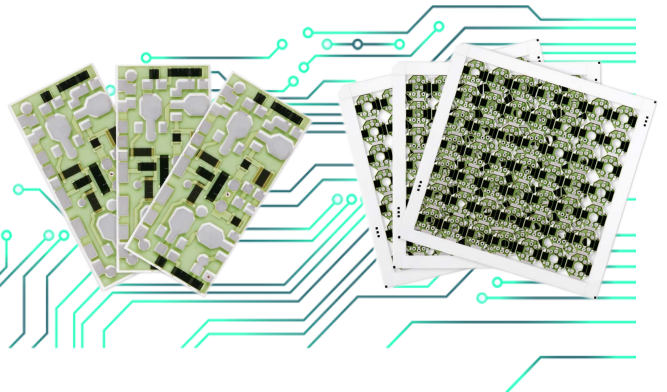


## Thick Film Substrates Product Introduction

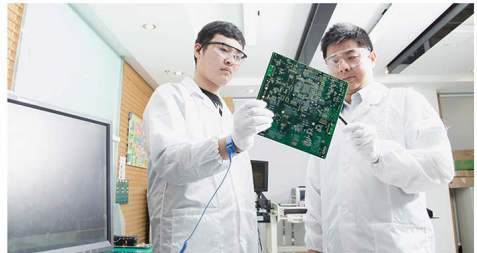


❁ Product Overview

❁ Product Solutions

❁ Product Applications

❁ Design Guidelines

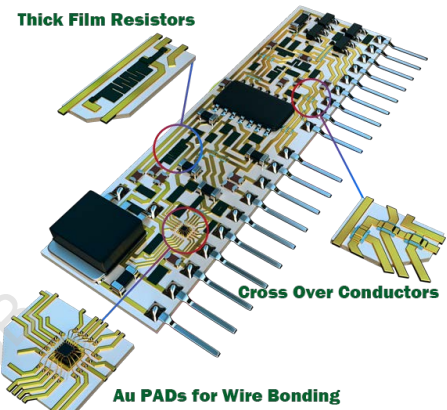


# ❁ Product Overview

## What are Thick Film Substrates ?

**Thick Film Substrates** are advanced electronic materials used for hybrid microcircuits and integrated electronics, typically made from ceramics, metals, or glass for their electrical insulation, thermal stability, and mechanical strength, with the process involving screen printing conductive patterns, resistors, capacitors, and other passive components onto the substrate followed by high-temperature firing to bond them, creating reliable, highly integrated circuits ideal for applications in automotive, aerospace, and industrial electronics where performance and durability are crucial.

**Thick Film Substrates** are a versatile and robust solution for creating electronic circuits, particularly in applications that demand high reliability, thermal performance, and resistance to harsh conditions.



## Key Features :

- **Screen Printing Process:** Materials are printed onto the substrate through a screen or stencil, creating circuit patterns with a thickness typically between 10-100 microns.
- **High-Temperature Firing:** The printed materials are fired at high temperatures to fix them and achieve the desired electrical properties.
- **Multilayer Structure:** It allows the creation of multilayer circuits, integrating resistors, capacitors, conductors, and other components.
- **High Durability:** Thick film components are resistant to high temperatures, moisture, and vibration, making them suitable for harsh environments.
- **Cost-Effective:** The process is simple and suitable for mass production, making it cost-efficient for large-scale manufacturing.
- **High Power Handling:** It can handle higher power levels, making it ideal for power resistors and high-voltage components.

Thick Film Technology is widely used in automotive, industrial, and power electronics due to its cost-effectiveness, reliability, and durability.



## Key Advantages :

- **Diverse Material Choices:** Supports conductive, resistive, and insulating materials, meeting various application needs.
- **High Power Handling:** Suitable for high-power electronics with good heat dissipation properties.
- **Durability:** Resistant to temperature extremes, moisture, vibration, and corrosion, ideal for harsh environments.
- **Miniaturization and Integration:** Allows multiple components to be integrated on the same substrate, saving space.
- **High Reliability:** Long-lasting and stable performance, perfect for applications requiring high reliability.
- **Design Flexibility:** Enables quick customization and small-batch production of circuit designs.
- **High Precision Electrical Performance:** Provides accurate resistance, capacitance, and inductance, ideal for sensors and RF circuits.
- **Compatibility with Various Substrates:** Can be applied to ceramics, glass, metal, offering broad adaptability.
- **Environmental Friendliness:** Supports lead-free materials, meeting environmental standards like RoHS.



# ❁ Product Solutions

## Thick Film Solutions :

**Thick Film Substrates** are methods of fabricating electronic components by applying thick film materials onto different substrates. They are widely used across various electronic industries. Here are several major solutions based on thick film technology:

- **Flexible Thick Film PCB :** Flexible thick film PCBs use polyimide (PI) as the substrate material, making them suitable for electronic devices that need to be bent or folded, such as wearable devices and portable electronics. These PCBs can withstand high temperatures and mechanical stress, offering high reliability and flexibility.

- **Thick Film Resistor PCB :** Thick film resistor PCBs use FR4 as the substrate, commonly applied in various electronic circuits to provide high-precision, high-power-resistance solutions. FR4 substrates offer excellent insulation and mechanical strength, making them suitable for a wide range of industrial applications.

- **Thick Film Ceramic PCB :** Thick film ceramic PCBs are used in sensor applications, with ceramic substrates offering outstanding thermal conductivity and high-temperature resistance. These are commonly used in automotive, aerospace, and medical industries that require high precision and stability for sensor products.



- **Thick Film Potentiometer PCB :** Thick film potentiometer PCBs use thick film materials to create potentiometers, which are used to adjust voltage or current. These potentiometers are widely used in audio devices, testing instruments, and industrial control systems, offering high-temperature resistance and long lifespan.

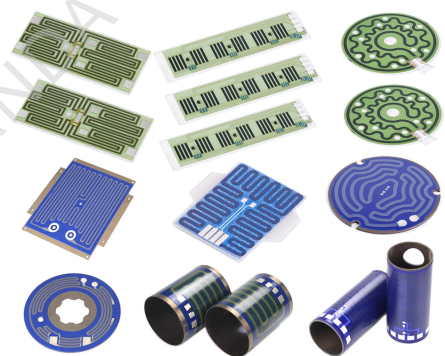
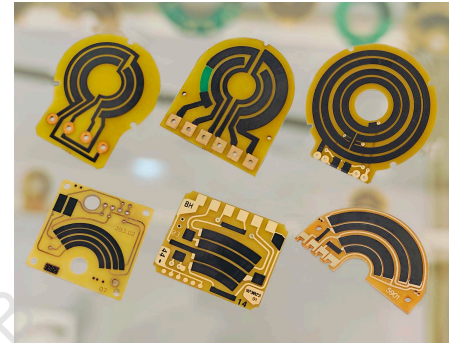
- **Thick Film Ceramic Resistors :** Thick film ceramic resistors use ceramic materials as substrates, with thick film technology applied to form high-precision resistors. These are used in power systems, communication equipment, automotive electronics, and other fields, providing excellent stability and anti-interference capabilities.

- **Thick Film Hybrid Circuits :** Thick film hybrid circuits combine both thin-film and thick-film technologies, integrating multiple electronic components into a single package to provide higher functional density. These hybrid circuits are used in high-frequency, power-dense applications, such as aerospace electronics, medical devices, and military technology.

- **Thick Film Heaters :** Thick film heaters are manufactured using thick film technology to create heating components that provide uniform heat distribution in small volumes. These are widely used in heaters, electric warmers, and vehicle heating systems, offering long service life and stable heating performance.

- **Thick Film Sensors :** Thick Film Sensors enable the fabrication of sensors with a broad spectrum of functionalities. By integrating diverse materials and adjusting the composition of the thick film paste, these sensors can be tailored to detect a multitude of physical or chemical stimuli. This includes variations in temperature, pressure, humidity, or the presence of specific chemicals.

- **Hybrid Integrated Circuits:** Hybrid integrated circuits combine different materials and processes, using thick film technology to integrate multiple components into a single package, offering high performance and multi-functionality. These are commonly applied in communications, consumer electronics, and medical devices.

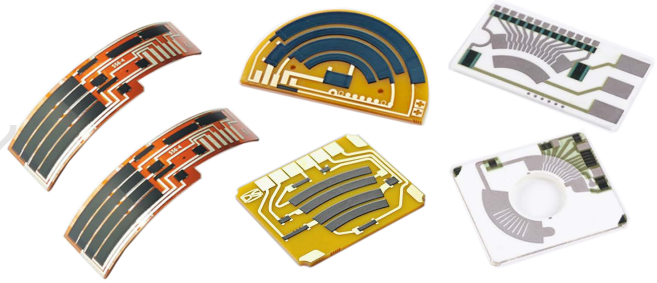




# ❁ Product Applications

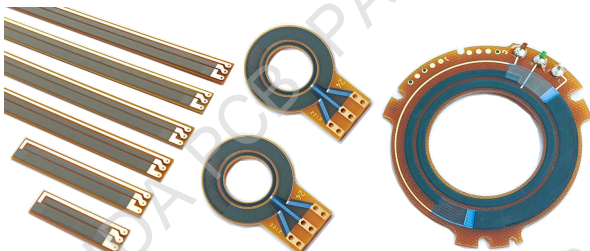
## Automotive Industry :

- Fuel Level Sensor PCB (Fuel Level Sender PCB)
- Tank Fuel Level Sensor PCB
- Liquid Level Sensor PCB
- LP Gas Liquid Level Gauges
- Oil Level Sensor PCB
- Motorcycle Fuel Level Sender PCB
- Throttle Position Sensor PCB
- Pedal Position Sensor PCB
- Engine Oil Pressure Sensor PCB



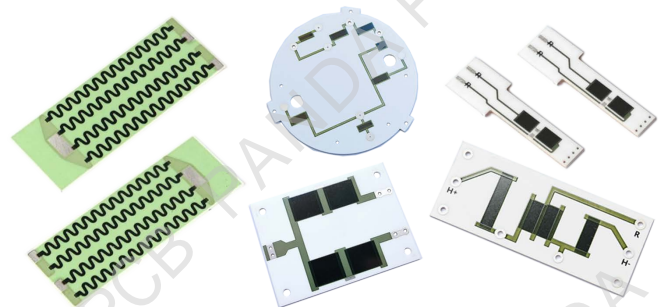
## Industrial Control Systems :

- Potentiometer PCB
- Flexible Potentiometer PCB
- Linear Potentiometer PCB
- Rotary Potentiometer PCB
- Position Sensor PCB
- Flexible Position Sensor PCB
- Linear Position Sensor PCB
- Rotary Position Sensor PCB



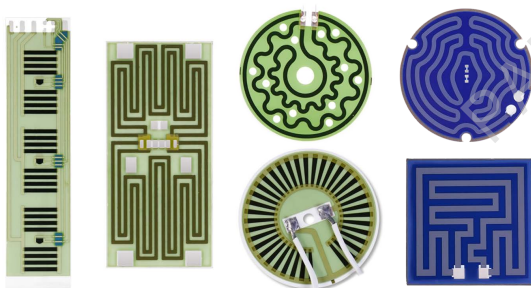
## Ceramic Resistors :

- High Voltage Ceramic Resistors
- High Value Ceramic Resistors
- Ceramic Humidity Sensitive Resistors
- Non-Inductive Thick Film Resistors
- Radio Frequency Power Resistors
- High Energy Thick Film Resistors
- High Power Thick Film Resistors
- Thick Film Resistor Networks
- Tubular Thick Film Resistors
- Ceramic Variable Resistors



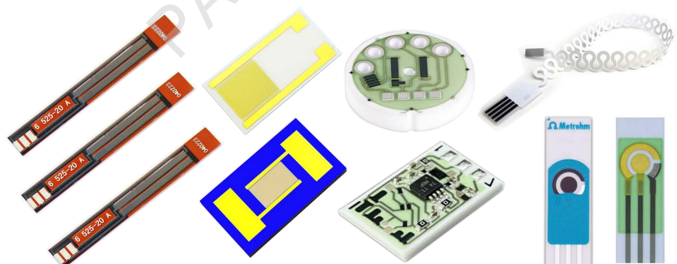
## Heating Elements :

- Ceramic Thick Film Heaters
- Stainless Steel-Thick Film Heaters
- Flexible Heaters
- PI Heaters
- PET Heaters
- Mica Heaters
- Vacuum Packer- Thick Film Heaters
- E-Cigarettes Heaters
- Laser Printer-Thick Film Heaters



## Electronic Sensors :

- Interdigital Electrodes
- Printed Flexible Electronic PCB
- Flexible Sensor PCB
- Ceramic Pressure Sensors
- Piezoelectric Ceramic Pressure Sensors
- Screen Printed Electrodes (Electrochemical Sensors)

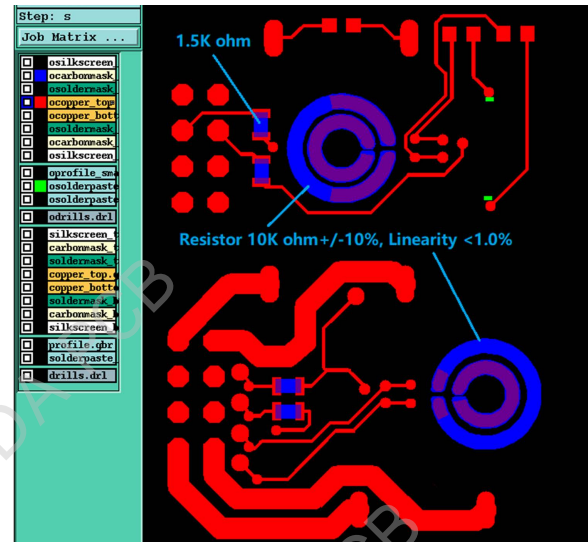


# ❁ Design Guidelines

## Design Guidelines :

Design guidelines for thick film substrate focus on several key factors to ensure the reliability and performance of the circuits. First, the Engineering Specification provides the foundation for the entire design, ensuring the product's adaptability and functionality under specific application conditions. The Metallization Process is a crucial step in the manufacturing process, determining the quality and stability of the conductive layers, typically involving processes such as metal screen printing and sintering. The choice of substrate is critical, with flexible PI, FR4, ceramic or metal substrates commonly used.

Common paste used in thick film substrate include conductive pastes, resistive pastes, dielectric pastes, and insulating pastes. Each paste formulation and its performance need to be carefully designed according to the circuit's functional requirements to ensure electrical performance, thermal stability, and long-term reliability. Overall, the design must consider thermal expansion matching, material compatibility, and manufacturing feasibility to ensure the performance, stability, and production efficiency of thick film substrates.

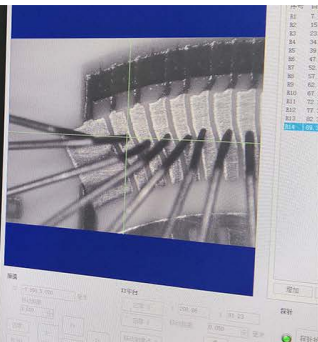


## 1, Engineering Specification

Items:	Typical Values	Advanced Capabilities
1, Substrates :	FR4, Ceramic ( Al2O3, ALN, BeO, ZrO2), Polyimide (Flexible PI), Stainless Steel (SUS304), Mica	FR4, Ceramic ( Al2O3, ALN, BeO, ZrO2), Polyimide (Flexible PI), Stainless Steel (SUS304), Mica
2, Conductor (Paste) Materials :	Copper, Silver , Gold , Silver-Palladium, Palladium-Gold, Platinum-Silver, Platinum-Gold	Copper, Silver , Gold , Silver-Palladium, Palladium-Gold, Platinum-Silver, Platinum-Gold
3, Thick Film Carbon Thickness :	15um +/-5 um	30um +/-5 um
4, Conductors Thickness :	12um+/-5um	20um+/-5um
5, Min Width of Thick Film Line :	0.30 mm +/-0.05 mm	0.20 mm +/-0.05 mm
6, Min Space of Thick Film Line :	0.30mm +/-0.05 mm	0.20 mm +/-0.05 mm
7, Min Overlap (Carbon to Conductor) :	No less than 0.25mm	0.20mm (Minimum)
8, Sheet Resistivity (ohms/square):	Printed resistors in milli ohm to mega ohm range (Customizable) with tolerances of 1-10% are fabricated and protected with overglaze materials.	Printed resistors in milli ohm to mega ohm range (Customizable) with tolerances of 0.5-10% are fabricated and protected with overglaze materials.
9, Resistor Value Tolerance (ohms) :	+/-10.0% (Standard) (Customizable)	+/-0.5% (Laser trimming)
10, Linearity :	+/-1.0% (Standard) (Customizable)	+/-0.2 ~ +/-0.5% (Laser trimming)
11, Synchronism of Double Channels :	+/-2.0% (Standard) (Customizable)	+/-1.0% (Laser trimming)
12, Durability of Carbon Ink (Life time) :	0.5 Million (Min), 2.0 Million (Standard)	5.0-10.0 Million (Max) with Surface Polishing
13, Working Temperature :	- 40°C / + 150°C	- 40°C / + 180°C

## 2, Optional Metallization Processes

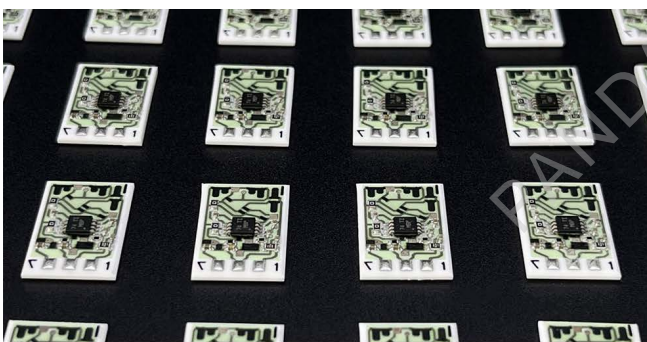
Metalization Types :	Thick Film Substrates (Screen-Printed)		Thin Film Substrates (Photo-Imaged)		
Process Types :	TFM Capabilities	HTCC / LTCC Capabilities	DBC Capabilities	DPC Capabilities	AMB Capabilities
Layer Counts :	1, 2, 3, 4 Layers	1, 2 Layers	1, 2 Layers	1, 2 Layers	1, 2 Layers
Max Board Dimension :	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 :	Al2O3, ALN, BeO, ZrO2	Al2O3, ALN, BeO, ZrO2	Al2O3, AlN, ZrO2, PbO, SiO2, ZTA, Si3N4, SiC, Sapphire, Polycrystalline Silicon, Piezoelectric	Al2O3, AlN, ZrO2, PbO, SiO2, ZTA, Si3N4, SiC, Sapphire, Polycrystalline Silicon, Piezoelectric	Al2O3, 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)





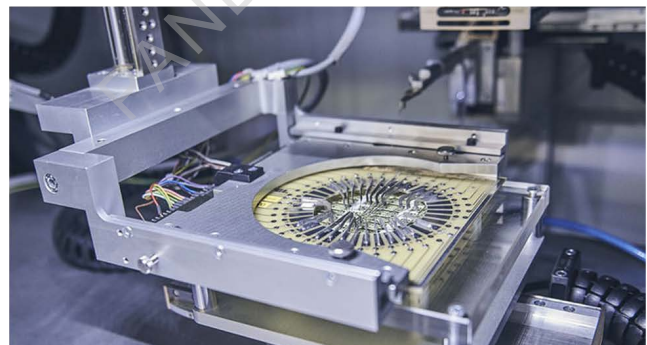
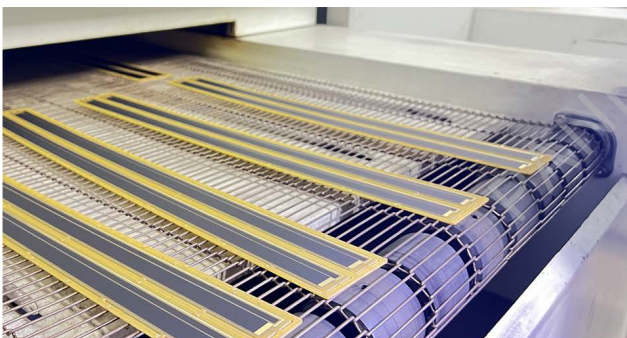
### 3, Ceramic Substrates

Substrates :	Alumina (Al <sub>2</sub> O <sub>3</sub> )	Aluminum Nitride (AlN)	Beryllium Oxide (BeO)	Zirconium Dioxide (ZrO <sub>2</sub> )
Max Application Temperature :	662 - 1832	1832	2300	2432
Max Power Density (W/in <sup>2</sup> ):	75	1010	250	300
Max Ramp Up Speed (°F/sec):	122	572	400	350
Thermal Conductivity (W/mK):	20-35	180-220	200-300	2.0-5.0
Density (g/cm <sup>3</sup> ):	3.75	3.26	2.8	5.9
Dielectric Loss:	0.0001 - 0.001	0.0001 - 0.0005	0.0001 - 0.0002	0.0005 - 0.001
Dielectric Constant:	9.4 - 10.2	8.5 - 9.0	6.0 - 7.0	25 - 30
CTE, ppm/°C:	6.0 - 8.0	4.0 - 5.0	7.0 - 9.0	10.0 - 11.0
Substrate Thickness (mm):	0.25 - 2.0	0.25 - 2.0	0.25 - 2.0	0.25 - 2.0
Typical Max. Dimension (inch):	6 x 12	5 x 11	6 x 6	4 x 4
Theoretical Total Wattage (W):	5400	55000	15000	20000



## 4, Conductive Paste

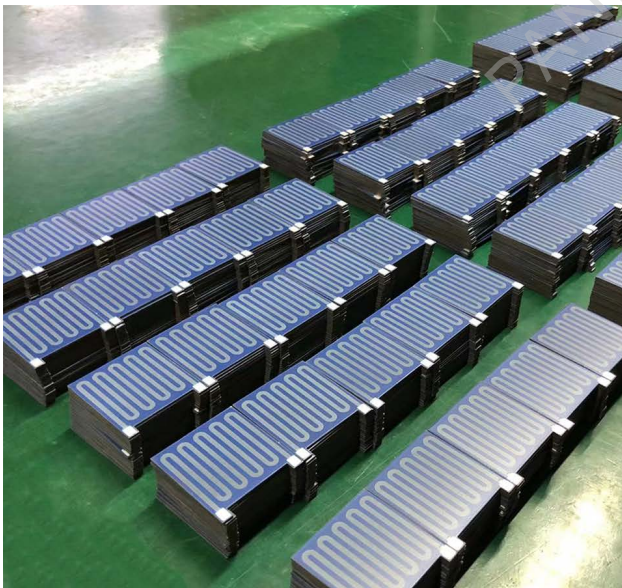
Paste ( Materials ) :	Conductor Width/Space	Soldering / Bonding
Gold :	8/8mil (0.20/0.20mm)	Gold is a good conductor material and allows thermo-compression gold wire bonding and eutectic die attachment. It is, of course, costly and has poor solderability.
Silver :	8/8mil (0.20/0.20mm)	Soldering & Silver is lower in cost, and solderable, but is not leach-resistant with tin/lead solders. More seriously, silver atoms migrate under the influence of DC electric fields, both causing short-circuits and reacting with many of the resistor paste formulations.
Platinum-Silver :	6/6mil (0.15/0.15mm)	Soldering & Surface Mount, Palladium and platinum alloyed to the gold and silver produce good conductor pastes, with good adhesion to the substrate, good solderability, and moderately good wire bonding characteristics.. Copper and nickel are examples of materials that have been proposed for paste systems as substitutes for noble metals.
Palladium-Silver :	8/8mil (0.20/0.20mm)	Soldering & Surface Mount ,Solderable, Wire bondable, (good aged adhesion general purpose), Silver-palladium conductor inks are the most commonly used materials, with both price and performance (primarily resistance to solder) increasing with palladium content.
Platinum-Gold :	6/6mil (0.15/0.15mm)	Soldering & Au or Al Wire Bonding, Solderable (excellent aged adhesion with no migration).
Palladium-Gold :	8/8mil (0.20/0.20mm)	Soldering & Au or Al Wire Bonding, Wire bondable.





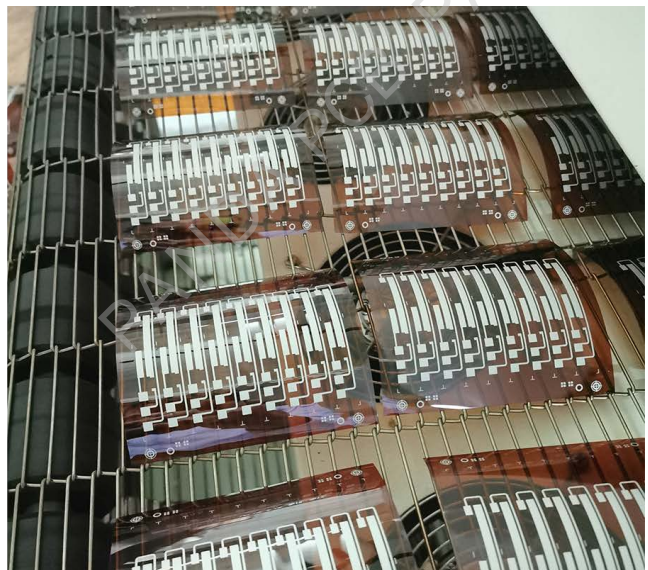
## 5, Resistive Paste

Performances :	Common Values/Range	Description
Resistance Value :	1Ω to several MΩ	The resistance value depends on the type and ratio of carbon black, typically ranging from 1Ω to Mega ohm.
Resistance Tolerance :	±1% to ±10%	High-precision resistors can achieve ±0.1% tolerance used laser trimming process.
Temperature Coefficient (TCR) :	±50ppm/°C to ±200ppm/°C	High-quality resistive paste should have a low TCR, preferably below ±100ppm/°C.
Stability :	≤1%	Resistors must undergo high-temperature aging and humidity tests to ensure stability.
Sintering Temperature :	850°C to 950°C	The sintering temperature for carbon paste depends on material properties, typically in this range.
Conductivity :	10 <sup>4</sup> S/m to 10 <sup>8</sup> S/m	Conductivity depends on the type and ratio of carbon black, affecting resistance precision and stability.
Surface Smoothness :	Ra ≤ 1 μm	The surface must be free of cracks, bubbles, and non-uniform layers to ensure good mechanical and electrical properties.
Insulation Resistance :	≥10 <sup>9</sup> Ω	Carbon paste should have good insulation properties to avoid leakage or short circuits.
Mechanical Strength :	≥100 MPa	The resistive layer must have good compressive and bending strength to ensure the reliability of the resistor.
Volatility :	Solvent residue ≤ 1%	High volatility solvents help with even coating and drying, but excessive volatility may affect electrical performance.
Oxidation Resistance :	>1000 hours	High-quality carbon paste should have strong oxidation resistance to extend the service life.
Humidity Resistance :	≥1000 hours	Resistors should be able to withstand high-humidity conditions to ensure long-term stable performance, no significant changes.



## 6, Dielectric Paste

Performances :	Typical Value	Explanation
Material Types :	Epoxy Resin, Polyimide, Polyurethane, Polytetrafluoroethylene	These resin types are commonly used to manufacture dielectric materials, providing good electrical insulation, thermal stability, and mechanical strength.
Dielectric Constant ( $\epsilon_r$ ) :	3 ~ 4.5 (Epoxy), 3.0 ~ 3.5 (PI), 2.1 ~ 2.5 (PTFE)	Epoxy and polyimide are typically used in low-to-medium frequency circuits, while PTFE is preferred for high-frequency applications due to its lower dielectric constant.
Insulation Resistance :	$\geq 10^{12} \Omega \cdot \text{cm}$	Resin-based materials usually exhibit extremely high insulation resistance, effectively isolating electrical currents and preventing leakage.
Dielectric Loss :	$\leq 0.01$ (Epoxy), $\leq 0.005$ (PI), $\leq 0.0002$ (PTFE)	Polyimide and PTFE have lower dielectric loss, making them ideal for high-frequency applications.
Operating Temperature :	-55 ~ +180°C (Epoxy), -50 ~ +250°C (PI), -200 ~ +260°C (PTFE)	The sintering temperature for carbon paste depends on material properties, typically in this range.
Sintering Temperature :	150 ~ 200°C	Resin-based dielectric materials require lower sintering temperatures, making them more energy-efficient compared to ceramic materials.
CTE, ppm/°C :	20 ~ 60 $\times 10^{-6}$ (Epoxy), 10 ~ 40 $\times 10^{-6}$ (PI), 100 ~ 200 $\times 10^{-6}$ (PTFE)	PTFE has a higher thermal expansion coefficient but offers excellent chemical stability and corrosion resistance. Epoxy and polyimide have lower coefficients, making them more thermally stable.
Volume Resistivity :	$\geq 10^{13} \Omega \cdot \text{cm}$	Resin materials typically have very high volume resistivity, making them ideal for electrical isolation applications.
Surface Resistivity :	$\geq 10^9 \Omega \cdot \text{cm}$	Resin materials exhibit high surface resistivity, ensuring that surface leakage currents are minimized.
Thermal Conductivity :	0.2 ~ 0.3W/m·K (Epoxy), 0.2 ~ 0.3W/m·K (PI), 0.1 ~ 0.3W/m·K (PTFE)	Resin materials have low thermal conductivity, requiring additional heat dissipation designs to ensure thermal stability.
Adhesion Strength :	$\geq 20 \text{ N/cm}^2$	Epoxy resin has good adhesion strength, making it suitable for various substrates, such as metal and ceramics.





## 7, Insulating Paste

Material Types :	Glass Enamel (Overglaze)	Epoxy Resin	Organic Polymers (Polyurethane, Polystyrene)
Insulation Resistance :	$\geq 10^{12} \Omega \cdot \text{cm}$	$\geq 10^{12} \Omega \cdot \text{cm}$	$\geq 10^{12} \Omega \cdot \text{cm}$
Dielectric Constant ( $\epsilon_r$ ) :	5 ~ 7	3 ~ 4.5	2 ~ 3.5
Dielectric Loss :	$\leq 0.01$	$\leq 0.01$	$\leq 0.01$
Operating Temperature :	-40 ~ +450 °C	-55 ~ +180 °C	-40 ~ +150 °C
Sintering Temperature :	600 ~ 800 °C	150 ~ 200 °C	120 ~ 180 °C
Thermal Conductivity :	1.0 ~ 1.5 W/m·K	0.2 ~ 0.3 W/m·K	0.1 ~ 0.3 W/m·K
CTE, ppm/°C :	$30 \sim 50 \times 10^{-6} / ^\circ\text{C}$	$30 \sim 60 \times 10^{-6} / ^\circ\text{C}$	$50 \sim 150 \times 10^{-6} / ^\circ\text{C}$
Density :	2.5 ~ 3.0 g/cm <sup>3</sup>	1.1 ~ 1.4 g/cm <sup>3</sup>	1.1 ~ 1.4 g/cm <sup>3</sup>
Adhesion Strength :	High (suitable for metal substrates)	High, good adhesion properties	Medium (depends on polymer type)
Chemical Stability :	Excellent, resistant to acids, alkalis, and solvents	Good, resistant to most chemicals, but sensitive to some solvents	Moderate, some polymers like PVC have strong chemical resistance
Arc Resistance :	Excellent	Good	Moderate
Mechanical Strength :	High (hard and brittle)	Medium, good flexibility	Low, but good flexibility
Characteristics :	High-temperature sintering, excellent electrical insulation, good thermal and chemical stability	Low-temperature sintering, good adhesion and flexibility, good chemical resistance	Good flexibility, suitable for flexible circuits, but poor high-temperature performance



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