Several ceramic materials are commonly used for the ceramic PCB

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Ceramic substrate is the most common is alumina and aluminum nitride ceramics, but is there any other ceramic substrate?

Before answering this question, let's understand the DPC film process.

DPC (DirectPlatingCopper) thin film process is a method of prepare copper film using magnetron sputtering technology. This process is a process in which the copper target with the target material is placed in a true cavity chamber, and plasma is generated on the copper target surface by magnetron sputtering technology. The ions in the plasma are bombarded on the surface of the target, which is sputtered into fine particles and deposited on the substrate to form a copper film.

In view of the characteristics and advantages of DPC process, magnetron sputtering can be plane, 3D and any shape of materials covered with metal layer, and have a good combination force, so in many ceramic materials can become ceramic substrate, to achieve line interconnection, based on the characteristics of different ceramic materials, also applied in all walks of life.

Top ten common ceramic materials:

96 Alumina (Al2O3), 99 Alumina (Al2O3), zirconia (ZrO2), aluminum nitride (AlN), silicon carbide (SiC), silicon nitride (Si_3N_4), piezoelectric ceramics, diamond, sapphire, toughened ceramics (ZTA).

Uncommonly used ceramic materials:

二氧化硅(SiO2),氧化锆钛($ZrTiO_4$),氮化硼(BN),碳化硼(B_4C),氧化镁(MgO),氧化铁(Fe_2O_3),氧化铈(CeO2),氮化硅(Si_3N_4),氧化锆钇(Y_2O_3-ZrO2),氧化铝钇($Y_3Al_5O_{12}$),氧化钛(TiO2),氧化锆硅($ZrSiO_4$),碳化钨(WC),碳化钛(TiC),氮化钛(TiN),氮化硅氧(SiOxNy).

Properties of the top ten commonly used ceramic materials:

材料参数	单位	96%Al2O3	99.6%Al2O3	96%AlN	SiC	Si3N4	ZrO2	ZTA	压电陶瓷	蓝宝石	金刚石	测试标准
颜色	/	白色	白色	灰色	灰色	灰色	白色	白色	浅黄色/深棕色	透明	淡黄色	/
体积密度	g/cm3	≥3.7	3.9	≥3.33	3.1-3.15	≥3.22	≥6.0	≥4.10	7.7	≥3.86	3.42-3.52	GB/T 2413
翘曲度	‰	≤2	≤2	≤2	≤2	≤3.18	≤4	≤4	≤2	/	/	/
表面粗糙度	μm	0.2~0.75	0.05~0.1	0.2~0.6	0.2~0.4	0.2~0.4	0.1~0.2	0.1~0.2	1.6-6.4	0.05~0.08	0.02-0.002	GB/T 6062
热导率	20℃ W/(m·K)	≥24	29	≥170	≥100	≥20	≥3	≥27	2.5-3.5	≥26	1400-1850	GB/T 5598
热膨胀系数	20~800℃ ×10⁻⁶/K	6.5~8.0	6.5-8.2	2.0~3.5	4	3	7.8	8	4.0-4.3	7.2	1`1.5	GB/T 5593
介电常数	1MHz	9~10	9-10.5	8~10	/	8~10	33	10.4	2.1	9.6~10.2	5.6	GB/T5594.4
击穿电压	KV/mm	≥17	≥17	≥17	/	1014	≥10	≥10	24-30	/	≥10	GB/T 5593
体积电阻	20℃ Ω·cm	≥10~14	≥10~14	≥10~13	/	≥10~14	≥10~13	≥10~14	>10^{12}	≥10~14	≥10~14	GB/T5594.5
抗弯强度	MPa	≥350	450	≥330	≥400	980	≥800	≥650	1200	≥550	≥450	GB/T 5593

1. 99 out of alumina

99 Alumina refers to the purity of 99% or higher alumina materials, usually with chemical pure alumina or high purity alumina as raw materials, through high temperature calcination, crushing, molding, sintering and other processes made. Compared with 96 alumina, 99 alumina has higher chemical purity, density and hardness, as well as better high temperature stability and corrosion resistance.

99 Alumina is widely used in electronics, machinery, chemical industry, aerospace and other fields. In electronic field, 99 alumina is usually used to manufacture high frequency electronic components, integrated circuit packaging, dielectric and other devices; in mechanical field, 99 alumina is mainly used in manufacturing high hardness of ceramic tools, bearing ball, etc.; in chemical field, 99 alumina can be used to manufacture catalyst and adsorbent; in the aerospace field, 99 alumina is often used to manufacture high temperature structural parts, aviation engine components, etc.

2. 96 for alumina

96 Alumina, also known as industrial alumina or α -alumina, is a high-purity ceramic material. Its chemical formula is Al203, which belongs to oxide ceramics.96 Alumina is usually made of alumina powder by pressing, molding, sintering and other processes. The "96" refers to its aluminum oxide purity of more than 96%.96 alumina has high hardness, high

strength, high wear resistance, high temperature stability and other characteristics, is widely used in the manufacturing of ceramic products, refractory materials, abrasive, electronic devices and other fields.

What are the advantages and disadvantages of 99 alumina substrate and 96 alumina substrate comparison?

The 99 alumina substrate and 96 alumina substrate are common high purity alumina materials, and they have different advantages and disadvantages in some applications.

99 Advantages of alumina substrate:

High purity, usually can reach the purity level of 99.99%, excellent electrical performance, with a high dielectric constant and low dielectric loss.

High temperature stability, can work stably in high temperature environment, usually can withstand up to 1700℃ temperature.

High mechanical strength, high strength, high hardness, not easy to be damaged, can withstand the greater force and pressure.

With excellent corrosion resistance, not eroded by most chemical substances, suitable for acid, alkali and other chemical medium.

A thin substrate can be prepared, which is beneficial for microelectronic device preparation.

96 Advantages of alumina substrate:

Cheaper than 99 alumina substrate, relatively low cost.

More easily than 99 alumina substrate processing, can be cut, drilling and other processing processing, convenient for the preparation of various shapes of substrate.

In some applications with low temperature and low electric field strength, the dielectric constant and dielectric loss are lower than the 99 alumina substrate, with better signal transfer performance.

shortcoming:

Compared with 99 alumina substrate, 96 alumina substrate has lower purity and higher dielectric constant and dielectric loss.

The agile fracture is easy to occur in high temperature environment.

Application industry segmentation:

99 Alumina oxide substrate: suitable for high power LED, high voltage integrated circuit, high temperature sensors, high frequency electronic components and other fields.

96 Alumina oxide substrate: suitable for low-power electronic components, sensors, capacitors, micro-relays, microwave components and other fields.

2. Aluminum Nitride (AlN)

Aluminum nitride ceramic is a high-performance ceramic material made of aluminum nitride powder after sintering at high temperature. Its main components are aluminum nitride (AlN), has a high melting point (about 2800℃), hardness (9.0 to 9.5 Mohs), strength and thermal conductivity and other characteristics. At the same time, it also has good insulation performance, chemical stability and high temperature resistance. Because of these characteristics, aluminum nitride ceramics are widely used in microelectronics, optoelectronics, power electronics, aerospace and other fields.

Aluminum nitride ceramic is a high-performance ceramic material with the following

properties:

High hardness: the hardness of aluminum nitride is close to diamond, is more than 3 times of traditional alumina, can be used to make high strength mechanical parts.

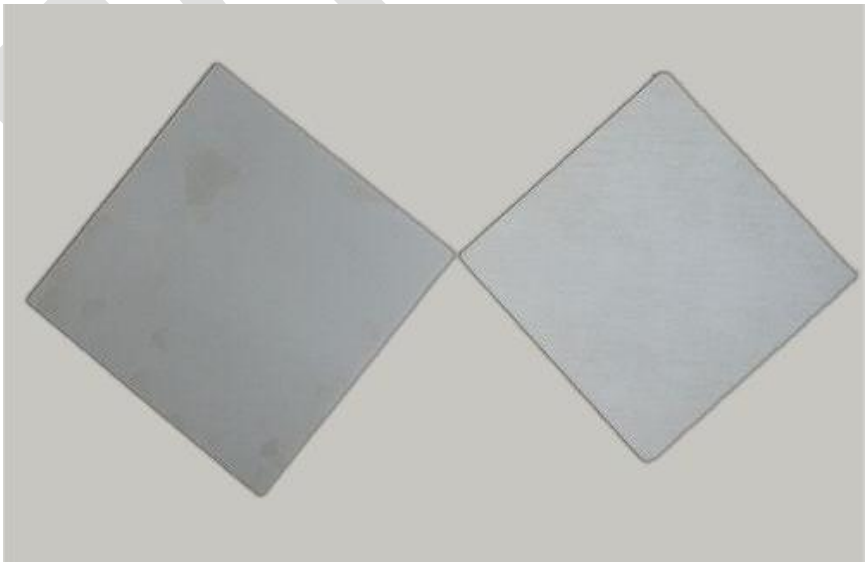
High strength: aluminum nitride has high strength, has good wear resistance and corrosion resistance, can be used in the production of high load, high wear, corrosion resistant parts.

High thermal conductivity: The thermal conductivity of aluminum nitride is very high, can reach 170-230W / (m · K), is more than 4 times of traditional alumina, can be used to make high power, high frequency radio frequency components.

High insulation: the dielectric constant of aluminum nitride is low, is about 1 / 3 of the traditional alumina, can be used to make high frequency, high precision microwave components.

Oxidant resistance: aluminum nitride has a very good antioxidant performance at high temperature, and can be used to make parts in high temperature environment.

Considering the above characteristics, aluminum nitride ceramics are widely used in semiconductor, aerospace, electronics, military and other fields. For example, for the production of high-frequency RF devices, microwave components, electronic ceramics, thermistors, high-temperature sensors, etc.



四、 Zirconia (ZrO2)

Zirconia ceramic material is a high strength, high hardness, high temperature resistance, corrosion resistance and good insulation performance. It has the chemical formula ZrO2 and usually adopts the stabilization treatment to improve the stability and wear resistance of its lattice. Zirconia ceramic materials have the characteristics of low thermal conductivity coefficient and high melting point, so they are widely used in the industrial fields of high temperature, high pressure, high speed and high precision, such as aerospace, electronics, medical and energy fields.

Zirconia ceramic is a high-performance engineering ceramic material with the following characteristics and properties:

High hardness: The hardness of zirconia ceramics is very high, usually above HRA 90, or even up to HRA 95, more than 10 times that of steel.

High strength: Zirconia ceramics have extremely high strength, which can reach 900MPa at room temperature, and can still maintain high strength at high temperature.

Good wear resistance: zirconia ceramic surface high, hardness, so it has good wear resistance.

Good corrosion resistance: zirconia ceramics chemical inert, not easy to be eroded by acid, alkali and alkali and other chemicals, can be long-term stable operation in harsh environment.

Excellent insulation performance: zirconconia ceramics excellent insulation performance, can be used in high voltage insulation materials.

High temperature stability: zirconia ceramics have high melting point and high temperature stability, can be used in high temperature environment.

Zirconia ceramics have the above characteristics and properties, so they are widely used in high-end manufacturing, electronics, aerospace, medical devices, chemical industry and other fields, such as abrasive, high temperature structure, pneumatic parts, medical devices,

sensors, capacitors, etc.

五、carborundum (SiC)

Silicon carbide is a chemical compound with the chemical formula SiC and consists of two elements: silicon and carbon. It is a kind of high temperature resistance, corrosion resistance, high hardness of ceramic materials, but also a widely used in high temperature, high frequency, high pressure and other extreme environment of industrial materials. Silicon carbide has excellent mechanical, electromagnetism and thermal properties, so it has been widely used in semiconductor, disk, aerospace and other fields. In addition, silicon carbide also has a very good semiconductor performance, and is also widely used in power electronics, optoelectronics and other fields.

Silicon carbide materials have the following properties:

High hardness: The hardness of silicon carbide material is 5 times higher than that of steel, and 3 times higher than that of aluminum.

High strength: the silicon carbide material has high strength, and the tensile strength can reach more than 400MPa.

High temperature resistance: the melting point of silicon carbide material is high, can withstand high temperature heat impact, the general use of temperature in 1200℃ -1600℃.

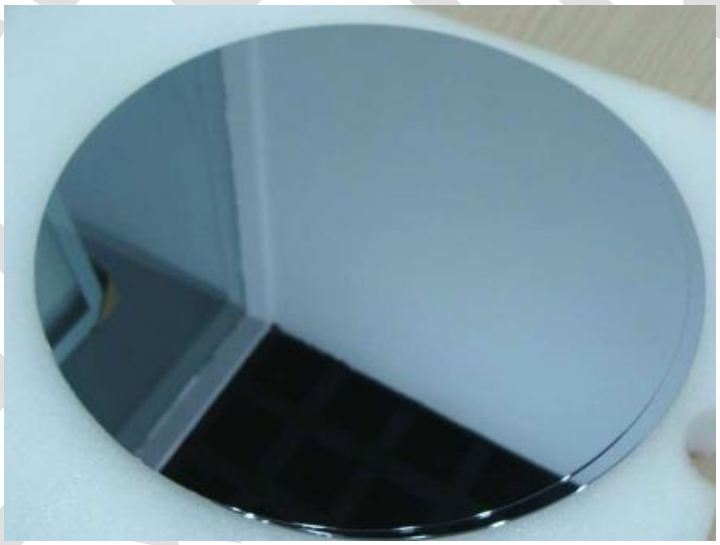
Good oxidation resistance: silicon carbide material can resist high temperature oxidation corrosion and can be used in air.

Good wear resistance: silicon carbide material has high hardness, small friction coefficient, and has good wear resistance performance.

Good thermal conductivity: silicon carbide material excellent thermal conductivity, 2-3 times of the metal, can effectively heat.

Good chemical stability: silicon carbide material has good chemical stability, will not be corroded by acid, alkali, etc.

Based on these properties, silicon carbide materials are widely used in high temperature, high pressure, high speed, high load, corrosion resistance and other fields, such as power, electronics, machinery, aviation, metallurgy and other industries.



六、 Silicon nitride (Si3N4)

Silicon nitride ceramic material is a high-temperature ceramic material based on nitrogen and silicon elements. It has high strength, high hardness, high wear resistance, high temperature resistance, oxidation resistance, corrosion resistance and other excellent

properties. Its chemical stability is extremely high, not easy to be subject to acid, alkali, solvent and other corrosion.

The hardness of silicon nitride ceramic materials can be comparable to diamond, or even higher, reaching about 24 GPa, harder than ordinary ceramic materials, not easy to wear. At the same time, it has good insulation performance and thermal stability, can work in high temperature environment.

Silicon nitride ceramic material is a kind of high performance ceramic material made from silicon nitride powder by pressing and sintering process. It has the following properties:

High hardness: the hardness of silicon nitride ceramic material is close to that of diamond, which can reach more than 30 GPa.

High strength: the flexural strength is high, can reach more than 1000MPa.

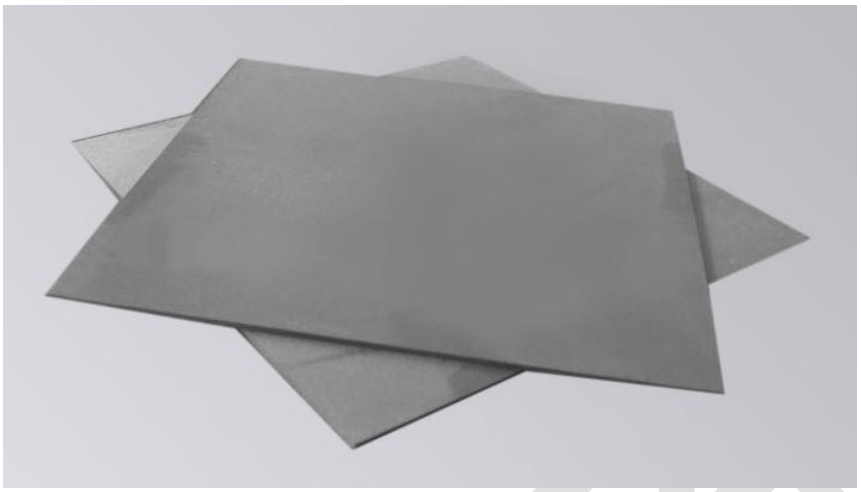
High wear resistance: silicon nitride ceramic materials have good wear resistance, and can be used to manufacture high-speed running bearings and cutting tools.

High temperature resistance: silicon nitride ceramic material has high high temperature resistance, can be used in the high temperature environment of more than 1000℃.

Corrosion resistance: silicon nitride ceramic materials have excellent corrosion resistance, which can be used in the working environment of some acid and alkaline media.

Lightweight: silicon nitride ceramic material is lighter than steel and can be used for lightweight design.

In conclusion, silicon nitride ceramic materials have the advantages of high hardness, high strength, high wear resistance, high temperature resistance, corrosion resistance and lightweight, and are widely used in aerospace, optoelectronics, electronics, semiconductor, machinery and other fields.



七、piezoelectric ceramics

Piezoelectric ceramic material is a kind of ceramic material with piezoelectric effect, which can deform under external electric field or mechanical stress, and produce electric charge during deformation. They are usually made of barium lead acid (Pb (Zr, Ti) O3) or niobium lead acid (Pb (Mg1 / 3 Nb 2 / 3) O3-PbTiO3) as the main ingredients.

The main properties of the piezoelectric ceramic materials include:

Piezoelectric effect: it can convert mechanical stress into electrical signals, or convert electrical signals into mechanical movement. This effect makes piezoelectric ceramic materials widely used in sensors, actuators, acoustic devices and other fields.

Dielectric performance: with a high dielectric constant and low dielectric loss, make the piezoelectric ceramic materials in electronic components used as capacitors, filters and other components.

Mechanical properties: with high hardness, strength and wear resistance, so that the piezoelectric ceramic materials in mechanical engineering application.

Thermal stability: with good thermal stability and high temperature resistance, it can work stably in a high temperature environment.

In general, piezoelectric ceramic materials have a variety of excellent properties, and are widely used in sensors, actuators, acoustic devices, electronic components, mechanical engineering and other fields.

八、diamond

Diamond ceramic material is a new type of material made of diamond powder and ceramics through high temperature and high pressure sintering. Because of the high hardness of diamond, can reach mohs hardness level 10, and has excellent wear resistance, corrosion resistance and high temperature oxidation resistance, so the diamond ceramic material has extremely high physical and chemical properties.

Diamond ceramic materials have the following characteristics:

Very high hardness and strength, more resistant than ordinary ceramic materials, scratch resistance and impact resistance;

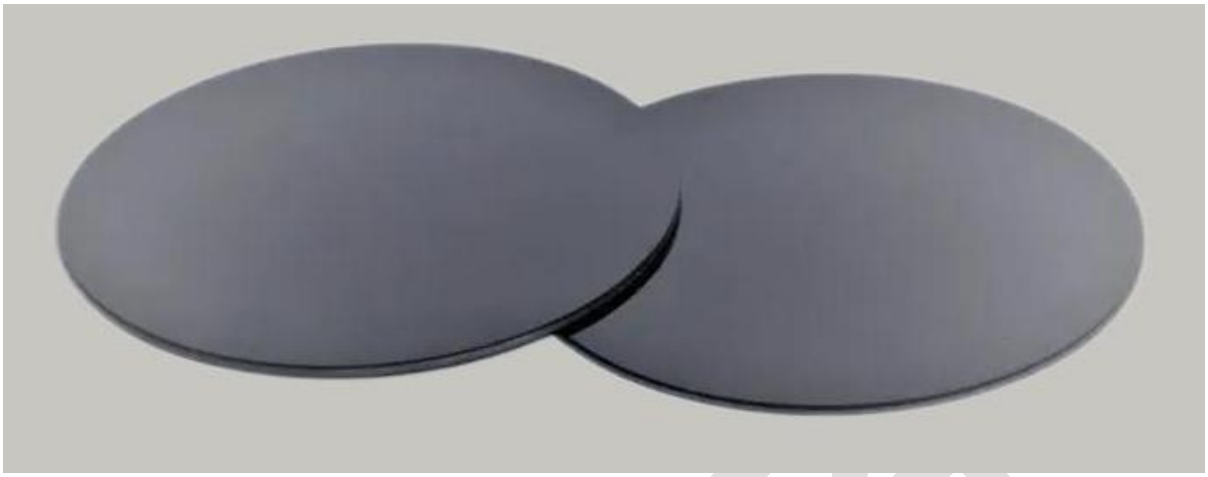
Excellent corrosion resistance, can resist strong acid and alkali and other corrosion medium;

High temperature antioxidant performance, can be used in high temperature for a long time is not damaged;

Excellent thermal conductivity and insulation performance;

Easy to process into a variety of shapes and sizes of ceramic products.

Due to its excellent performance, diamond ceramic materials are widely used in high-end mechanical, electronic, optical, medical and chemical fields, such as bearings, nozzles, cutting tools, hydraulic cylinders, electrical insulation, laser parts, etc.



Nine, sapphire

Sapphire ceramic material, also known as artificial sapphire (SyntheticSapphire), is a kind of artificial single crystal material, with high hardness, high wear resistance, high corrosion resistance and other excellent properties. Sapphire ceramic material is mainly composed of alumina (Al2O3), which is prepared by melting method or heat treatment method at high temperature.

The unique properties of sapphire ceramic materials mainly include:

High hardness: the hardness of sapphire ceramic material is second only to diamond, which has high wear resistance.

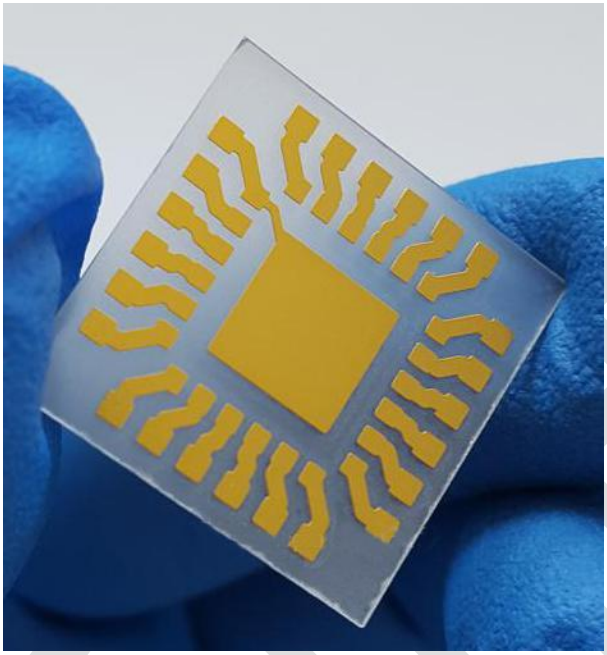
High corrosion resistance: sapphire ceramic materials have excellent corrosion resistance and can be used for long-term stable time in harsh environments such as strong acid and strong alkali.

High light transmittance: sapphire ceramic materials have high light transmittance, and can be used in optics, laser and other fields.

High temperature stability: the sapphire ceramic material has a high melting point and can be used stably in a high temperature environment.

High strength: Sapphire ceramic material has a very high strength and toughness, not easy to rupture and deformation.

Sapphire ceramic materials are mainly used in optics, electronics, aerospace and other fields, such as the production of laser Windows, LED substrates, watch mirrors, high voltage insulators, etc.



X. Tened ceramics (ZTA)

Toughened ceramic (ZTA) material is a new composite material, composed of alumina (Al203) and zirconia (ZrO2), with zirconia content between 10-30%. Compared with pure alumina ceramics, toughened ceramics have better toughness and cracking resistance. Its main properties are as follows:

High hardness and high strength: toughened ceramics have high hardness and high strength similar to alumina ceramics.

Good toughness: Due to the presence of zirconia, toughened ceramics have better toughness than alumina ceramics and stronger cracking resistance.

Good wear resistance: toughened ceramics have a very good wear resistance, suitable for high wear environment.

Good corrosion resistance: toughened ceramics have excellent corrosion resistance, suitable for some corrosive environments.

Good high temperature resistance: toughened ceramics use a wide range of temperature, can be used in high temperature environment.

Tened ceramic materials have the above excellent properties, so they are widely used in the manufacturing of cutting tools, bearings, mechanical seals and other high strength, high wear resistance, high temperature, high corrosion performance parts.