

Materials

Alumina Oxide, Boron Nitride, Macor, Zirconia, and Steatite

All considered to be good electrical insulators, alumina oxide (Al_2O_3), boron nitride, Macor, zirconia, and steatite all have very different mechanical, thermo mechanical, and wear characteristics. Unlike many of the metallic materials used in front end wafer operations, these materials often do not follow broad standards such as AMS or ASTM. Rather, they are often engineered to meet a specific application or small set of requirements. For this reason, individual material characteristics such as purity are often left broadly classified as >94, 96, or 99%. For specific material or application information, contact our [engineering staff](#).

Alumina oxide is most often formed using small additions of silica, magnesia, and calcia. As purity is increased (% alumina) the volume resistivity and dielectric constant is (generally) improved. Depending on purity and origin of the bulk material, alumina may range in color from off-white (yellowing) to white. Since many of the best available grades of alumina oxide are not controlled under AMS or ASTM specifications Electro-Graph selects application specific grades and occasionally includes raw form of the material as part of the material specification; e.g. manufactured from rod (not bar) or injection molded). Listed below is a typical purity specification for 96% pure alumina oxide. Note: sodium, potassium, and calcium are not always reduced through specification of a higher purity alumina. Rather, they are best controlled by specification of the raw form and manufacturer. Contact our [engineering staff](#) for information specific to your application.

Constituent		Constituent		Constituent	
Al_2O_3	96.28%	SiO_2	2.68%	MgO	0.81%
CaO	0.01%	Fe_2O_3	0.05%	K_2O	0.01%
Na_2O	0.16%	TiO_2	0.01%	SrO	0.00%

Due to its mechanical limitations boron nitride (BN) is specified only where lower cost, higher strength, alumina oxide is known to fail. Boron nitride outperforms alumina oxide in two categories; machinability and operating temperature. Operating between 2000 and 3000 degrees C, high purity boron nitride can survive operating environments nearly 1000 degrees C higher than most alumina oxides. Electro-Graph uses two levels of available boron nitride (HBN/A and HBC/AX05). Although other grades are available, the combination of HBN/A's cost effectiveness coupled with the high purity and temperature range of HBC/AX05 cover the full range of implant, CVD, and PVD applications. Listed below are typical purities for both levels of boron nitride. Contact our [engineering staff](#) for information specific to your application.

Element	HBN/A	HBC/AX05
Carbon	1.00% max	1.00% max
Oxygen	4.00% max	1.00% max
Calcium	0.10% max	0.04% max
Other	0.20% max	0.05% max

Macor is a machinable ceramic produced by Corning Glass Works and is used by Electro-Graph to fabricate quick turn electrical insulators. Poor strength and high cost relative to most high volume alumina oxides often prohibit its use beyond prototype status.

Zirconias are available in both magnesia and yttria stabilized forms. Their fine grain size, high density, hardness, flexural strength, and fracture toughness outperform alumina oxide in high wear and structural applications. Volume resistivity and dielectric constants are sufficient for most isolation applications but high volume injection molding techniques are not as advanced as alumina oxide and often result in delayed or higher cost components.

Offering good high voltage isolation and comparable operating temperatures, steatite is a useful low-cost alternative to alumina oxide. Reduced fracture toughness and purity limit its application to voltage standoff.