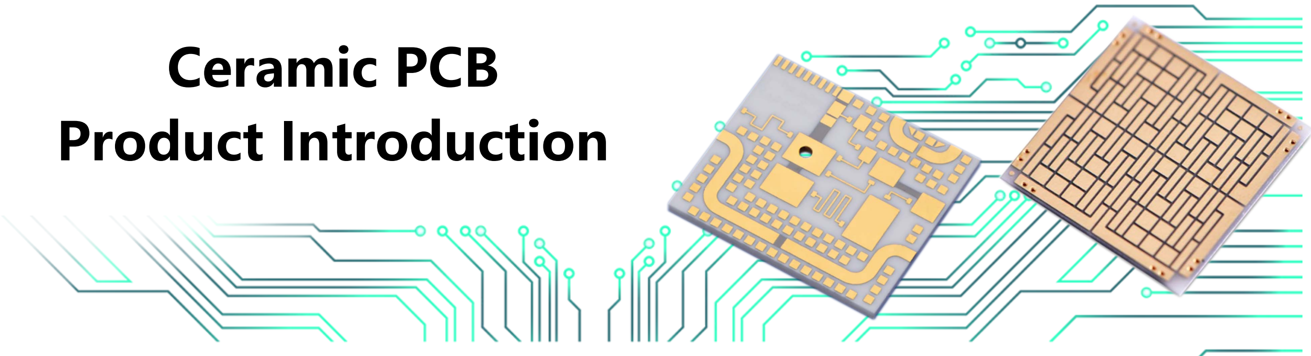
Ceramic PCB
Product Introduction



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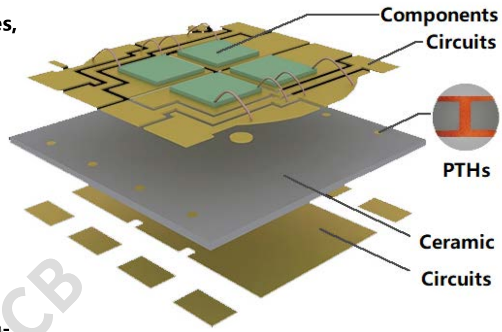
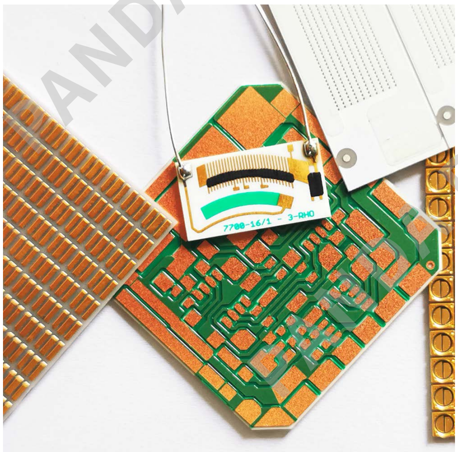
What are Ceramic PCBs ?



Ceramic PCBs are high-performance printed circuit boards that utilize ceramic materials (aluminum oxide, aluminum nitride, and beryllium oxide) as substrates, offering excellent thermal conductivity, mechanical strength, and insulation properties, with manufacturing processes involving thin-film metallization or thick-film metallization techniques to apply conductive materials to the substrates, followed by etching or high-temperature sintering to create highly reliable circuits, making them widely used in electronic systems requiring high power, high frequency, and high thermal conductivity, such as LED drivers, lasers, communication, automotive electronics, aerospace, and medical fields.

Ceramic PCBs provide exceptional functionality in high-performance electronic systems. The high thermal conductivity of the ceramic substrate allows heat to be quickly dissipated, making it particularly suitable for power electronics, high-frequency applications, and systems that generate significant heat during operation.

Main Types of Ceramic PCBs :

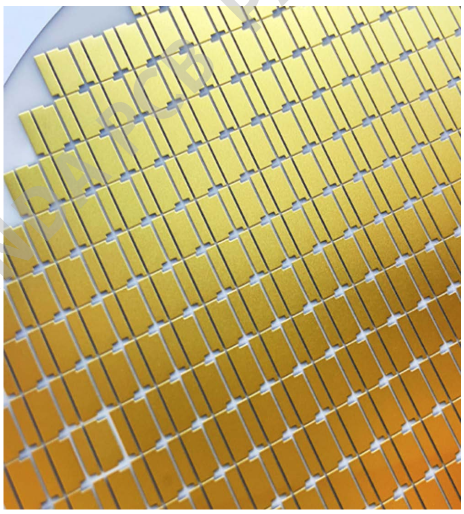


1, Thick Film Ceramic PCB :
Thick film metallization typically involves applying a metal paste (which includes conductive or resistive materials) onto the surface of the ceramic substrate, followed by a sintering process to bond the metal to the substrate. The sintering temperature is relatively high, usually between 800°C and 1000°C. The thickness of the metal layer is typically between 10 microns and 100 microns.

2, Thin Film Ceramic PCB :
Thin film metallization involves using techniques such as Physical Vapor Deposition (PVD) or Chemical Vapor Deposition (CVD) to precisely deposit metal materials onto the ceramic substrate in the form of a thin film. This process usually takes place at lower temperatures, allowing for the deposition of metal layers with precise thickness and uniformity. The metal layer is typically much thinner, usually a few microns.

Key Advantages of Ceramic PCBs :

- **Excellent Electrical Insulation:** Ceramic PCBs provide excellent electrical insulation, making them ideal for high voltage or high-frequency applications. Their dielectric strength prevents leakage and interference, ensuring reliable performance.
- **High Operating Temperatures:** Ceramic PCBs can withstand extreme temperature fluctuations without performance loss, making them suitable for high-temperature or thermal cycling environments.
- **Durability:** The tough ceramic material ensures long-lasting durability, with resistance to wear and slow aging. High thermal resistance also extends the PCB's lifespan.
- **Versatility:** With metal core technology and sintering methods, ceramic PCBs withstand high processing temperatures. They offer efficient heat distribution, making them versatile for various applications.
- **Stability:** Ceramic PCBs have stable dielectric properties, minimizing radio frequency loss. Their chemical resistance to moisture and solvents boosts stability in diverse environments.
- **Corrosion Resistance:** Ceramic materials naturally resist corrosion, protecting the PCB from moisture, humidity, and harsh chemicals, enhancing longevity and reliability in challenging environments.



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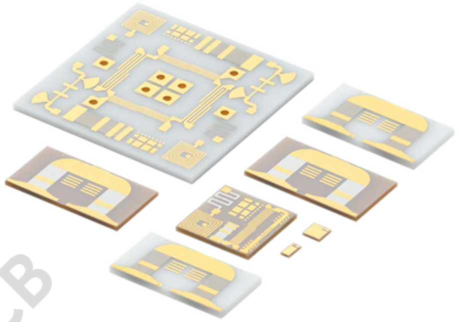
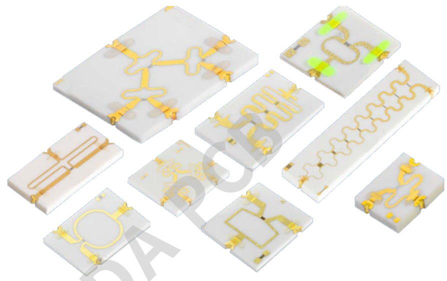
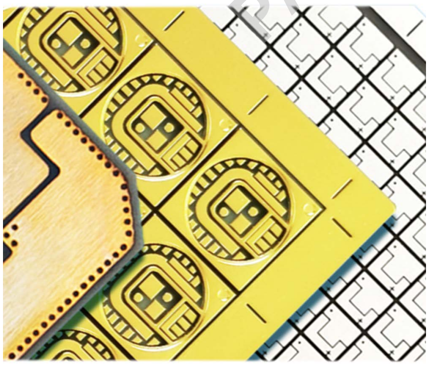
Appilcations of Ceramic PCBs :

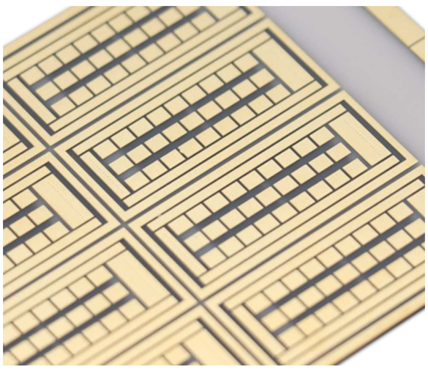




- **Aerospace and Defense:** Ceramic PCBs are used in radar systems, avionics, missile guidance, satellite communications, and electronic warfare. Their mechanical strength, temperature resistance, and high-frequency capabilities make them ideal for these demanding applications.
- **LED Lighting:** Ceramic PCBs are widely used in LED lighting due to their high thermal conductivity, which ensures effective heat dissipation and prolongs LED lifespan. Their electrical insulation properties also ensure reliable connections.
- **Medical Devices:** Ceramic PCBs are used in medical devices like implantable devices, diagnostic equipment, and surgical instruments. Their biocompatibility, sterilization resistance, and ability to provide high-density interconnects make them suitable for medical applications.
- **Power Electronics:** Ceramic PCBs are common in power devices like inverters, converters, and motor drives. Their excellent thermal conductivity helps dissipate heat, ensuring efficient and reliable performance.
- **Telecommunications:** Ceramic PCBs are found in base stations, antennas, routers, and high-speed data transmission devices. Their low dielectric loss and signal integrity enable efficient transmission of high-frequency signals.
- **Industrial Equipment:** Ceramic PCBs are used in power supplies, robotics, control systems, and monitoring devices. Their thermal conductivity and reliability ensure proper functioning in harsh industrial environments.
- **Automotive Electronics:** Ceramic PCBs are used in advanced driver-assistance systems (ADAS), engine control units (ECUs), lighting systems, and power management modules. Their superior thermal and electrical properties ensure stable performance in high-temperature conditions.

Ceramic PCBs are extensively used in a wide range of applications where high-performance, reliability, thermal management, and electrical insulation are crucial,Their unique properties make them well-suited for demanding industries.





Why Choose Custom Ceramic PCBs ?

- **Tailored to Specific Requirements:** Custom ceramic PCBs are designed to meet the precise needs of a particular application, ensuring optimal performance. Whether it's for high-frequency electronics, thermal management, or biocompatibility, custom designs can cater to unique specifications.
- **Superior Thermal Management:** Ceramics have excellent thermal conductivity, which helps in efficient heat dissipation. Custom ceramic PCBs can be engineered to manage heat effectively, improving the performance and longevity of high-power or temperature-sensitive devices.
- **Enhanced Durability and Reliability:** Ceramic materials offer exceptional mechanical strength and resistance to harsh environments such as high temperatures, humidity, and vibration. Custom ceramic PCBs provide reliability in challenging conditions, making them ideal for aerospace, automotive, and industrial applications.
- **High Electrical Performance:** Ceramic PCBs are known for their low dielectric loss and high-frequency capabilities. Custom designs can be optimized for superior signal integrity, making them perfect for telecommunications, radar systems, and other high-speed electronic applications.
- **Biocompatibility for Medical Use:** In the medical field, custom ceramic PCBs can be designed with biocompatible materials, ensuring they are safe for use in implantable devices and other medical equipment that require sterilization.
- **Cost-Effective for Specialized Needs:** While the initial cost of custom ceramic PCBs may be higher, they can provide significant cost savings in the long run by improving the efficiency and reliability of devices, reducing the need for maintenance or replacements.

✿ Design Guidelines

Design Guidelines :

1, Material Selection: The first step in designing a ceramic PCB is choosing the right ceramic material. Materials like alumina (Al_2O_3), aluminum nitride (AlN), and beryllium oxide (BeO) are commonly used. Consider factors like thermal conductivity, dielectric properties, and mechanical strength when selecting the material.

2, Thermal Management: Ceramic PCBs excel at thermal conductivity, but proper design is essential to ensure heat dissipation. Ensure that the layout allows for efficient heat flow, such as incorporating heat sinks, vias for thermal management, or placing high-power components near the board' s edges.

3, Via and Hole Design: Vias and through-holes should be carefully planned to minimize thermal stress and electrical resistance. In ceramic PCBs, via filling and plating processes must be precisely managed to avoid any damage to the board. Blind or buried vias are often used to enhance reliability and performance.

4, Trace Width and Spacing: The width and spacing of traces must be designed according to the current-carrying capacity and the power requirements of the application. Ensure that trace widths can handle the required current without excessive heating. For high-frequency applications, the trace layout should be designed to minimize signal loss and reflection.

5, High-Frequency Considerations: Ceramic PCBs are often used in high-frequency applications, so impedance control is critical. Use controlled impedance traces to maintain signal integrity, particularly for RF (Radio Frequency) and microwave circuits. Minimizing signal reflection and crosstalk should be prioritized when designing high-frequency circuits.

6, Surface Mount Technology Compatibility: While ceramic PCBs are well-suited for traditional through-hole components, they can also support SMT designs. Pay attention to the compatibility of the ceramic material with soldering processes like reflow or wave soldering. Special soldering techniques may be required for ceramic boards.

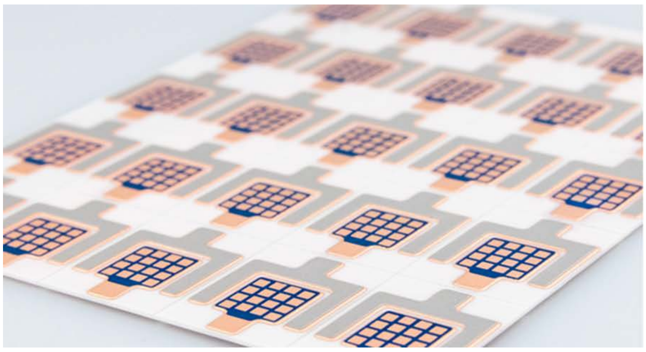
7, Thermal Expansion Matching: Ensure that the coefficient of thermal expansion (CTE) of the ceramic PCB material matches the CTE of the components and solder used. Mismatched CTEs can cause mechanical stresses and lead to cracking or failure of the PCB during temperature changes.

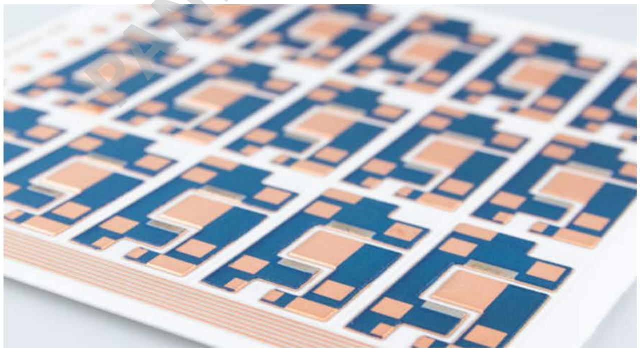
1, Optional Substrates

Substrates :	Alumina (Al_2O_3)	Aluminum Nitride (AlN)	Beryllium Oxide (BeO)	Zirconium Dioxide (ZrO_2)	Quartz Glass (SiO_2)	Sapphire	Microwave Substrate
Max Application Operating Temperature (°C):	662	1832	2300	2432	1200	2000	300
Max Power Density (W/in²):	75	1010	250	300	10	100	30
Max Ramp Up Speed (°F/sec):	122	572	400	350	20	20	10
Thermal Conductivity (W/mK):	20 ~ 35	180 ~ 220	200 ~ 300	2.0 ~ 5.0	1.3 ~ 1.5	30 ~ 40	4 ~ 6
Density (g/cm³):	3.75	3.26	2.8	5.9	2.2	3.98	3
Dielectric Loss:	0.0001 ~ 0.001	0.0001 ~ 0.0005	0.0001 ~ 0.0002	0.0005 ~ 0.001	0.0002 ~ 0.0005	0.0001 ~ 0.0003	0.0003 ~ 0.005
Dielectric Constant:	9.4 ~ 10.2	8.5 ~ 9.0	6.0 ~ 7.0	25 ~ 30	3.78 ~ 4.0	9.4 ~ 10.0	5.5 ~ 10.0
CTE, ppm/°C:	6.0 ~ 8.0	4.0 ~ 5.0	7.0 ~ 9.0	10.0 ~ 11.0	0.5 ~ 0.7	5.0 ~ 7.0	5.0 ~ 10.0
Substrate Thickness (mm):	0.25 ~ 2.0	0.25 ~ 2.0	0.25 ~ 2.0	0.25 ~ 2.0	0.2 ~ 2.0	0.3 ~ 2.0	0.5 ~ 3.0
Typical Max. Dimension (inch):	6 x 12	5 x 11	6 x 6	4 x 4	12 x 12	8 x 8	8 x 8
Theoretical Total Wattage (W):	5400	55000	15000	20000	20	100	50

2, Optional Metallization Processes

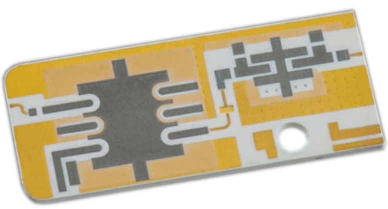
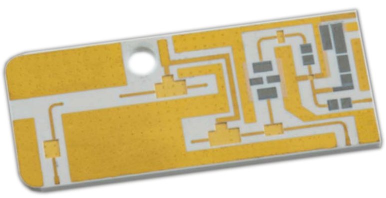
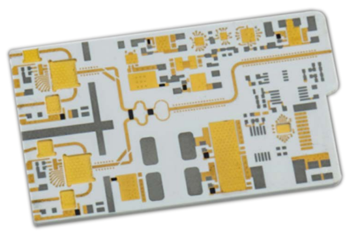
Metalization Types :	Thick Film Substrates (Screen-Printed)		Thin Film Substrates (Photo-Imaged)		
Process Types :	TFM Capabilities	HTCC / LTCC Capabilities	DBC Capabilities	DPC Capabilities	AMB Capabilities
Layer Counts :	1, 2, 3, 4 Layers	1, 2, 4, 6 Layers	1, 2 Layers	1, 2 Layers	1, 2 Layers
Max Board Dimension :	200*230mm	200*200mm	138*178mm	138*190mm	114*114mm
Min Board Thickness :	0.25mm	0.25mm	0.30mm~0.40mm	0.25mm	0.25mm
Max Board Thickness :	2.2mm	2.0mm	2.0mm	2.0mm	1.8mm
Conductor Thickness :	10um - 20um	5um - 1500um	1oz - 9oz	1um - 1000um	1oz- 22oz
Min Line Width/Space :	8/8mil (0.20/0.20mm)	6/6mil (0.15/0.15mm)	10/10mil (0.25/0.25mm)	6/6mil (0.15/0.15mm)	12/12mil (0.30/0.30mm)
Substrates Types :	Al203, ALN, BeO, ZrO2	Al203, ALN, BeO, ZrO2	Al2O3, AlN, ZrO2, PbO, SiO2, ZTA, Si3N4, SiC, Sapphire, Polycrystalline Silicon, Piezoelectric Ceramics	Al2O3, AlN, ZrO2, PbO, SiO2, ZTA, Si3N4, SiC, Sapphire, Polycrystalline Silicon, Piezoelectric Ceramics	Al203, ALN, BeO, ZrO2, Si3N4
Min Hole Diameter :	4mil (0.15mm)	4mil (0.15mm)	4mil (0.1mm)	4mil (0.1mm)	4mil (0.1mm)
Outline Tolerance :	Laser: +/-0.05mm	Laser: +/-0.05mm	Laser: +/-0.05mm	Laser: +/-0.05mm	Laser: +/-0.05mm
	Die Punch: +/-0.10mm	Die Punch: +/-0.10mm	Die Punch: +/-0.10mm	Die Punch: +/-0.10mm	Die Punch: +/-0.10mm
Substrate Thickness :	0.25, 0.38, 0.50, 0.635, 0.80,1.0, 1.25, 1.5, 2.0mm, Customizable	0.25, 0.38, 0.50, 0.635, 0.80,1.0, 1.25, 1.5, 2.0mm, Customizable	0.25, 0.38, 0.50, 0.635, 0.80,1.0, 1.25, 1.5, 2.0mm, Customizable	0.25, 0.38, 0.50, 0.635, 0.80,1.0, 1.25, 1.5, 2.0mm, Customizable	0.25, 0.38, 0.50, 0.635, 0.80,1.0, 1.25, 1.5, 2.0mm, Customizable
Thickness Tolerance :	0.25-0.38: +/-0.03mm	0.25-0.38: +/-0.03mm	0.25-0.38: +/-0.03mm	0.25-0.38: +/-0.03mm	0.25-0.38: +/-0.03mm
	0.50-2.00: +/-0.05mm	0.50-2.00: +/-0.05mm	0.50-2.00: +/-0.05mm	0.50-2.00: +/-0.05mm	0.50-2.00: +/-0.05mm
Surface Treatment :	Ag, Au, AgPd, AuPd	Ag, Au, AgPd, AuPd	OSP/Ni Plating, ENIG	OSP/ENIG/ENEPIG	OSP/ENIG/ENEPIG
Min Solder PAD Dia :	10mil (0.25mm)	10mil (0.25mm)	8mil (0.20mm)	6mil (0.15mm)	8mil (0.20mm)





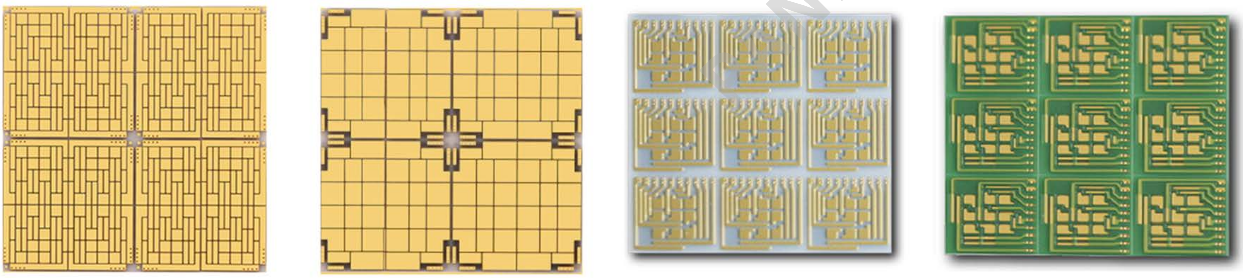
3, Optional Conductive Metal Material (Single Layers)

Layer Types	Metal Material	Electrical Conductivity (S/m)	Melting Point (°C)	Density (g/cm³)	Hardness (HV)	Corrosion Resistance	Thermal Expansion Coefficient (ppm/°C)	Operating Temperature Range (°C)	Applications
Conductor Layer	Copper (Cu)	5.8×10^7	1085	8.96	35	Poor	16.5	-200 to 250	Circuits, contact materials
	Gold (Au)	4.1×10^7	1064	19.32	25	Excellent	14.2	-100 to 250	High-reliability electronic devices
	Silver (Ag)	6.3×10^7	961	10.49	25	Poor	19	-200 to 300	High-frequency signal transmission
	Aluminum (Al)	3.8×10^7	660	2.7	15	Poor	23.1	-200 to 150	Low-power electronic devices
Adhesive Layer	Chromium (Cr)	1.4×10^7	1907	7.19	600	Excellent	5.9	-150 to 450	Coatings, adhesion enhancement
	Titanium (Ti)	2.4×10^7	1668	4.54	350	Excellent	8.6	-200 to 500	Adhesive layer, conductive layer
Isolation Layer	Molybdenum (Mo)	2.0×10^7	2623	10.28	150	Good	4.8	-200 to 300	Isolation, shielding materials
	Tungsten (W)	1.8×10^7	3422	19.25	400	Good	4.5	-200 to 350	High-temperature isolation layer
	Nickel (Ni)	1.4×10^7	1455	8.9	200	Good	13.4	-200 to 300	Isolation layer, soldering materials
Resistance Layer	Chromium (Cr)	1.4×10^7	1907	7.19	600	Poor	5.9	-150 to 450	Resistors, conductive layers
	Nickel-Chromium Alloy (NiCr)	1.0×10^6	1400	8.4	200	Poor	13.4	-100 to 400	Resistance layers, heating elements
	Aluminum-Nickel Alloy (AlNi)	3.5×10^6	660	7.12	150	Poor	22	-50 to 300	Resistors, sensors
Soldering Layer	Tin (Sn)	1.2×10^7	232	7.31	15	Good	23.3	-100 to 250	Soldering materials, contact layers
	Tin-Lead Alloy (SnPb)	6.0×10^6	183	8.53	40	Good	24	-100 to 250	Soldering layers, connection materials
	Silver Alloy (AgSn)	3.7×10^6	960	10.48	100	Poor	19	-50 to 250	High-efficiency soldering, contact layers
	Copper Alloy (CuSn)	5.8×10^7	1085	8.96	30	Poor	16.5	-200 to 250	Soldering, electronic component connections

4, Thin-Film Composite Layers

Layer Types	Maximum Reflow Temperature (°C)	Gold Wire Bonding	Soldering Properties	Application Areas
Metal Thin-Film Composites (e.g., Au/Cr, Au/Ni)	250 - 350	Good	Suitable for low-temperature soldering, good contact and conductivity	Electronic packaging, chip connections, microelectronic components
Titanium/Metal Thin-Film Composites	250 - 300	Good	Can be soldered at high temperatures, strong corrosion resistance	Microelectronic devices, sensors, packaging materials
Aluminum/Titanium Thin-Film Composites	300 - 350	Fair	Good thermal stability and soldering performance, suitable for high-frequency applications	Integrated circuit packaging, microwave communication, power devices
Lead-Solder Alloy/Silver Thin-Film Composites	200 - 250	Moderate	Suitable for low-temperature reflow soldering, but sensitive to high temperatures	PCB soldering, electronic connections
Copper/Gold Thin-Film Composites	250 - 350	Fair	Good conductivity and thermal stability, suitable for high-power applications	Semiconductor device packaging, microelectronic component connections
Gold/Palladium Thin-Film Composites	250 - 300	Good	Good soldering properties, suitable for precision connections	High-end electronic components, sensor packaging, packaging applications
Silver/Gold Thin-Film Composites	200 - 250	Good	Good soldering properties, suitable for high-frequency and microwave soldering	High-frequency communication, microwave packaging, signal transmission
Tungsten/Gold Thin-Film Composites	300 - 350	Poor	Suitable for high-temperature applications, but poor soldering performance	Circuit connections in high-temperature environments, electronic packaging
Nickel/Titanium Thin-Film Composites	250 - 300	Fair	Good soldering properties and corrosion resistance, suitable for high-temperature environments	High-temperature sensors, environmental monitoring devices, electronic packaging
Aluminum/Copper Thin-Film Composites	200 - 250	Fair	Good conductivity, suitable for low-temperature soldering and high-frequency applications	Circuit boards, RF packaging, high-power electronic components
Chromium/Silver Thin-Film Composites	250 - 300	Good	Good soldering properties at lower temperatures, suitable for precision circuit soldering	High-precision electronic devices, sensors, integrated circuit packaging



5, Engineering Design and Manufacturing Capabilities

Category	Parameter	Minimum Value/Range	Description
Circuits	Minimum Line Width (W)	10µm - 50µm	The minimum line width depends on material properties and equipment capabilities, typically ranging from 10µm to 50µm.
	Minimum Line Spacing (S)	10µm - 50µm	Line spacing is generally required to be between 10µm and 50µm, similar to line width.
	Line Dimension Accuracy	±5µm - ±20µm	Accuracy of dimensions, influenced by material, equipment precision, and process control.
	Alignment Accuracy	±5µm - ±10µm	Alignment precision is crucial for multilayer thin-film circuits; any error may cause circuit failure.
	Conductor Thickness	1µm - 10µm	The typical conductor thickness range can be adjusted based on requirements; thicker conductors are used for higher current needs.
	Minimum Line Width/Conductor Thickness Ratio	2:1 - 5:1	The ratio of line width to conductor thickness ensures reliable electrical performance.
	Minimum Line Bending Radius (R)	0.5mm - 1mm	For flexible circuits, the bending radius must ensure the stability of the lines without breaking.
Shapes	Minimum Hole Size (Ø)	0.1mm - 0.2mm	The minimum hole size is usually related to the line thickness and processing precision.
	Minimum Hole Center Distance (P)	0.2mm - 0.5mm	The minimum distance between holes, ensuring structural stability.
	Minimum Distance from Hole to Edge (Edge)	0.2mm - 0.5mm	The minimum distance from a hole to the edge of the circuit board, ensuring strength and reliability.
	Minimum Slot Width (W)	0.2mm - 0.5mm	Slot width should be within a reasonable range to ensure electrical performance and mechanical strength.
	Minimum Slot Inner Corner Radius (R)	0.2mm - 0.3mm	The radius of inner corners affects slot hole processing and longevity.
	Hole Depth-to-Diameter Ratio (L/D)	10:1 - 20:1	The ratio of hole depth to diameter, as deeper holes increase processing difficulty.
	Hole Taper (Conical Hole)	3° - 5°	The taper angle of the hole affects solderability and electrical performance, typically kept between 3° and 5°.
	Hole Wall Quality	Smooth, burr-free, crack-free	Hole walls should be smooth and free from defects to ensure good electrical contact and solderability.