Superior Technical Ceramics
Engineering. Partnership. Solutions.

HIGH PURITY ALUMINA CERAMICS

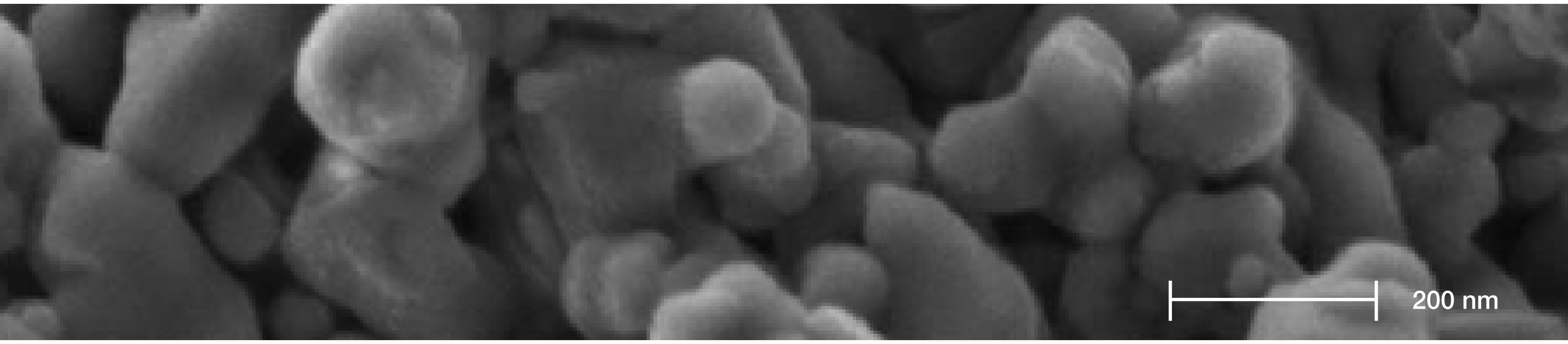

Figure 1: Scanning electron microscopy of ultra pure alumina powder. Source: ResearchGate

OVERVIEW

Alumina (Al_2O_3) is a common workhorse material in the world of technical ceramics and is utilized in an extensive variety of industries and applications. The versatility of alumina stems from its broadly impressive material properties, ease of manufacture, wide availability, and budget-friendly cost. STC's existing offerings include fully dense alumina materials in a wide variety of purity, from 74% to 99.8%, plus specialty porous aluminas such as bisque-fired and nano-porous (read the STC Porous Alumina white paper on our website).

Now, STC is announcing its highest purity dense alumina yet: 99.96%. We developed this ceramic material in response to growing industry need for mechanical, thermal, and electrical properties that go beyond 99.8%'s already high performance in ever more demanding applications.

ADVANTAGES

99.96% alumina offers several advantages over lower purity aluminas, which stem from both the extremely high purity level as well as the uniquely fine grain size (≈ 1 µm average) found in the fired bulk material. Such advantages include:

- Extremely High Hardness
  - » Vickers 500g ≈ 2,000+ kg/mm^2 (≈ 20 GPa) (30 – 50% higher than 99.8%)
- High Flexural Strength
  - » Weibull Average (4-pt): 55,000 psi (379 MPa) (Weibull Modulus=21+, n=31)
- High Dielectric Strength
  - » .125" thick: 400+ V/mil (compared to 310 V/mil for 99.8%)

Plus:

- Improved corrosion resistance due to lower impurity/glass content.
- Improved surface finishes are possible due to the fine average grain size.
- Improved thermal shock resistance.

See the full property chart for high purity alumina ceramics below.

APPLICATIONS

STC's 99.96% alumina offers improved performance over lower purity alumina ceramics in demanding operating conditions while remaining an economical alternative to silicon carbide in critical wear- and corrosion-resistance applications.

Our 99.96% alumina is currently utilized in a variety of demanding applications, including:

- High voltage dielectric components for nuclear energy production
- Mineral grinding wear components
- Dielectric components for semiconductor wafer handling
- High strength, thin-walled, high temperature components for heater wire support and mass spectrometer applications

STC can fashion 99.96% alumina into a wide variety of component shapes and sizes and to any precision and quality requirements necessary to suit your specific application needs.

PROPERTY COMPARISON CHART: HIGH PURITY ALUMINAS

	Property	ASTM Method	Units	AL995 99.5%	AL9980 99.8%	AL9996 99.96%
General	Crystal Size (Average)	Thin Section	Microns	6	6	2
	Color	--	--	Ivory-White	Ivory	Off White/Blush
	Gas Permeability	--	atms-cc/sec	gas tight $<10^{-10}$	gas tight $<10^{-10}$	gas tight $<10^{-10}$
	Water Absorption	C 20-97	%	0	0	0
Mechanical	Density	C 20-97	g/cc	3.88	3.91	3.93
	Hardness	Vickers 500 gm	GPa (kg/mm^2)	14.3 (1459)	15 (1530)	19.6 (2000)
	Hardness	--	R45N	82	86	90
	Fracture Toughness	Notched Beam	MPam$^{1/2}$	4 - 5	3 - 4	5 - 6
	Flexural Strength (MOR) (3 point) @ RT	F417-87	MPa (psi x 10^3)	338 (49)	379 (55)	455 (66)
	Tensile Strength @ RT	--	MPa (psi x 10^3)	172 (25)	200 (29)	275 (40)
	Compressive Strength @ RT	--	MPa (psi x 10^3)	2137 (310)	2240 (325)	2413 (350)
	Elastic Modulus	C848	GPa (psi x 10^6)	379 (55)	379 (55)	393 (57)
	Poisson's Ratio	C848	--	0.23	0.23	0.23
Thermal	C.T.E. 25 - 100° C	C 372-96	x 10^{-6}/C	6.3	6.5	6.5
	C.T.E. 25 - 300° C	C 372-96	x 10^{-6}/C	6.9	7.9	7.9
	C.T.E. 25 - 600° C	C 372-96	x 10^{-6}/C	7.6	8.1	8.2
	Thermal Conductivity @ RT	C 408	W/m K	30	30	35
	Max Use Temp	--	Fahrenheit (°F)	3047	3047	3100
		--	Celsius (°C)	1675	1675	1700
Electrical	Dielectric Strength (.125" Thick)	D 149-97A	V/mil	270	290	422
	Dielectric Constant @ 1 MHz	D 150-98	--	9.8	9.8	9.9
	Dielectric Constant @ Gigahertz	D 2520-95	--	9.7	10	--
				9.8	9.6	--
	Dielectric Loss @ 1 MHz	D 150-98	--	0.0002	< .0001	< .0001
	Dielectric Loss @ Gigahertz	D 2520-95	--	< .0001	< .0001	--
				9.8	9.6	--
	Volume Resistivity, 25°C	D 257	ohms-cm	> 1 x 10^{14}	> 1 x 10^{14}	> 1 x 10^{14}
	Volume Resistivity, 300° C	D 1829	ohms-cm	1 x 10^{12}	3 x 10^{12}	1 x 10^{13}
	Volume Resistivity, 500° C	D 1829	ohms-cm	5 x 10^{10}	6 x 10^{10}	5 x 10^{12}
	Volume Resistivity, 700° C	D 1829	ohms-cm	2 x 10^9	6 x 10^9	1 x 10^{12}

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