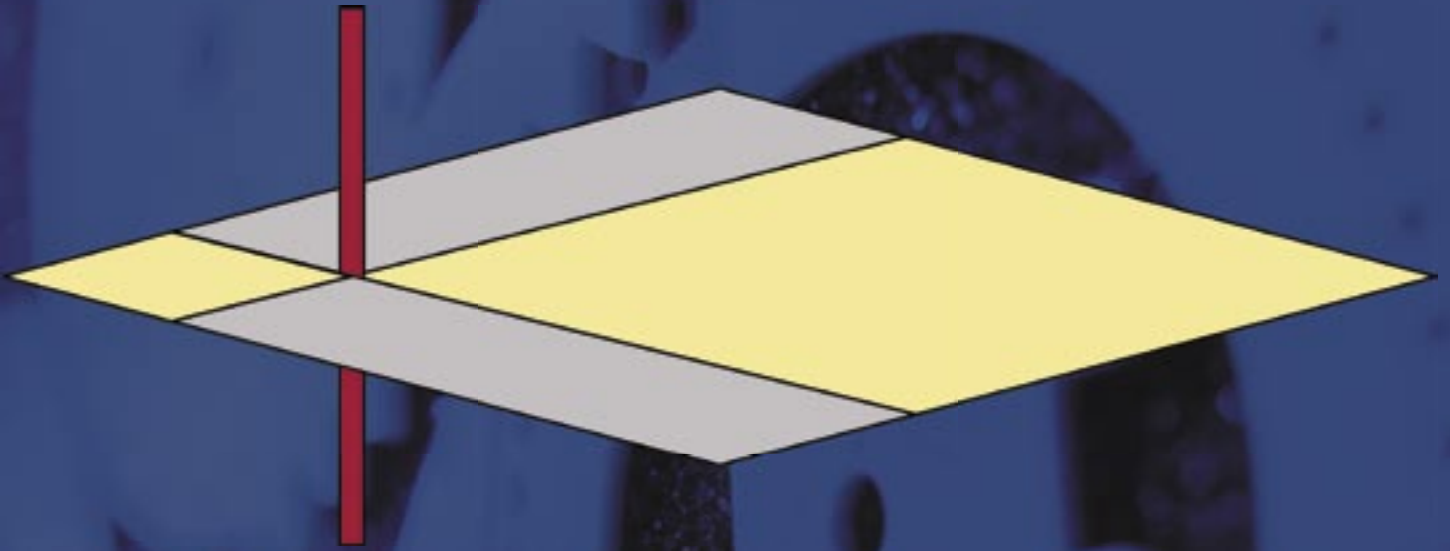


Laser Cutting Ceramics Ltd.



HYBRID MICRO-ELECTRONICS
Technical Specifications

Laser Cutting Ceramics Ltd.

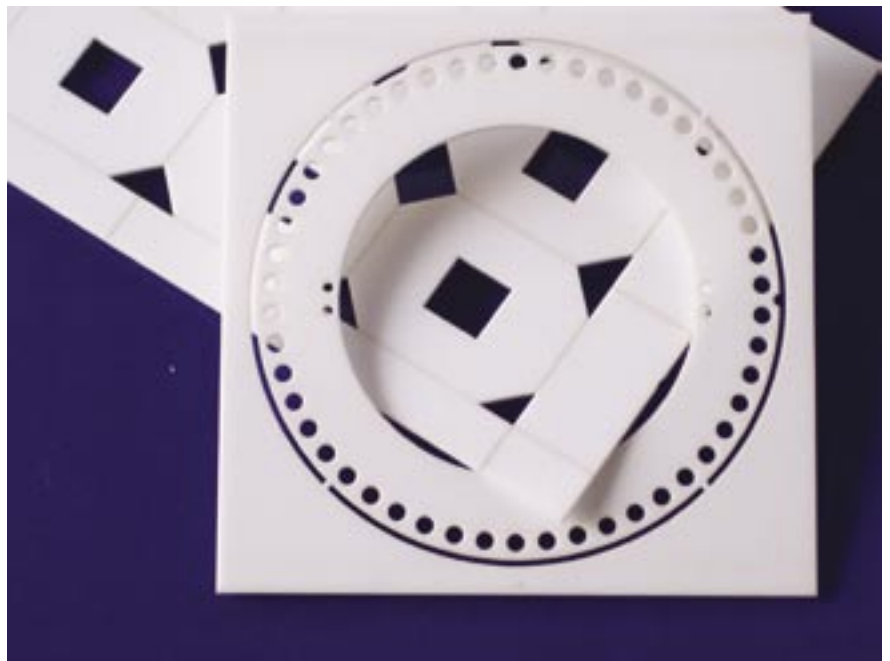
Laser Cutting - Ceramics Ltd is a new name for an old, established company. As the Ceramics Division of The Laser Cutting Company Ltd, it pioneered the use of laser technology to become one of Europe's leading forces in its practical and commercial application.

The company has been supplying precision laser cut ceramic substrates to the micro-electronics industry since 1981. Its policy of continual improvement and innovation has satisfied the industry's demand for ever increasing levels of quality and complexity, whilst meeting ever shorter delivery dates.

This level of experience and industry expertise has also enabled us to develop overseas markets, and we now supply laser cut components to many of the leading hybrid micro-electronics companies throughout Europe and other parts of the world.

The company specialises in laser cutting materials for the micro-electronics industry and other markets requiring high quality precision laser cutting.

A key aspect of our service is the commitment we make to every customer. This includes understanding your exact requirements, supplying a level of quality that matches those requirements, and delivering on time and at a price that is realistic.



SERVICES AVAILABLE

With many years experience in laser profiling, drilling and scribing thick and thin film substrates, we can help optimise laser cut substrate design to meet your technical requirements in the most cost-effective manner.

Printed or sputtered substrates with high quality circuits can be precision lasered.

In addition, we supply laser cut ceramics for lids, frames, packages, jigs, fixtures, guides, wear plates, cores, thermal and electrical insulators, spacers, washers, test pieces, kiln supports and wave guides.

Many other materials used in the micro-electronics industry can also be processed. If your application requires the use of a material not listed please ask.

We are happy to receive inquiries by email with drawings in dxf or dwg format addressed to dave@lasercutting-ceramics.co.uk

We aim to provide samples within 48 hours from receipt of final drawing subject to material availability.

MATERIALS PROCESSED

- *Aluminium nitride
- *Aluminium oxide (black)
- *Aluminium oxide (white)
- Ceramic tube
- Flexible circuit board
- FR4
- Garnet
- Graphite
- Kapton polyimide film
- Magnesium oxide
- Mica
- Mylar
- *Nomex
- *Nylon 66
- Perspex
- Polyester
- *PTFE
- Pyrex
- Quartz substrates
- Quartz tube
- Silicon nitride
- Silicon wafer
- Silicone rubber
- Stainless steel foils (up to 0.25mm)
- Zirconia

*material regularly stocked

We are also able to obtain FR4, Mylar, Kapton polyimide film, Perspex, polyester, stainless foil, silicone rubber, silicon wafer

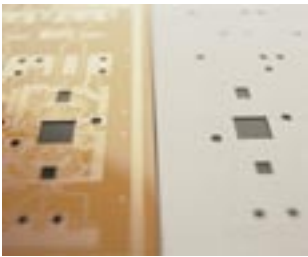
The remaining materials we would try to source but would prefer to have free issued.



MATERIALS STOCKED

Thickness (inches)	Size (inches)	Kyocera A476 (96%)	Kyocera A493 (99.6%)	Coors ADS96R	Coors ADOS90R (black)	Ceramtec 708S (96%)	Ceramtec AIN	Maruwa 96%	Nomex 410 (roll)
0.003									•
0.005									•
0.006	2 x 2	•							
0.007									•
0.008	2 x 2	•							
0.01									•
	3.5 x 3.5			•					
	4.5 x 4.5	•	•	•		•			
0.0125	4.5 x 4.5	•							
0.015	4.5 x 4.5	•	•	•					
	6.5 x 4.5			•		•			
0.02	4.5 x 4.5				•		•		
	6.5 x 4.5			•		•		•	
0.025	4 x 4			•					
	4.5 x 4.5		•	•	•	•	•		
	6.5 x 4.5			•		•			
	7.5 x 5.5							•	
0.03	4.5 x 4.5			•					
	6.5 x 4.5					•			
0.04	4.5 x 4.5	•	•	•	•		•		
	6.5 x 4.5			•		•		•	
	7.5 x 5.5							•	
0.05	4.5 x 4.5			•		•			
0.06	4.5 x 4.5			•		•			
0.08	4.5 x 4.5					•			





DESIGN GUIDELINES

LASER DRILLING AND PROFILING

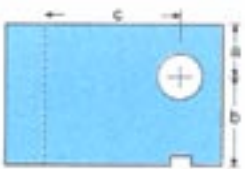
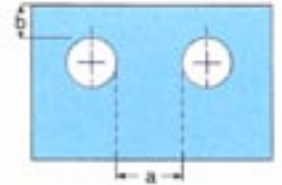


Tolerances for optimum cost effective manufacture are ...



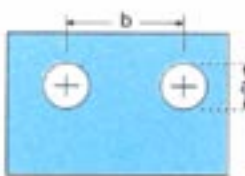
- 1** Length and width:
between scribed edges $+0.006''$
 $-0.002''$ ($+0.15\text{mm}/-0.05\text{mm}$)
profiled edges $\pm 0.002''$ ($\pm 0.05\text{mm}$)

- 5** a. Wall thickness between adjacent holes \geq substrate thickness
b. Wall thickness between hole edge and another edge \geq substrate thickness



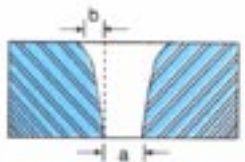
- 2** a. Scribed edge to hole centre $+0.006''$ $-0.002''$ ($+0.15\text{mm}/-0.05\text{mm}$)
b. Profiled edge to hole centre $\pm 0.002''$ ($\pm 0.05\text{mm}$)
c. Centre of scribed line to hole centre $\pm 0.002''$ ($\pm 0.05\text{mm}$)

- 6** Narrowest cut slot $0.004''$ (0.10mm) minimum



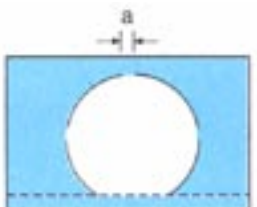
- 3** a. Hole diameter:
standard tolerance $\pm 0.002''$ ($\pm 0.05\text{mm}$)
special tolerance $\pm 0.0008''$ ($\pm 0.02\text{mm}$)
b. Hole centre to hole centre
standard tolerance $\pm 0.002''$ ($\pm 0.05\text{mm}$)
special tolerance $\pm 0.0008''$ ($\pm 0.02\text{mm}$)

- 7** Corner radius \geq substrate thickness (specify internal corner radii rather than sharp corners to minimise the risk of microcracking)



- 4** a. Minimum hole diameter
pulsing $0.0025''$ (0.06mm)
drilling $0.006''$ (0.15mm)
b. Hole tapers $\sim 5\%$ of substrate thickness

- 8** Disc retention by scribed flats or tags
Minimum tag size is $0.006''$ (0.15mm)



ALTERNATIVE TOLERANCES MAY BE AVAILABLE ON REQUEST.

PLEASE CONTACT OUR REPRESENTATIVE OR THE TECHNICAL SALES DEPARTMENT.

Telephone 0114 249 4005, Fax 0114 242 5194
e-mail dave@laser-cutting-ceramics.co.uk

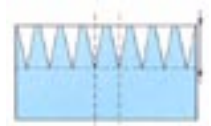
DESIGN GUIDELINES • LASER SCRIBING

Laser scribed substrates are normally supplied without tooling or computer part programme costs
All dimensions are non-accumulative. Tolerances for economic manufacture are:



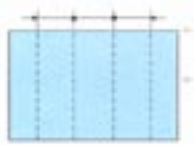
① Length and width between scribed edges +0.006" -0.002" (+0.15mm -0.05mm)

④ Depth of scribing is normally 30-50% of material thickness. Laser pulse spacing is normally 0.006" ±0.001" (0.15mm±0.02mm) centreline to centreline. Pulse depth and spacing can be adjusted to optimise individual customer specifications.



② Laser scribed edge to first scribed line +0.006" -0.002" +0.15mm -0.05mm
Laser profiled edge to first scribed line










⑤ Edge to design. Border edge to be snapped off should be at least 5 times material thickness:



③ Scribe line to scribe line +0.002" (±0.05mm)

QUALITY ASSURANCE

VISUAL INSPECTION; ALLOWABLE SURFACE IMPERFECTIONS TO AQL 2,5 (LEVEL II)

Thick film substrates	Thin film substrates	Surface Imperfections
None	CRACKS 	None
<0.025" (0.635mm) wide	CHIPS 	$\frac{3}{4}\%$ of substrate length NLT >0.005" (0.127mm)
<0.0007" (0.018mm) deep	SURFACE SCRATCHES 	1 per in ²
<0.001" (0.025mm) high	BLISTERS 	None
<0.001" (0.025mm) high	BURRS 	<0.0004" (0.01mm) high
<0.001" (0.025mm) high	RIDGES 	None
<0.007" (0.18mm) diameter	PITS 	0.0004" (0.01mm) high
Acceptable unless opened	PORES 	None
Acceptable if within camber requirement	WAVINESS 	None
Acceptable unless exposed even if it shows discolouration	FOREIGN MATERIAL	None

CERAMTEC • ALUMINA MATERIAL PROPERTIES

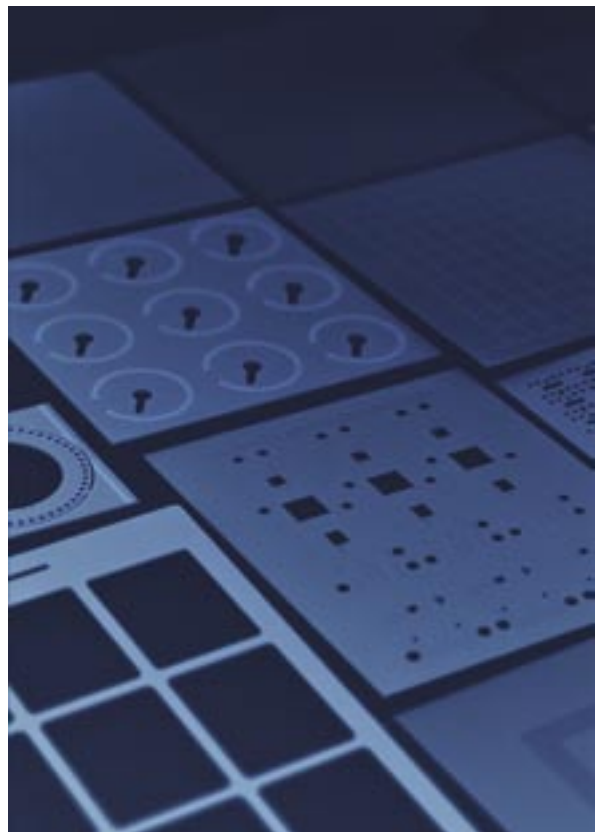
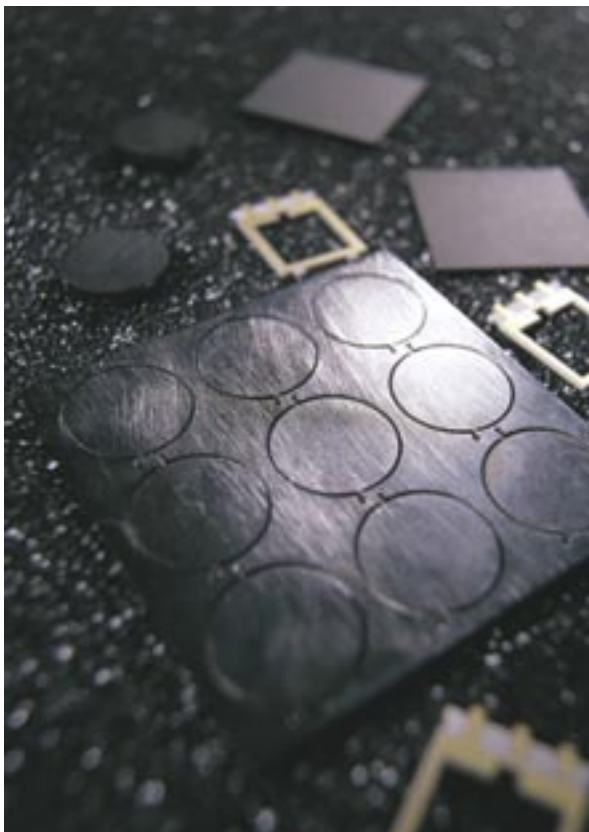
Properties	UNITS	RUBALIT® 708S 96% Al ₂ O ₃	RUBALIT® 710 99.6% Al ₂ O ₃	ALUNIT® Ain	TEST PER
Colour	-	white	white	translucent medium gray	-
Medium grain size d ₅₀	µm	3-5	2	4-5	-
Surface roughness R _a	µm	0.6 max	0.1	0.6 max	-
Bulk density	Kg/m ³	3780	3900	3330	ASTM C 20
Water absorption capacity	%	0	0	0	ASTM C 373
Bending strength					
- 4-point method (40x4x3 mm ³)	Mpa	400	400	360	ASTM F 417
- dual ring method (0.63 mm substrate thickness)	Mpa	500	350		DIN 52292
Modules of elasticity	GPa	340	28	320	ASTM F 417
Thermal conductivity 20- 100%	W/m°K	24.3	-	180	ASTM C 408
Specific heat	J/kg°K	800		738	
Coefficient of linear expansion	10 ⁻⁶ /°K				ASTM C 373
20-300°C		6.8	6.8	4.7	
20-600°C		7.3	7.5	5.2	
20-1000°C		8.0	8.5	5.6	
Dielectric constant					ASTM C 150
- 1MHz		9.8±10%	10.1±10%	9.0 ±10%	
- GHz		10.0±10%	10.1±10%		
Dielectric loss factor (1 MHz)	10 ⁻³	0.3	0.2	0.4	ASTM D 150
Breakdown strength	KV/mm				ASTM D 149
-1 mm substrate thickness		15		16	
-0.63 mm substrate thickness		20	>10		
-0.25 mm substrate thickness		28			
Volume resistivity	ohm x cm				ASTM D 257
-20°C		10 ¹³	10 ¹³	10 ¹³	
-200°C		10 ¹²	10 ¹³		
-400°C		10 ¹¹	10 ¹²		
-600°C		10 ⁸	10 ⁹		

COORS • ALUMINA MATERIAL PROPERTIES

Characteristic	Unit	Test Method	ADOS-90R	ADS-96R
Alumina content	weight%	ASTM D2442	91	96
Colour	-	-	dark brown	white
Density	g/cm ³	ASTM C 373	3.72 min.	3.75 min.
Hardness-Rockwell	-	ASTM E18 R45N	78	82
Surface finish - CLA (as fired)	Microinches	Profilometer, .0004" radius style .030" cut off, ANSI/ASME B 46.1	≤45	≤ 35
Average grain size	micrometers	intercept method	5-7	4-7
Water absorption	%	ASTM C 373	NIL	NIL
Gas permeability	-	-	NIL	NIL
Flexural strength	Kpsi	ASTM F 94	53	58
Elastic Modules	10 ⁶ psi	ASTB C 623	45	44
Poisson's Ratio	-	ASTM C 623	.24	.21
Coefficient of linear Thermal Expansion	10 ⁻⁶ /° C	ASTM C 372		
25° - 200° C			6.4	6.3
25° - 500° C			7.3	7.1
25° - 800° C			8.0	7.6
25° - 1000° C			8.4	8.0
Thermal Conductivity	W/m° K	Various		
20° C			13	26
100° C			12	20
400°			8	12
Dielectric Strength (60 cycles AC avg. RMS)	volts/mil	ASTM D 149		
.025" Thick			540	600
.050" Thick			-	-
Dielectric Constant - (Relative Permittivity)		ASTM D 150		
1KH			11.8	9.5
1MHz			10.3	9.5
Dissipation Factor (Loss Tangent)		ASTM D 150		
1 KHz			.1	.0010
1MHz			.005	.0014
Loss index (Loss Factor)		ASTM D 150		
1KHz			1.2	.009
1MHz			.05	.004
Volume Resistivity	ohm/cm	ASTM D 1829		
25°			>10 ¹⁴	>10 ¹⁴
300°			4 x 10 ⁸	5.0 x 10 ⁷
500°			-	1.0 x 10 ⁹
700°			7 x 10 ⁶	4.0 x 10 ⁷

KYOCERA • ALUMINA MATERIAL PROPERTIES

Kyocera No.		A-445	A-473	A-476T	A-493		
Appearance		Dense	Dense	Dense	Dense		
Colour		Dark Brown	White	White	White		
Alumina Content (%)		91	92	96	99.6		
Main Characteristics		Opacity High Heat Dissipation	Metalising Mechanically Strong	Standard Substrate Material	Good surface smoothness		
Main Applications		IC Packages, Lids	Lids, Substrates For Refractory	Thick Film Substrates	Thin Film Substrates		
	Bulk Density	-	3.9	3.6	3.8	3.9	
	Water Absorption	%	0	0	0	0	
Mechanical Characteristics	Vickers Hardness (Load 500g)	kg/mm ²	1,100	1,350	1,500	1,650	
	Flexural Strength	psi, kg/cm ²	30,000 2,100	46,000 3,200	40,000 2,800	70,000 5,000	
	Compressive Strength	psi, kg/cm ²	- -	- -	- -	- -	
	Youngs (x10 ⁶) Modulus (x10 ⁶)	psi, kg/cm ²	- -	39 2.7	- -	- -	
Thermal Characteristics	Coefficient of Linear Thermal Expansion	40°-400°	1/°C	7.2	6.9	7.1	7.2
		40°-800°C	(x10-6)	8.1	7.7	7.8	8.2
	Thermal Conductivity	20°	cal-cm/cm ² -sec-°C	0.04	0.04	0.05	0.08
	Specific Heat		cal/g°C	0.19	0.19	0.19	0.19
	Max. Use Temperature		°C	1,200	1,500	1,600	1,750
Electrical Characteristics	Dielectric Strength		kv/mm	10	10	10	10
	Volume Resistivity	20°C	Ω-cm	>10 ¹²	>10 ¹⁴	>10 ¹⁴	>10 ¹⁴
		300°C		10 ⁸	10 ¹³	10 ¹⁴	10 ¹⁴
		500°C		10 ⁷	10 ¹⁰	10 ¹¹	10 ¹²
	Dielectric Constant	(1MHz)	-	7.9	9.5	10.2	9.9
	Dielectric Loss Angle	(1MHz)	(10 ⁻⁴)	-	8	2	2
Loss Factor		(x10 ⁻⁶⁴)	-	76	19	19	



MARUWA • ALUMINA MATERIAL PROPERTIES

Properties	Unit	HA-995	HA-96-2	Method	Related
Material	-	99.6%Al ₂ O ₃	96%Al ₂ O ₃	-	-
Colour	-	white	white	-	-
Bulk density	kg/m ³	3900	3750	JIS C2141	ASTM C 20
Water absorption	%	0.0	0.0		ASTM C 373
Surface roughness Ra	μ m	0.1	0.5		-
Bending strength (3 point method)	MPa	400	400	JIS R 1601	DIN EN 843-1
Compressive strength	MPa	2300	2000	JIS R 1608	ASTM F 417
Modulus of elasticity	GPa	370	340	JIS R 1602	
Vickers hardness	GPa	15.0	13.5	JIS R 1610	
Thermal conductivity 25°C 300°C	M/m*K	30 15	24 14	JIS R 1611	ASTM C 408
Specific heat	J/kg*K	750	750		
Coefficient of thermal expansion 40~400°C 40~800°C	10 ⁶ /K	7.2 8.1	7.0 7.7	JIS R 1618	ASTM C 373
Dielectric const -1MHz -1GHz		9.7+/-10% 10.2+/-10%	9.5+/-10% 10.0+/-10%	JIS C 2141	ASTM C 150
Dielectric loss factor -1MHz	10 ³	0.2	0.3		
Breakdown strength -0.63mm thickness -0.25mm thickness	kV/mm	15 20 28	15 20 30		ASTM D 149
Volume resistivity -20°C -300°C -500°C	Ohm*cm	10 ¹⁴ 10 ¹² 10 ¹⁰	10 ¹⁴ 10 ¹⁰ 10 ⁸		ASTM D 257

MARUWA • ALUMINA MATERIAL ADDITIONAL CHARACTERISTICS

Property	Units	96% Alumina	99.5% Alumina	ALN
Colour	-	white	white	grey
Grain Size (d50)	μ m	3-5	2	4
Density	g/cm ³	3.7	3.9	3.3
Water Absorption	%	0.0	0.0	0.0
Surface roughness	μ m	0.3	0.5	0.5
Bending strength	MPa	340	400	400
Young's module	GPa	340	380	380
Specific heat	J/Kg°K	800	740	740
Thermal conductivity (20-100%)	W/m°K	24	170	170
Coefficient of linear expansion (20-600%)	10E-6/°K	7.3	4.0	4.0
Dielectric constant (1MHz 25°C)	-	9.4	9.0	9.0
Dielectric loss factor (1MHz)	-	0.3	0.4	0.4
Breakdown voltage (t=0.63mm)	KV/mm	20	15	15
Volume resistivity 200°C	Ohm x cm	1 x 10E12	1 x 10E14	1 x 10E14

NOMEX® ARAMID PAPER - TYPE 410

DESCRIPTION

Nomex® Type 410 is a calendared insulation paper, which offers high inherent dielectric strength, mechanical toughness, flexibility and resilience. Type 410 is the original form of Nomex® paper and is widely used in a majority of electrical equipment applications. Available in 11 thicknesses (0.05 to 0.76 mm), Type 410 is used in most known electrical sheet insulation applications

AVAILABILITY

Standard rolls are 914 mm and 610 mm wide.

TYPICAL ELECTRICAL PROPERTIES

Thickness	mm	0.05	0.08	0.13	0.18	0.25	0.30	0.38	0.51	0.61	0.65	0.76
Dielectric strength												
AC rapid rise	kV/mm	17	22	26	33	32	33	32	31	32	32	27
Dielectric constant	at 60Hz	1.6	1.6	2.4	2.7	2.7	2.9	3.2	3.4	3.7	3.7	3.7

HUMIDITY EFFECTS ON ELECTRICAL PROPERTIES

Relative humidity	Oven dry	50	90	
Dielectric strength	kV/mm	37.8	35.4	33.8
Dielectric constant	at 60Hz	2.5	2.7	3.2
Dissipation factor	at 60 Hz x 10 ⁻³	6	6	11

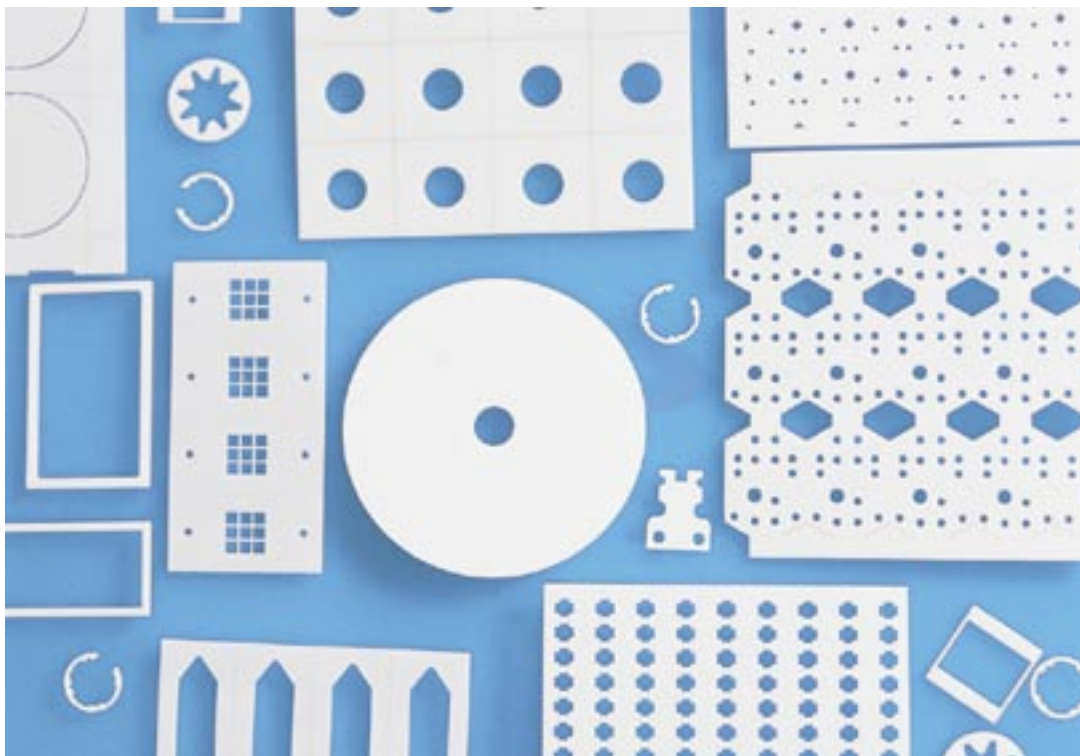
TYPICAL MECHANICAL PROPERTIES

Nominal		0.05	0.08	0.13	0.18	0.25	0.30	0.38	0.51	0.61	0.65	0.76	Test method
Tensile strength	MD	43	70	144	228	306	385	482	657	823	715	910	ASTM
	XD	18	34	68	116	152	203	263	376	534	505	613	D-828
Elongation %	MD	11	11	16	19	20	23	21	22	21	20	20	ASTM
	XD	8	0	13	15	16	19	17	17	15	14	16	D-828
Initial Tear strength	MD	11	16	32	49	71	93	116	162	187	176	240	ASTM
	XD	6	8	16	25	43	51	71	110	146	146	191	D-1004

THERMAL CONDUCTIVITY

Nominal Thickness	mm	0.05	0.08	0.13	0.18	0.25	0.38	0.51	0.76
Density	g/cc	0.72	0.80	0.87	0.94	0.96	1.01	1.05	1.08
Thermal conductivity ¹⁾	mWatt/meter K	103	114	123	143	139	149	157	175

¹⁾ All data taken at 150°C



KAPTON® POLYIMIDE FILM

Description

Kapton® Polyimide film possesses a unique combination of properties previously unavailable among polymeric film materials. The ability of Kapton® to maintain its excellent physical, electrical and mechanical properties over a wide temperature range has opened new design and application areas for plastic films.

Kapton® is extensively used for aerospace, printed circuit and traction motor applications, operating up to 400°C. It has proved to be an indispensable material for advanced applications. Several types of Kapton® are available:-

KAPTON® HN - used for the majority of applications, where its properties are required over a wide temperature range

KAPTON® FN - where heat sealability is required. Kapton® is combined with Teflon FEP resin. It is commonly used for lapping of copper conductors in electric motors and aerospace wires

KAPTON® VN - only occasionally called for, being similar to HN but with superior dimensional stability

FEATURES:

- Operating range -269°C to +400°C
- UL94-VO rating
- No melting point
- Flexible and light
- Excellent properties:
 - Mechanical
 - Electrical
 - Thermal
- chemical resistance

APPLICATIONS:

- aerospace
- slot liners
- magnet wire
- flexible printed circuits
- transformer insulation
- bar code labels
- loudspeaker voice coils
- heating elements
- metallising
- heat sink
- radar chaff
- smoke hoods
- adhesive tape

TYPICAL KAPTON® PROPERTIES

Type		100HN	200 HN	200 VN	150 FN 019
Nominal Thickness	μm	25	50	50	38 (25μK/13μ FEP)
Tensile strength at 23°C	N/mm ²	165	165	165	162
Elongation at 23°C	%	40	45	50	70
Shrinkage at 250°C	%	2.5	2.5	0.05	n.a.
Dielectric strength at 60 hertz-	1/4" electrodes V/μm	236	197	197	138
Volume resistivity at 200°C	ohm-cm	10 ¹²	10 ¹²	10 ¹²	10
Dielectric constant at 1 kilohertz		3.9	3.9	3.9	3.9

MYLAR® POLYESTER FILM

DESCRIPTION

Mylar® polyester film is a flexible, exceptionally strong and durable transparent film with an unusual balance of properties making it suitable for many industrial applications. Type A Mylar® is primarily used for release application, office supplies, electrical insulation and industrial laminations when combined with other flexible materials.

PROPERTIES

Type A Mylar® has a tensile strength that averages 210 MPa, has excellent resistance to moisture and most chemicals and can withstand temperature extremes from -70°C to 150°C. Because it contains no plasticizers, Type A Mylar® does not become brittle with age under normal conditions

APPLICATIONS - Specific engineering functions include:-

- An electrical barrier in motors, transformers and wire, cables and a host of uses in electronic and aerospace equipment
- A physical barrier in protective laminates for decals and book covers
- A thermal and electrical barrier in wire and cables
- A substrate for coating or laminating of food and medical packaging
- General graphics and packaging applications
- A mechanical interface in membrane switches

TYPICAL VALUES FOR MAJOR THICKNESSES OF FILM

Property/Method	ASTM D		23μ	36μ	50μ	75μ	100μ	125μ	190μ	250μ
Tensile strength	MPa	882-80	M	200	220	200	190	190	190	190
			T	240	280	240	230	230	220	220
Modulus	MPa	882-80	M	3850	3800	3650	3550	3450	3300	3100
			T	4450	4500	4100	4000	3900	3700	3700
Elongation	%	882-80	M	130	130	130	140	150	150	190
			T	100	100	100	100	100	110	140
Shrinkage	%	1204-78	M	0.5	0.5	0.5	0.5	0.5	0.5	0.5
			T	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Shrinkage	%	1204-78	M	1.5	2.0	1.5	1.3	1.3	1.3	1.3
			T	1.5	2.5	1.5	1.3	1.3	1.3	1.3
Haze	%	1003-52		5	30	27	39	39	43	82
Dielectric Strength (minimum)	kV	149		2.5	5.5	7.7	11.75	11.75	13.5	17.5

All of the information contained in this publication is believed to be reliable. User however, should independently evaluate the suitability of each product for their application.

HEALTH AND SAFETY: SUMMARY

- Toxicity:** Non toxic, unlikely to be ingested
- Combustibility:** ignition will occur over 200°C
- Storage:** will not degrade or decompose, keep dry and below 30°C
- Handling:** use suitable handling equipment and safety shoes and gloves
- Disposal:** suitable for normal recycling and refuse handling systems

QUALITY ASSURANCE



QUALITY SYSTEM

Our quality system for the laser machining of ceramic materials for the electronics industry is certified to ISO 9001:2000. Rigorous internal inspection, both of materials and production processes, is carried out at every stage of manufacture. Detailed computer print-out of dimensions, together with Certificates of Conformance, are available on request. All optical inspection systems are calibrated and traceable to the National Physical Laboratory.

QUALITY PROGRAM

Our quality program encompasses all aspects of design, production, inspection and testing. A strict system is maintained for defect prevention, equipment accuracy, production documentation and extensive product testing.

ACCEPTABLE QUALITY LEVEL (AQL) REQUIREMENTS

We apply the BS6001 attribute sampling plan, General inspection Level S2, for the qualification of outgoing products. The following table details the AQL criteria for typical product attributes. Alternative acceptance plans and criteria can be agreed at the time of ordering.

QUALITY ASSURANCE PROVISIONS	
ATTRIBUTE	AQL, LEVEL S2 THICK FILM & THIN FILM
SURFACE IMPERFECTIONS	100%
CRACKS	0.65
DIMENSION	0.65
CAMBER	1.0

QUALITY POLICY

We are dedicated to meeting our customers' requirements for all products and services supplied. This requires total commitment from management and total involvement from all staff and is achieved by working together with our customers, getting it right first time and through prevention, not detection.

This policy is a permanent feature of company life: we have an ongoing commitment to quality improvement.

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