADS-996, and ADS-995. These products cover a range of grain sizes and surface finishes. SuperStrate 996, an extremely fine-grained material with superior surface finish characteristics, remains the industry standard.

This technical specification is designed to provide a guide to common sizes, material property information, laser machining information, inspection methods, and quality standards for CoorsTek thin film alumina substrates.

Design Guidelines

Materials

Fine-line resolution, spacing, and process yields are directly influenced by surface finish (reference Table I, below), grain size (reference Figure 1, right), and surface imperfections (reference Table IV, page 4). For optimum fine-line definition, SuperStrate 996 and ADS-996 are the preferred material choices. Our ADS-995 is an economical alternative for less demanding applications. SuperStrate 996, ADS-996, and ADS-995 are available in as-fired resistor and as-fired standard grades. All materials are available in lapped and polished configurations.



Figure 1. Scanning Electron Photomicrographs of "A" side (2,000x and 0° tilt).

Table I—Typical Surface Finish Centerline Average (CLA)*				
Material	"A" Side	"B" Side	Lapped	Polished
SuperStrate 996	2 μin (50 nm)	3 μin (76 nm)	< 10 μin (250 nm)	< 1 μin (25 nm)
ADS-996	3 μin (76 nm)	4 μin (101 nm)	< 12 μin (300 nm)	< 1 μin (25 nm)
ADS-995	5 μin (127 nm)	7 μin (178 nm)	< 30 μin (762 nm)	< 2 μin (50 nm)

Standard Thickness and Common Sizes

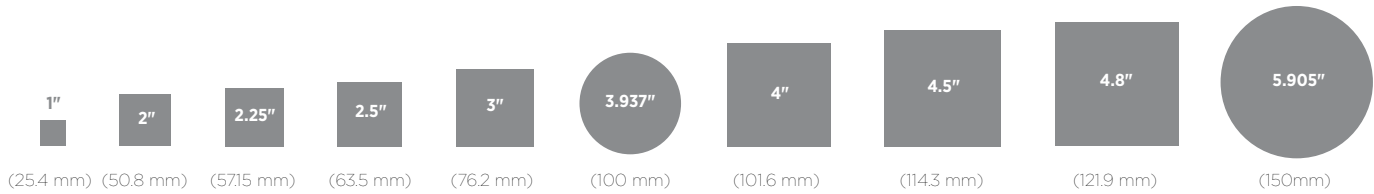
CoorsTek offers a wide range of sizes and thicknesses. The tables below represent our standard thicknesses and common sizes. Our standard length and width tolerance is $\pm 1\%$, while standard as-fired thickness tolerance is $\pm 10\%$. If your requirements are outside those listed below, we can customize our products to meet your needs.

Table II-Standard Thicknesses & Thickness Tolerances

Thickness	Thickness Tolerance			
	As-Fired "Standard"	As-Fired "Select"	Lapped	Polished
0.005" (0.127 mm)	$\pm 0.0005"$ (0.0127 mm)	Not Available	$\pm 0.0005"$ (0.0127 mm)	$\pm 0.0005"$ (0.0127 mm)
0.010" (0.254 mm)	$\pm 0.001"$ (0.0254 mm)	$\pm 0.0005"$ (0.0127 mm)	$\pm 0.001"$ (0.0254 mm)	$\pm 0.0005"$ (0.0127 mm)
0.015" (0.381 mm)	$\pm 0.0015"$ (0.0381 mm)	$\pm 0.00075"$ (0.01905 mm)	$\pm 0.001"$ (0.0254 mm)	$\pm 0.0005"$ (0.0127 mm)
0.020" (0.508 mm)	$\pm 0.002"$ (0.0508 mm)	$\pm 0.001"$ (0.0254 mm)	$\pm 0.001"$ (0.0254 mm)	$\pm 0.0005"$ (0.0127 mm)
0.025" (0.635 mm)	$\pm 0.0025"$ (0.0635 mm)	$\pm 0.00125"$ (0.03175 mm)	$\pm 0.001"$ (0.0254 mm)	$\pm 0.0005"$ (0.0127 mm)
0.030" (0.762 mm)	$\pm 0.003"$ (0.0762 mm)	$\pm 0.0015"$ (0.0381 mm)	$\pm 0.001"$ (0.0254 mm)	$\pm 0.0005"$ (0.0127 mm)
0.035" (0.889 mm)	$\pm 0.0035"$ (0.0889 mm)	$\pm 0.00175"$ (0.04445 mm)	$\pm 0.001"$ (0.0254 mm)	$\pm 0.0005"$ (0.0127 mm)
0.040" (1.016 mm)	$\pm 0.004"$ (0.1016 mm)	Not Available	$\pm 0.001"$ (0.0254 mm)	$\pm 0.0005"$ (0.0127 mm)
0.050" (1.270 mm)	$\pm 0.005"$ (0.127 mm)	Not Available	$\pm 0.001"$ (0.0254 mm)	$\pm 0.0007"$ (0.01778 mm)
0.060" (1.524 mm)	$\pm 0.006"$ (0.1524 mm)	Not Available	Not Available	Not Available

Common Sizes

Sizes below are squares and discs. Contact your Coorstek sales representative for unlisted sizes and more complex geometries.



Camber and Flatness

CoorsTek as-fired and lapped substrates are 100% inspected for camber using two ground, parallel plates spaced at a fixed distance by the formula below. CoorsTek polished substrate flatness is measured in the restrained state.

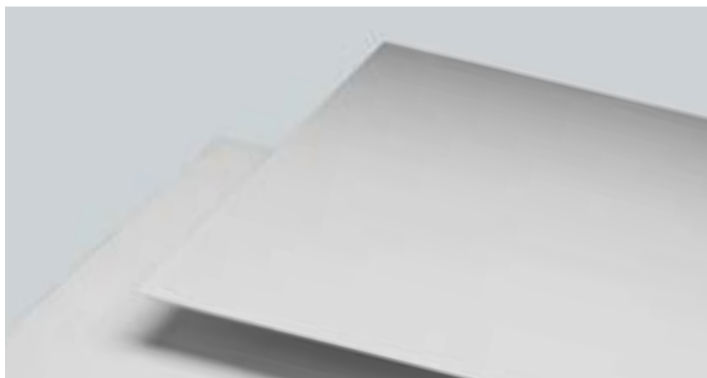


Table III-Camber		
As-Fired Camber	Lapped Camber	Polished Flatness
Standard Grade: 0.3% (0.003"/")	0.1% (0.001"/")	2-Side 0.05% (0.0005"/")
Resistor Grade / Premium: 0.2% (0.002"/")		1-Side 0.10% (0.0010"/")

Note: Tighter as-fired camber is available upon request. For a substrate with thickness of $< 0.010"$ (0.254 mm), please call for camber specifications.

$$D = T + (C \cdot L)$$

D =
 T +
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 C ·
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)

D: camber distance setting
T: substrate mode of thickness
C: camber value
L: substrate length

Design Guidelines (continued)



Visual Criteria for Surface Imperfections

See CoorsTek visual criteria in Table IV. CoorsTek uses ANSI standards for our in-process and final inspection. For as-fired substrates, inspection applies to the “A” face only. If a customized inspection is required, please submit your requirements when requesting quotation.

Substrates measuring 3.5" (88.90 mm) x 3.5" (88.90 mm) or greater typically have a 0.25" (6.35 mm) border around the perimeter for which only chips and cracks are inspected and rejectable.

- Parts < 1" (25.4 mm) square chip specification:
- Resistor – none over 0.0075" (0.1905 mm)
 - Standard – none over 0.010" (0.254 mm)

Table IV - Alumina Surface Imperfections for "A" Side					
Visual Attribute		Standard Grade (Conductor, Hybrid)	Resistor Grade (Precision Resistor, Hi-Rel, Micro-Rel)	Lapped	Polished
Burrs Fragments of excess material or foreign particle adhering to the surface		> 0.001" (0.0254 mm) high > 0.010" (0.254 mm) diameter	> 0.0005" (0.0127 mm) high > 0.005" (0.127 mm) diameter	None allowed per 0-1" (0-25.4mm) micrometer or camber	None allowed per fluorescent lighting, unaided eye
Pits, Holes, and Pocks A deep depression or void		> 0.010" (0.254 mm) diameter	> 0.005" (0.127 mm) diameter	None allowed per low angle light, unaided eye	None allowed per fluorescent lighting, unaided eye
Stains, Spots Contamination		None allowed	None allowed	None allowed per low angle light, unaided eye	None allowed per polarized microscope
Blisters Bubbles or gaseous inclusion at the surface which, if broken, could form a pit, pock, or hole		None allowed	None allowed	None allowed per 0-1" (0-25.4mm) micrometer or camber	None allowed per fluorescent lighting, unaided eye
Scratches Relatively long, narrow, shallow groove or cut in the surface		> 0.0007" (0.01778 mm) deep x 0.25" (6.35 mm) length	> 0.0002" (0.00508 mm) deep x 0.25" (6.35 mm) length	None allowed per low angle light, unaided eye	None allowed per fluorescent lighting, unaided eye
Bumps, Fins, Ridges		None allowed	None allowed	None allowed per 0-1" (0-25.4mm) micrometer or camber	None allowed per fluorescent lighting, unaided eye
Chips Open - Material broken off along an edge or corner Closed - Material has not broken off or separated		> 1% substrate length unlimited length X unlimited depth	> 0.75% substrate length unlimited length X unlimited depth	> 0.75% substrate length unlimited length X unlimited depth	> 0.75% substrate length unlimited length X unlimited depth
Cracks Line of fracture without complete separation		None allowed	None allowed	None allowed per low angle light, unaided eye	None allowed per fluorescent lighting, unaided eye

Note: The criteria in the table does not apply to substrates with surface areas greater than 20 square inches (12,903mm²). Please specify acceptance criteria for large area substrates when requesting quotation.

Laser Services

The following are designed to provide engineers with design guidelines, inspection methods, and quality standards for laser machining/profiling, drilling, and scribing of CoorsTek thin-film alumina substrates. These guidelines will aid in optimizing lasered substrate design in order to meet your technical requirements cost effectively. Figure 2 depicts some of our laser capabilities.

If a lasered substrate design does not comply with these guidelines, we may still be able to offer options to your specific design requirements. CoorsTek will indicate exceptions to customer drawings and specifications, should they differ from these guidelines, for the purpose of offering alternatives and possible cost reduction.

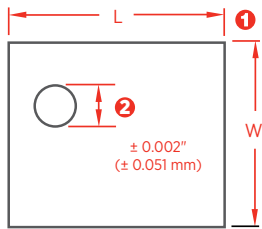
We provide the following services:

- Design Consultation
- Rapid Prototyping
- Scribing
- Machining
- Annealing

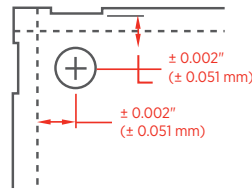
Laser Machining

CoorsTek offers machining services for precise hole location, edge definition, and to produce custom shapes and sizes. The following figures show typical hole configurations, design guidelines, and tolerances.

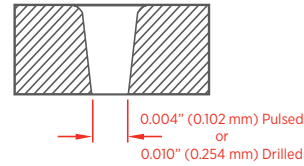
Specifications Guide



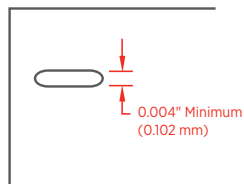
- 1. Length and Width**
 $\pm 0.002'' (\pm 0.051 \text{ mm})$
- 2. Hole Diameter**
 $\pm 0.002'' (\pm 0.051 \text{ mm})$



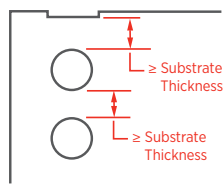
- 3. Hole Location: $\pm 0.002'' (\pm 0.051 \text{ mm})$**
- from any machined area to hole centerline
 - from center of scribe lines to hole centerline



- 4. Minimum Hole Diameter**
- pulsing $0.004'' (0.102 \text{ mm})$
 - drilling $0.010'' (0.254 \text{ mm})$

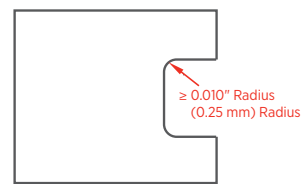


- 5. Cut Slot**
- $0.004'' (0.102 \text{ mm})$ minimum



- 6. Minimum Web Thickness**
- hole edge to another edge—substrate thickness
 - between adjacent holes—substrate thickness

Note: Thinner materials are more forgiving in this area.



- 7. Corner Radius**
- $0.010'' (0.254 \text{ mm})$ Radius

Note: Specify internal corner radii rather than sharp corners (90°) to avoid microcracking and chipping.

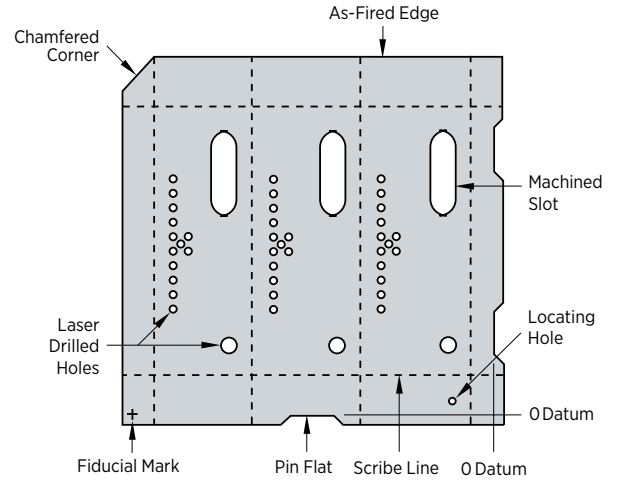
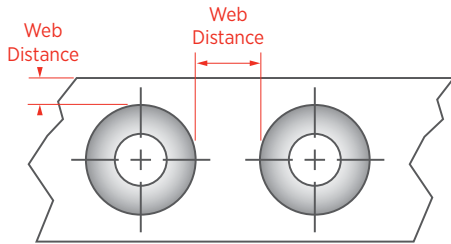


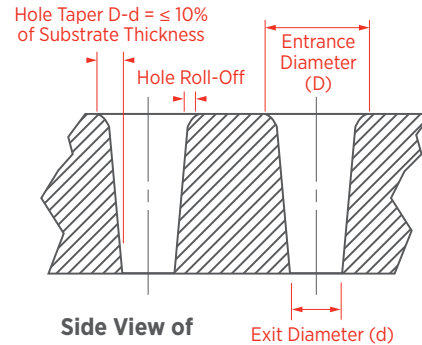
Figure 2. Typical Lasered Ceramic Substrate

Laser Services (continued)

Laser Machined Holes Typical Machining Configurations



Top View of Laser Hole

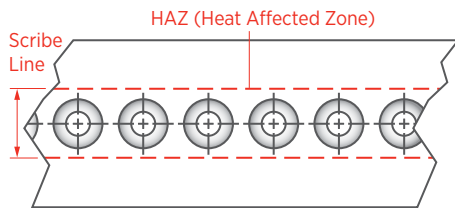


Side View of Laser Hole

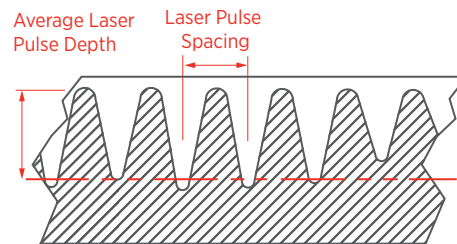
Laser Scribing

CoorsTek offers special differential scribing to enhance preferential singulation. By varying the laser pulse spacing and depth in the (x) and (y) scribe directions, the sequence of singulation may be controlled precisely. Enhanced laser scribing helps prevent

hooking, chipping, and premature breakage – which improves customer process yields. The following figures and tables show typical scribe line configurations and tolerances.



Top View of Laser Scribed Substrate



Side View of Laser Scribed Substrate

Table V-Laser Scribed Tolerances

Nominal Substrate Thickness	Resultant Segment From Two Broken Edges	Laser Scribed Edge to First Scribe Line
0.010" (0.254 mm) and 0.015" (0.381 mm)	+0.006" (0.152 mm) – 0.002" (0.051 mm)	+0.004" (0.102 mm) – 0.002" (0.051 mm)
0.020" (0.508 mm) and 0.025" (0.635 mm)	+0.006" (0.152 mm) – 0.002" (0.051 mm)	+0.005" (0.127 mm) – 0.002" (0.051 mm)
0.030" (0.762 mm) to 0.050" (1.207mm)	+0.008" (0.203 mm) – 0.002" (0.051 mm)	+0.007" (0.178 mm) – 0.002" (0.051 mm)
0.060" (1.524 mm)	+0.014" (0.356 mm) – 0.002" (0.051 mm)	+0.010" (0.254 mm) – 0.002" (0.051 mm)

Note: 1. Laser machined edges to first scribe line tolerance is $\pm 0.002"$ (± 0.051 mm) for all substrate thicknesses. 2. Scribe line to scribe line tolerance prior to breaking is $\pm 0.002"$ (± 0.051 mm). 3. Perpendicularity and parallelism of scribe lines and/or scribed and broken edges will not exceed 0.0005"/" (0.013mm/mm) when measured at laser pulse centers.

Annealing

Annealing treatments are also available. For thin-film materials, the customer defines the annealing parameters necessary to achieve specific circuit manufacturing requirements.

Tolerances

These specifications are based on the application of statistical process control methods to determine multibeam equipment capability to a Cpk 1.33. Dimensional tolerances should be specified as close as necessary to facilitate customer process requirements and minimize cost. Tighter tolerances are available upon request. For more information on tighter tolerances, please contact your CoorsTek sales representative or call +1 303 271 7100 for technical assistance.

Table VI—Recommended Laser Scribed Pulse Depth And Spacing

Nominal Substrate Thickness	Laser Pulse Depth	Spacing: Centerline to Centerline
0.010" (0.254 mm)	0.004" (0.102 mm)	0.005" (0.127 mm)
0.015" (0.381 mm)	0.006" (0.152 mm)	0.006" (0.152 mm)
0.020" (0.508 mm)	0.008" (0.203 mm)	0.006" (0.152 mm)
0.025" (0.635 mm)	0.012" (0.305 mm)	0.006" (0.152 mm)
0.035" (0.889 mm)	0.015" (0.381 mm)	0.006" (0.152 mm)
0.040" (1.016 mm)	0.018" (0.457 mm)	0.006" (0.152 mm)
0.060" (1.524 mm)	0.029" (0.737 mm)	0.007" (0.178 mm)

Note: Laser pulse depth and laser pulse spacing are reference dimensions. Laser pulse depth and laser pulse spacing can be adjusted to individual customer specifications.

Quality Assurance

CoorsTek is committed to providing the service and quality that customers have come to expect. CoorsTek is ISO 9001 Certified to ensure product quality and traceability.

Table VIII (see page 8) is a list of our standard requirements. If a customized inspection is required, please submit your requirements when requesting quotation.

Table VII: Inspection Table

Feature	Typical Inspection Level	Measurement Devices
External Sizes	C=0 Sampling Plan, Index 1.5	Calipers, Micrometers
Internal Feature Location and Size	C=0 Sampling Plan, Index 1.5	Optical Measurement
Surface Finish	3 parts per lot	Profilometer
Camber (As-Fired/Lapped)	Final Inspection	C=0 Sampling Plan, Index 1.5
	In-Process	100%
Flatness (Polished),	Final inspection	C=0 Sampling Plan, Index 1.5
	In-Process	100%
Visual	Final Inspection	C=0 Sampling Plan, Index 1.5
	In-Process	100%
Density	3 parts per lot	ASTM-C373

Thin-Film Ceramic Substrates Design Guide

Material Properties

Table VIII—Typical Material Characteristics							
Characteristics	Unit	Test Methods	ADS-995	ADS-996	SuperStrate® 996	SuperStrate® TPS	
Alumina Content	(Nominal)	Weight %	ASTM-D2442	99.5	99.6	99.6	99.6
Color	-	-	White	White	White	White	
Nominal Density		g/cm ³	ASTM-C373	3.88	3.88	3.88	3.95
Hardness		-	ASTM-E18, R45N	87	87	87	87
Surface Finish (Profilometer)	As-Fired		0.0004" Radius Stylus	5 (127)	3 (77)	2 (51)	n/a
	Lapped	Micrometers (Nanometers)	0.030" Cutoff	< 30 (762)	< 12 (305)	< 10 (254)	< 10 (254)
	Polished		ANSI/ASME B46.1	< 2 (51)	< 1 (26)	< 1 (26)	< 1 (26)
Grain Size		Microns		< 2.2	< 1.2	< 1.0	< 1.0
Water Absorption		%	ASTM-373	nil	nil	nil	nil
Gas Permeability		-	**	nil	nil	nil	nil
Flexural Strength		psi x 10 ³ (MPa)	ASTM-F394	83 (572)	86 (592)	90 (620)	99 (682)
Elastic Modulus		psi x 10 ⁶ (GPa)	ASTM-C848	54 (372)	54 (372)	54 (372)	54 (372)
Poisson's Ratio		-	ASTM-C848	0.2	0.2	0.2	0.2
Coefficient of Linear Thermal Expansion	25°-300° C	1 x 10 ⁻⁶ /°C	ASTM-C372	7.0	7.0	7.0	6.3
	25°-600° C	1 x 10 ⁻⁶ /°C	ASTM-C372	7.5	7.5	7.2	7.2
	25°-800° C	1 x 10 ⁻⁶ /°C	ASTM-C372	8.0	8.0	7.9	7.9
	25°-1000° C	1 x 10 ⁻⁶ /°C	ASTM-C372	8.3	8.3	8.2	8.2
Thermal Conductivity		W/m K	ASTM-C408	25.5	26.6	26.9	27
Dielectric Strength	0.025"	AC Volts/mil	ASTM-D116	575	575	600	640
	0.040"	AC Volts/mil	ASTM-D116	450	450	450	500
Dielectric Constant	@ 1 MHz	-	ASTM-D150	9.8	9.9	9.9	9.9
Dielectric Loss	@ 1 MHz	-	ASTM-D150	0.0001	0.0001	0.0001	0.0001
	25° C	ohm-cm	ASTM-D257	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁵
	100° C	ohm-cm	ASTM-D257	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁴	> 10 ¹⁵
	300° C	ohm-cm	ASTM-D257	> 10 ¹²	> 10 ¹²	> 10 ¹³	> 10 ¹⁵
	500° C	ohm-cm	ASTM-D257	> 10 ⁹	> 10 ⁹	> 10 ¹⁰	> 10 ¹²
Volume Resistivity	700° C	ohm-cm	ASTM-D257	> 10 ⁸	> 10 ⁸	> 10 ⁹	> 10 ¹⁰

Charts intended to illustrate typical properties. Property values vary with method of manufacture, size, and shape of part. Data contained herein is not to be construed as absolute and does not constitute a representation or warranty for which CoorsTek assumes legal responsibility. Information in this bulletin illustrates the general laser services of CoorsTek. Users are responsible for selection of laser services suitable for specific applications. European Union (EU) Directive on Restriction of Hazardous Substances (RoHS): The EU Directive on RoHS specifies that an electronic product or component may not contain a listed substance except as specifically provided in the directive. CoorsTek ceramic substrates meet the requirements of the Directive. SuperStrate and CoorsTek are registered trademarks of CoorsTek, Inc.



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