Aluminum Oxide, Al_2O_3 Material Characteristics

Alumina is the most cost effective and widely used material in the family of engineering ceramics. The raw materials from which this high performance technical grade ceramic is made are readily available and reasonably priced, resulting in good value for the cost in fabricated alumina shapes. With an excellent combination of properties and an attractive price, it is no surprise that fine grain technical grade alumina has a very wide range of applications.

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, Materials

Accuflect™
Aluminum Nitride
Aluminum Oxide
Boron Nitride
Fused Silica
Macor
Mullite
Sialon
Silicon Carbide
Silicon Nitride
Zirconium Oxide

.Key Properties

- Hard, wear-resistant
- Excellent dielectric properties from DC to GHz frequencies
- Resists strong acid and alkali attack at elevated temperatures
- Good thermal conductivity
- Excellent size and shape capability
- High strength and stiffness
- Available in purity ranges from 94%, an easily metallizable composition, to 99.5% for the most demanding high temperature applications.

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Typical Uses

- Gas laser tubes
- Wear pads
- Seal rings
- High temperature electrical insulators
- High voltage insulators
- Furnace liner tubes
- Thread and wire guides
- Electronic substrates
- Ballistic armor
- Abrasion resistant tube and elbow liners
- Thermometry sensors
- Laboratory instrument tubes and sample holders
- Instrumentation parts for thermal property test machines
- Grinding media

General Information

Aluminum oxide, commonly referred to as alumina, possesses strong ionic interatomic bonding giving rise to it's desirable material characteristics. It can exist in several crystalline phases which all revert to the most stable hexagonal alpha phase at elevated temperatures. This is the phase of particular interest for structural applications and the material available from Accuratus.

Alpha phase alumina is the strongest and stiffest of the oxide ceramics. Its high hardness, excellent dielectric properties, refractoriness and good thermal properties make it the material of choice for a wide range of applications.

High purity alumina is usable in both oxidizing and reducing atmospheres to 1925°C. Weight loss in vacuum ranges from 10^{-7} to 10^{-6} g/cm^2.sec over a temperature range of 1700° to 2000°C. It resists attack by all gases except wet fluorine and is resistant to all common reagents except hydrofluoric acid and phosphoric acid. Elevated temperature attack occurs in the presence of alkali metal vapors particularly at lower purity levels.

The composition of the ceramic body can be changed to enhance particular desirable material characteristics. An example would be additions of chrome oxide or manganese oxide to improve hardness and change color. Other additions can be made to improve the ease and consistency of metal films fired to the ceramic for subsequent brazed and soldered assembly.

Download 94% Alumina datasheet

Engineering Properties*

94% Aluminum Oxide

Mechanical	Units of Measure	SI/Metric	(Imperial)
Density	gm/cc (lb/ft^3)	3.69	(230.4)
Porosity	% (%)	0	(0)
Color	—	white	—
Flexural Strength	MPa (lb/in^{2}x10^3)	330	(47)
Elastic Modulus	GPa (lb/in^{2}x10^6)	300	(43.5)
Shear Modulus	GPa (lb/in^{2}x10^6)	124	(18)
Bulk Modulus	GPa (lb/in^{2}x10^6)	165	(24)
Poisson's Ratio	—	0.21	(0.21)
Compressive Strength	MPa (lb/in^{2}x10^3)	2100	(304.5)
Hardness	Kg/mm^2	1175	—
Fracture Toughness K_{IC}	MPa•m$^{1/2}$	3.5	—
Maximum Use Temperature (no load)	°C (°F)	1700	(3090)
Thermal			
Thermal Conductivity	W/m•°K (BTU•in/ft^2•hr•°F)	18	(125)
Coefficient of Thermal Expansion	10^{-6}/°C (10^{-6}/°F)	8.1	(4.5)
Specific Heat	J/Kg•°K (Btu/lb•°F)	880	(0.21)
Electrical			
Dielectric Strength	ac-kv/mm (volts/mil)	16.7	(418)
Dielectric Constant	@ 1 MHz	9.1	(9.1)
Dissipation Factor	@ 1 kHz	0.0007	(0.0007)
Loss Tangent	@ 1 kHz	—	—
Volume Resistivity	ohm•cm	>10^{14}	—

Download 96% Alumina datasheet

96% Aluminum Oxide

Mechanical	Units of Measure	SI/Metric	(Imperial)
Density	gm/cc (lb/ft^3)	3.72	(232.2)
Porosity	% (%)	0	(0)
Color	—	white	—
Flexural Strength	MPa (lb/in^{2}x10^3)	345	(50)
Elastic Modulus	GPa (lb/in^{2}x10^6)	300	(43.5)
Shear Modulus	GPa (lb/in^{2}x10^6)	124	(18)
Bulk Modulus	GPa (lb/in^{2}x10^6)	172	(25)
Poisson's Ratio	—	0.21	(0.21)
Compressive Strength	MPa (lb/in^{2}x10^3)	2100	(304.5)
Hardness	Kg/mm^2	1100	—
Fracture Toughness K_{IC}	MPa•m$^{1/2}$	3.5	—
Maximum Use Temperature (no load)	°C (°F)	1700	(3090)
Thermal			
Thermal Conductivity	W/m•°K (BTU•in/ft^2•hr•°F)	25	(174)
Coefficient of Thermal Expansion	10^{-6}/°C (10^{-6}/°F)	8.2	(4.6)
Specific Heat	J/Kg•°K (Btu/lb•°F)	880	(0.21)
Electrical			
Dielectric Strength	ac-kv/mm (volts/mil)	14.6	(365)
Dielectric Constant	@ 1 MHz	9.0	(9.0)
Dissipation Factor	@ 1 kHz	0.0011	(0.0011)
Loss Tangent	@ 1 kHz	—	—
Volume Resistivity	ohm•cm	>10^{14}	—

Download 99.5% Alumina datasheet

99.5% Aluminum Oxide

Mechanical	Units of Measure	SI/Metric	(Imperial)
Density	gm/cc (lb/ft^3)	3.89	(242.8)
Porosity	% (%)	0	(0)
Color	—	ivory	—
Flexural Strength	MPa (lb/in^{2}x10^3)	379	(55)
Elastic Modulus	GPa (lb/in^{2}x10^6)	375	(54.4)
Shear Modulus	GPa (lb/in^{2}x10^6)	152	(22)
Bulk Modulus	GPa (lb/in^{2}x10^6)	228	(33)
Poisson's Ratio	—	0.22	(0.22)
Compressive Strength	MPa (lb/in^{2}x10^3)	2600	(377)
Hardness	Kg/mm^2	1440	—

Fracture Toughness K_{IC}	MPa•$m^{1/2}$	4	—
Maximum Use Temperature (no load)	°C (°F)	1750	(3180)
Thermal			
Thermal Conductivity	W/m°K (BTU•in/ft^2•hr•°F)	35	(243)
Coefficient of Thermal Expansion	10^{-6}/°C (10^{-6}/°F)	8.4	(4.7)
Specific Heat	J/Kg•°K (Btu/lb•°F)	880	(0.21)
Electrical			
Dielectric Strength	ac-kv/mm (volts/mil)	16.9	(420)
Dielectric Constant	@ 1 MHz	9.8	(9.8)
Dissipation Factor	@ 1 kHz	0.0002	(0.0002)
Loss Tangent	@ 1 kHz	—	—
Volume Resistivity	ohm•cm	$>10^{14}$	—

*All properties are room temperature values except as noted.
The data presented is typical of commercially available material and is offered for comparative purposes only. The information is not to be interpreted as absolute material properties nor does it constitute a representation or warranty for which we assume legal liability. User shall determine suitability of the material for the intended use and assumes all risk and liability whatsoever in connection therewith.

See also: Ceramic Rod & Tube
See also: Ceramic Rod & Tube > Available Aluminum Oxide Sizes

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