UGPCB Metal Substrate Product Introduction

2025-4

Introduction of Metal Substrates Products

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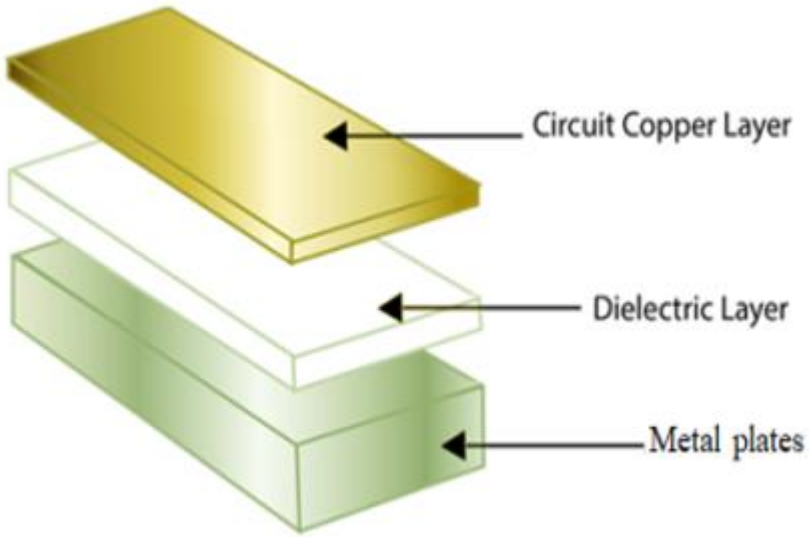
1. Definition of metal substrate

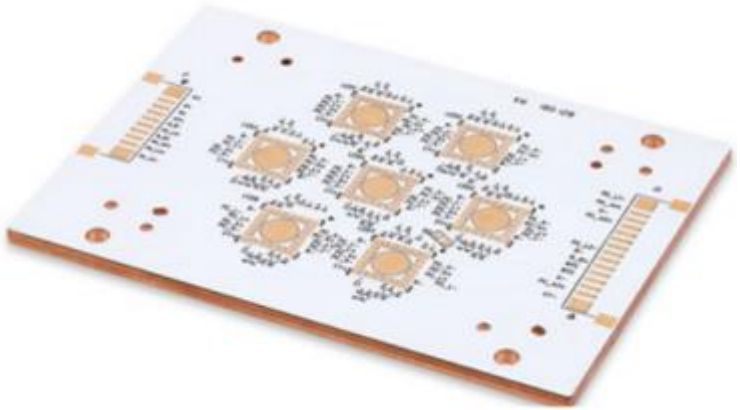


- **Definition**
- **A metal substrate is a type of copper-clad laminate with good thermal dissipation capabilities. Generally, a single-sided board consists of three layers: the circuit layer (copper foil), the dielectric layer, and the metal base layer.**

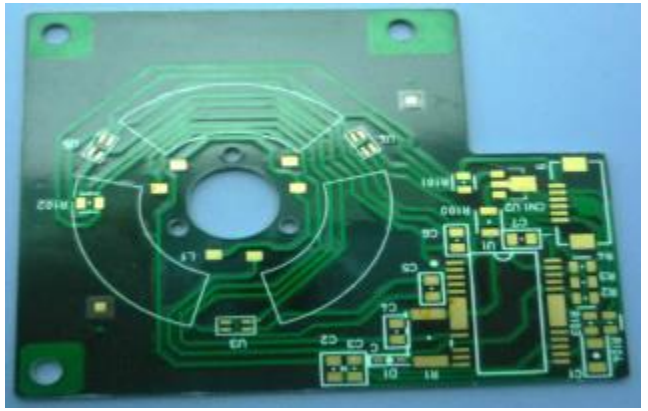
2. Categories of Metal Substrates

1） According to different types of metal substrates, the commonly used ones are:

Aluminum Base PCB



Copper Base PCB

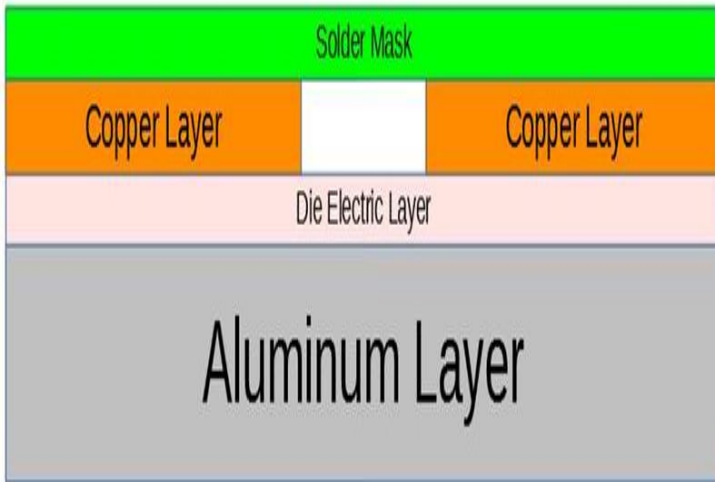


Iron Base PCB

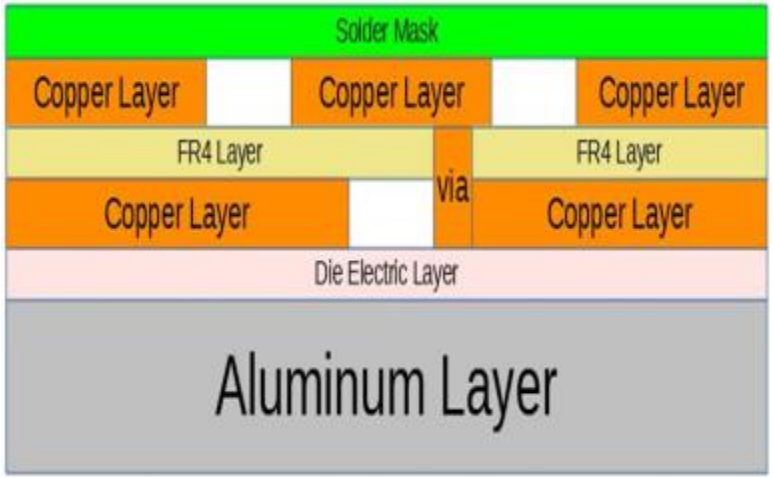
2. Categories of Metal Substrates

2） Based on the number of layers:

Single Sided Metal Base PCB



2-layer Metal base PCB



3. Introduction to Parameters of Aluminum PCB

1）Shengyi SAR20H datasheet:

SAR20H

Aluminium Base Laminate

FEATURES

- High CTI
- Halogen free
- Superior heat dissipation
- Excellent mechanical process ability
- Excellent thermal and insulation reliability

APPLICATIONS

On-board Charger, EPS, Automobile
Lighting, AC-Inverter, DC-DC Convertor
Power Supply Board
Hi-power LED lighting

GENERAL PROPERTIES

Test Items	Test Method	Test Condition	Unit	Typical Value
Thermal Conductivity	ASTM-D5470	Dielectric layer	W/(m·K)	2.1
Thermal Resistance	ASTM-D5470	Dielectric layer	K·cm²/W	0.52
Tg	IPC-TM-650 2.4.25D	DSC	℃	160
Td	IPC-TM-650 2.4.24.6	TGA (5% W.L)	℃	395
Thermal Stress	IPC-TM-650 2.4.13.1	288℃, float	min	30
CTE (Z-axis)	IPC-TM-650 2.4.24	Before Tg	ppm/℃	17
	IPC-TM-650 2.4.24	After Tg	ppm/℃	39
	IPC-TM-650 2.4.24	50-260℃	%	0.69
Volume Resistivity	IPC-TM-650 2.5.17.1	C-96/35/90	MΩ-cm	10^8
Surface Resistivity	IPC-TM-650 2.5.17.1	C-96/35/90	MΩ	10^8
Dielectric Breakdown	IPC-TM-650 2.5.6	D-48/50+D-0.5/23	kV	5.0
Hi-pot Test	GB/T-31988	DC	V	4000
		AC	V	3000
Peel Strength (1oz)	IPC-TM-650 2.4.8	288℃/10s	N/mm [lb/in]	1.3 [7.43]
Flammability	UL94	C-48/23/50	Rating	V-0
MOT	UL	A	℃	130
CTI	IEC60112	A	Rating	PLC 0

Remarks: 1. Typical value is based on specimen of 1.5mm Al/100um dielectric/1oz Cu.

2. All the typical value listed above is for your reference only, please turn to Shengyi Technology Co., Ltd. for detailed information, and all rights from this data sheet are reserved by Shengyi Technology Co., Ltd.

PURCHASING INFORMATION

	Material	Thickness
Cu	E/D Cu	Hoz-4oz
Dielectric Layer	Epoxy resin filled with inorganic filler	50-150um
Aluminium Plate	5052 Al	0.3-3.0mm
Protective Film	PET	
Standard Size	1040mm×1240, 510mm×610mm	

Remarks: Other sheet size and thickness could be available upon request.

3. Introduction to Parameters of Aluminum PCB

2） Introduction to Parameters of Aluminum PCB

ITEMS	Definition	Remark						
TG	The temperature at which the glassy state transitions to the rubbery state (or high-elastic state) is called TG. (Glass transition temperature)	normal TG		mid TG		high tg		
		110-150		150-170		>170		
TD	When the PCB is heated to a temperature at which its mass decreases by 5%, this temperature is referred to as the pyrolysis temperature of the PCB. (thermaldecomposition temperature)	normal		mid		high		
		>310		>325		>340		
CTI	The highest voltage value that the material surface can withstand without forming leakage traces when subjected to 50 drops of electrolyte (0.1% ammonium chloride aqueous solution) is called the Comparative Tracking Index (CTI). The CTI test is specifically for the PCB surface, and it refers to the ability of the PCB to resist contamination in the environment.	CTI	≧600	400-600	250-400	175-250	100-175	0-100
		PLC	0	1	2	3	4	5
		IEC	I	II	III	IIIA	IIIB	---
MOT	The maximum allowable operating temperature (which is the highest temperature guaranteed by UL for material usage, in degrees Celsius).							
Thermal Conductivity	The thermal conductivity refers to the amount of heat transferred through a 1-meter-thick material, with a temperature difference of 1 degree (K, °C) between the two surfaces, per 1 hour, per 1 square meter area, under steady-state heat transfer conditions. The unit is watts per meter per degree (W/(m•K), where K can be replaced by °C).	The thermal conductivity depends on the formulation of the thermal conductive adhesive (type of filler, particle size, and specific gravity).						
Thermal Impedance	When heat is transferred within an object through thermal conduction, the resistance encountered is called thermal resistance. Unit: ℃*in²/W (the temperature rise per 1W of power dissipated).	Influencing factors: the formula and thickness of the thermally conductive adhesive film.						
Dielectric breakdown	Based on the requirements of UL and IEC for various electrical safety standards, products must undergo a withstand voltage test. The insulation strength of the substrate directly affects the test results. Under certain conditions, the voltage applied to the specimen is gradually increased according to regulations until the specimen breaks down, thereby determining the breakdown electric field strength of the specimen.	The breakdown of insulating materials can be categorized into electrical breakdown, thermal breakdown, and electrochemical breakdown. There will be certain differences in the actual measurement results. The thickness of the material and the copper cladding affect the heat dissipation efficiency, thus resulting in different breakdown voltages. The higher the glass transition temperature (TG), the more difficult it is for thermal breakdown carbonization to occur, and the stronger the voltage withstand capability. Glass fiber has a stronger voltage withstand capability compared to epoxy resin. With the same thickness, the more layers of PP (polypropylene), the stronger the voltage withstand capability.						

3. Introduction to Parameters of Aluminum PCB

2） Introduction to Parameters of Aluminum PCB

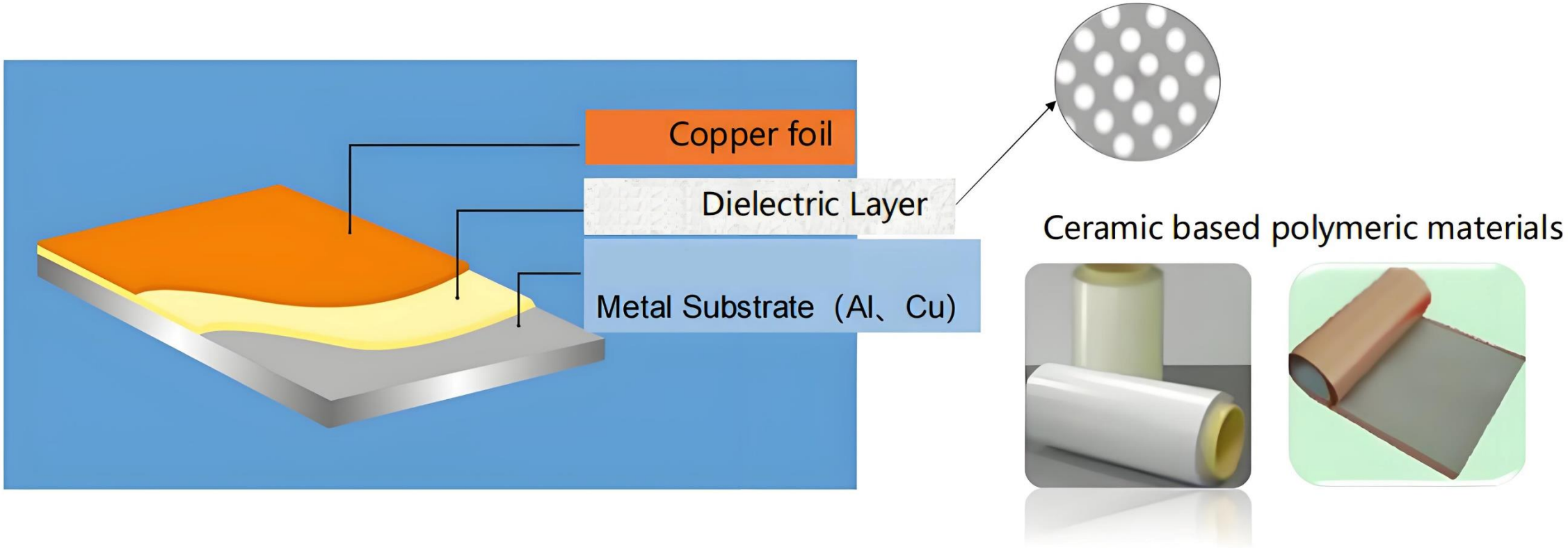
ITEMS	Definition	Remark
DK	When a medium is placed in an external electric field, it generates induced charges that weaken the electric field. The ratio of the original external electric field (in a vacuum) to the final electric field in the medium is the dielectric constant.	The primary factors influencing the DK value (Dielectric Constant) in PCB materials include **Fiberglass Cloth**, **Resin**, and **Filler**.
Flammability	Flammability Rating	
peel Strength	**Peel strength - refers to the adhesion between the copper foil and the substrate.**	
Volume/surface resistance	**Volume resistance surface resistance**	**What is reflected is the insulation quality of the PCB.**
Hi-pot Withstand	**Copper clad laminate manufacturers perform high-voltage testing before shipment.**	Mainly detect the quality of the insulation layer (impurities, cracks, etc.) of aluminum-based copper clad laminates.
CTE	The coefficient of thermal expansion (CTE), also referred to as the PCB's CTE, causes dimensional instability due to expansion and contraction during the heating process.	**The aluminum base plate mainly refers to the adhesive film layer in the middle, which is the insulating layer.**
Thermal stress	Immersion tin test at the condition of 288℃	

T300/T288/T260 Thermal Crack Resistance Time

ITEMS	normal	mid	high
T260	**30**	**30**	**30**
T288	**5**	**5**	**15**
T300	**-**	**-**	**2**

3. Introduction of Aluminum Substrate Board Parameters

3） Introduction to the material of the insulation layer on the aluminum substrate:



- **The insulating layer (thermal conductive adhesive film) not only serves to conduct heat and bond materials (specifically, aluminum plates and copper foil), but also acts as the dielectric material ensuring electrical insulation between the wiring layer and the aluminum base. Consequently, within the entire aluminum substrate, the insulating layer is the most crucial component, as it determines the thermal conductivity and the dielectric strength of the aluminum substrate. Compared to traditional FR-4 materials (with a thermal conductivity of 0.3-0.5 W/m•K), its thermal conductivity is more than three times higher.**

3. Introduction of Aluminum Substrate Board Parameters

3） Introduction to the Material of the Insulation Layer on Aluminum Substrates:

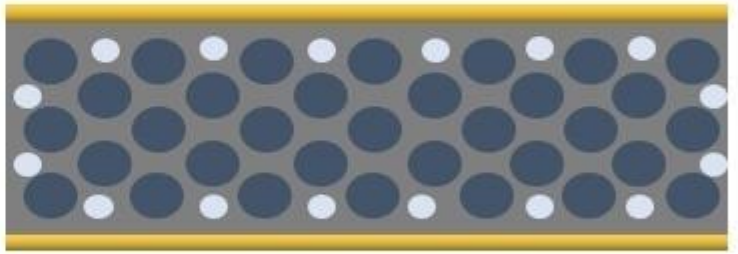
What are the factors that affect the thermal conductivity coefficient of insulating layer of aluminum substrate?

1. Types of fillers

Types of fillers	Thermal conductivity (W / m * K)	Breaking through voltage
Al_2O_3	25~40	+ +
MgO	25~50	+
SiO_2	9.6	+
Si_3N_4	50	-
BeO	270	-
SiC	25~100	- -
AlN	120~220	+
BN	100~250	+

NOTE: + GOOD - Bad.

2. Fill particle size and weight

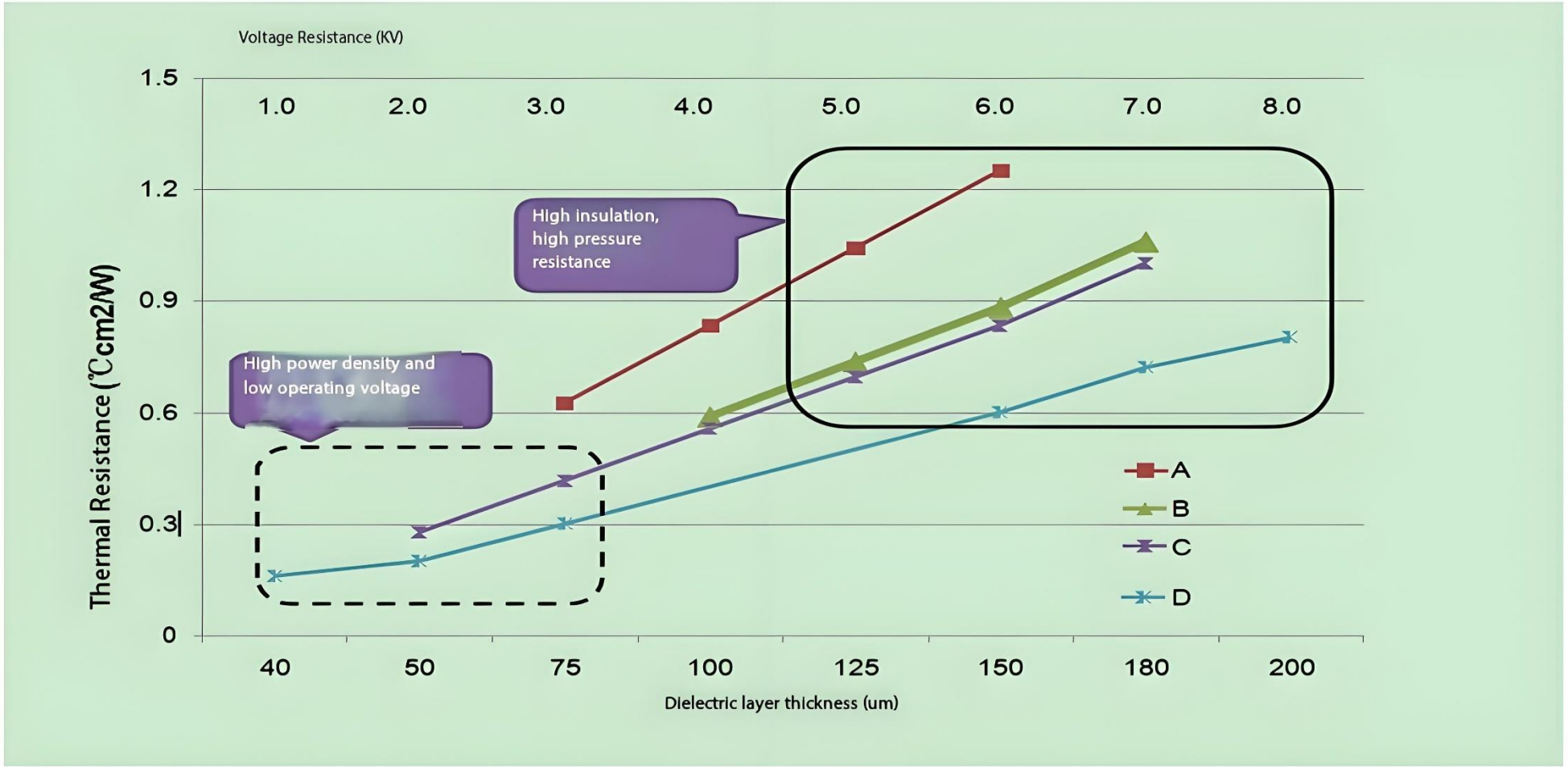


The way and weight of the thermal conductive material is also an effective way to effectively improve the thermal carrying capacity of the insulation layer.

The most commonly used type of thermally conductive filling for metal-based copper plating is alumina, as can be seen from the characteristics table of different types of filling above. Different fillers have a great influence on the thermal conductivity and pressure resistance of the insulation layer, and at the same time, the filling mode and weight of the thermally conductive material also have a large influence on the conductivity and the pressure resistance.

3. Introduction of Aluminum Substrate Board Parameters

3）Introduction to the Material of the Insulation Layer on Aluminum Substrates:



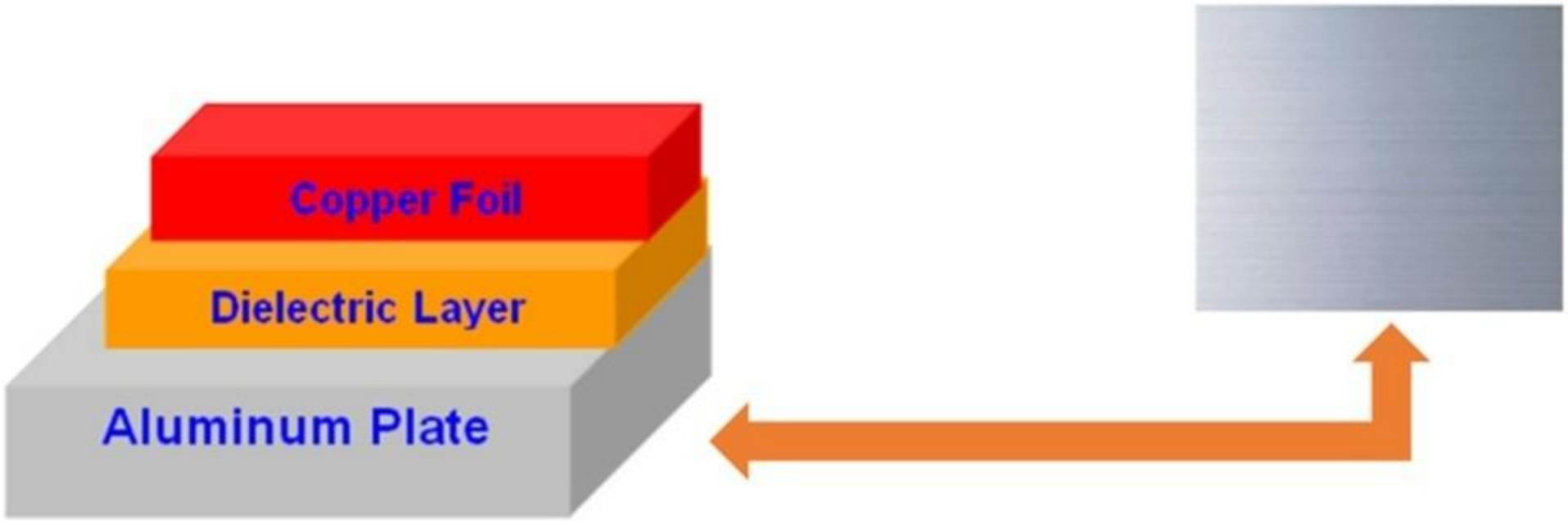
Same material:

Throughput Voltage: The piercing voltage is directly proportional to the thickness of the insulation layer. The thicker the insulation, the stronger the resistance to piercing Voltage.

Heat resistance: Heat resistance is also directly proportional to the thickness of the insulation layer, the thicker the insulation, the greater the thermal resistance and the worse the thermal conductivity.

3.Introduction of Aluminum Substrate Board Parameters

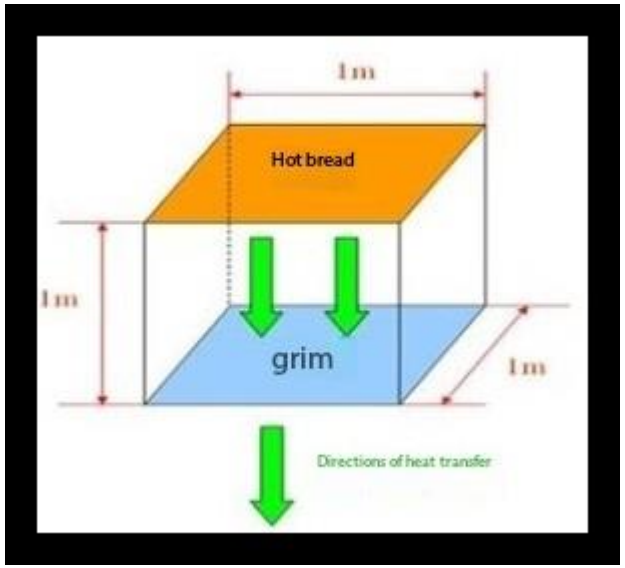
4）Aluminum Material Introduction:



- Aluminum not only plays the role of heat conduction in the aluminum substrate, but also the rigid support of the entire PCB.
- Different aluminum materials have different physical properties and applications, commonly used in the PCB industry aluminum 1xxx, 3xxx, 5xxx, 6xxx. Among them, 1xxx aluminum is mainly used in the lighting industry, belonging to low-cost materials, industrial power supplies or other high-end products are mainly 5xxx aluminum and 6xxx aluminum.

3. Introduction of Aluminum Substrate Board Parameters

5）Introduction to the Thermal Conductivity:



Test Method	Name
D5470	Thermal resistance method
E1461	Laser Method
ISO-22007	Flat plate method

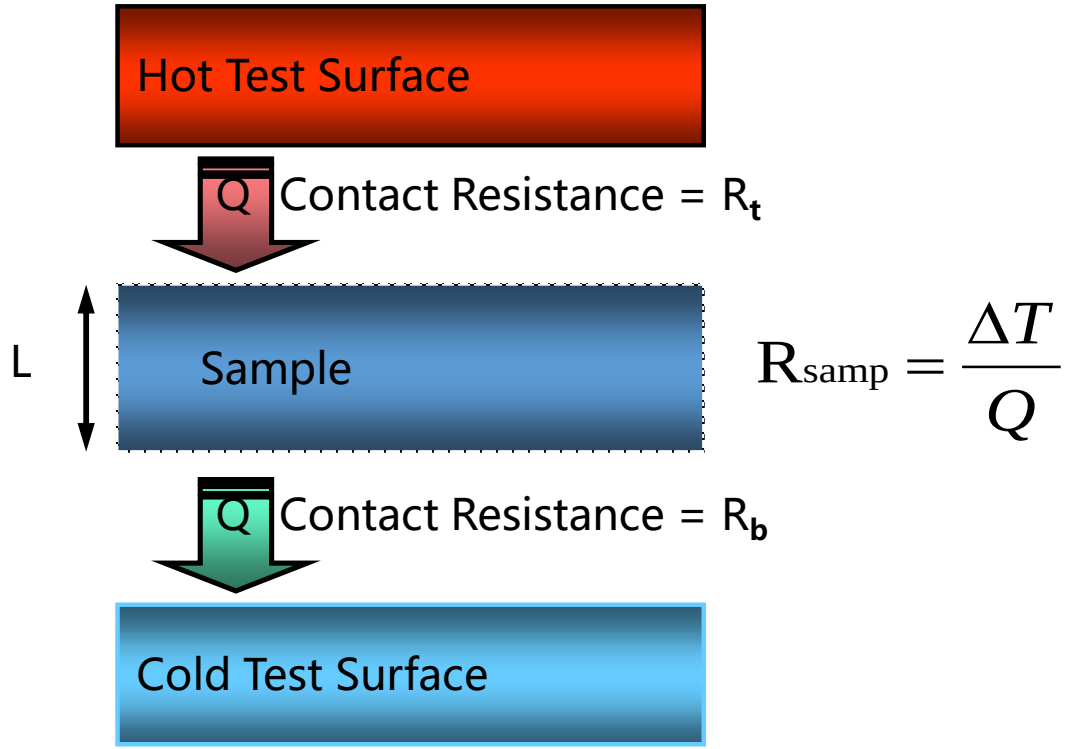
- **The thermal conductivity refers to the amount of heat transmitted through 1 square meter of material, 1 meter thick, with a temperature difference of 1 degree (K, ℃) between the two surfaces, within 1 hour under steady-state heat transfer conditions. The unit is watts per meter per degree (W/(m•K), where K can be replaced by ℃).**

- **Currently, there are three commonly used testing methods in the industry: the heat flow meter method, the laser flash method, and the guarded hot plate method. These three testing methods have different principles and can result in varying test outcomes.**

3.Introduction of Aluminum Substrate Board Parameters

5）Introduction to the Thermal Conductivity:

Introduction to the Testing Principle of D5470 - Heat Resistance Method



Thermal Conductivity Equation

$$k_{actual} \equiv \frac{L}{A * R_{samp}}$$

* The calculated thermal conductivity is the true thermal conductivity of the material only when the contact thermal resistances Rt and Rb are 0.

* Sources of contact thermal resistance:

① Surface contamination of the test sample

② Uneven surface of the test sample

③ Large surface roughness of the sample

The ASTM-D5470 standard by the American Society for Testing and Materials (ASTM) is designed for testing the thermal conductivity of electrical insulating materials, and it is currently the most recognized method in the industry for measuring the thermal conductivity coefficient of aluminum substrates. The testing procedure involves applying a constant heat flow to the aluminum substrate so that the heat flows perpendicularly through it, with no lateral heat diffusion. The temperatures on the upper and lower surfaces of the aluminum substrate are measured, and then the thermal conductivity coefficient of the aluminum substrate is calculated.

3. Introduction of Aluminum Substrate Board Parameters

5）Introduction to the Thermal Conductivity:

Introduction to the Testing Principle of E1461 Laser Method

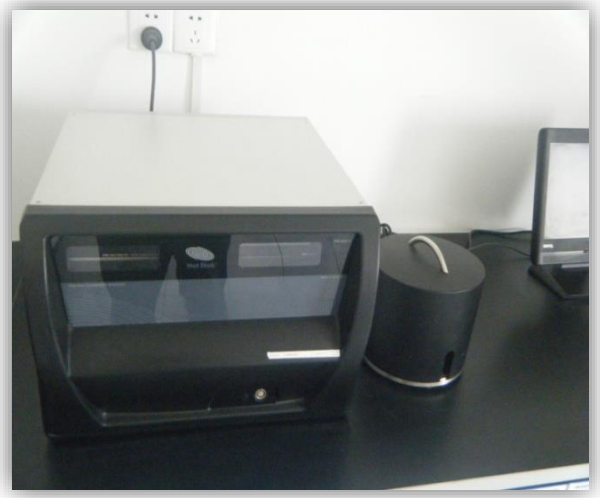
$$\lambda(T) = \alpha(T) * Cp(T) * \rho(T)$$

- A laser beam is directed at the top surface of the sample, and an infrared detector measures the temperature change on the bottom surface. The actual data measured is the thermal diffusivity of the sample. By comparing it with a standard sample, the density and specific heat of the sample are also obtained (or the specific heat obtained by other testing methods). The thermal conductivity of the sample is then calculated.
- The advantages are its speed, non-contact nature, and suitability for high-temperature, high-thermal-conductivity samples.

3. Introduction of Aluminum Substrate Board Parameters

5）Introduction to the Thermal Conductivity:

Introduction to the Testing Principle of the ISO-22007 Flat Plate Method



The high accuracy of this method depends on

- **Unique probes**
- **Innovative mathematical models**
- **Specialized electronic data acquisition systems**

- Utilizing a thermally resistive material [nickel] as the probe, which also serves as both a heat source and a temperature sensor. The thermal resistance coefficient of nickel—the relationship between temperature and resistance—is linear, meaning that changes in resistance can indicate heat loss, thereby reflecting the thermal conductivity of the sample.
- In the test, the probe is placed between two samples for testing. When current passes through the nickel, its temperature rises, and the generated heat spreads to the samples on both sides of the probe. The speed of this thermal diffusion depends on the thermal conductivity characteristics of the material. By recording the temperature and the response time of the probe, the thermal conductivity coefficient of the material can be calculated.

3. Introduction of Aluminum Substrate Board Parameters

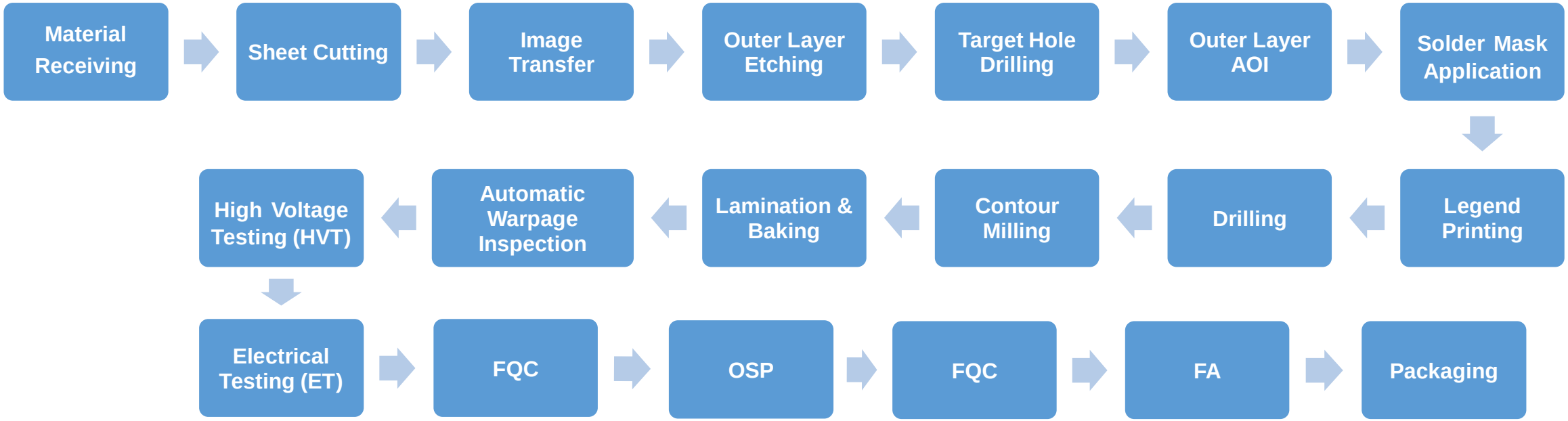
5）Introduction to the Thermal Conductivity:

Comparison of test data from different testing methods

Thermal Conductivity （W/m·K）					
Test Method			ASTM E1461	IS022007-2	ASTM D5470
Specimen Size(mm)			10×10	80×80	25.4×25.4
Specimen		Thk(mm)	60℃	25℃	60℃
A1	Film	0.213	1.376	1.942	1.321
A2	Al CCL	1.114	42.14	122.6	8.098
B1	Film	0.152	1.237	2.319	1.212
B2	Al CCL	1.067	46.11	120.8	8.736
C	CEM-3	1.552	0.921	△	0.803
D	Thermal FR-4	1.505	1.180	△	0.910
E	Normal FR-4	1.522	0.403	△	0.386
Remark			△-The samples are too thick, and its surface temperature is too high to be measured by the test instrument.		

Remark: Above data is the test result for reference only.

4. Introduction to the PCB Processing Flow of Aluminum Substrates PCB



Unlike traditional FR-4, the main component of aluminum boards is aluminum. Therefore, the biggest difference in the processing of aluminum PCBs compared to traditional non-metallic PCBs lies in the mechanical processing steps (drilling & shaping). The mechanical processing of aluminum boards requires different equipment and tools than those used for traditional PCBs.

Introduction to UGPCB Metal Substrate Capabilities

No.	Item	MCPCB Capability	
		Mass Production	Sample/Development
1	Layer Count	1-2L	1-4L
2	Laminate Supplier	Shengyi,Ventec, Boyu, Wazam, Doosan	Shengyi,Ventec, Boyu, Wazam, Doosan
3	Metal Substrate Type	Al Base, Cu Base	Al Base, Cu Base
4	Laminate Type	AL:SY SAR20H, SY SAR10S,Wazam HA88-T3, Boyu AL-01-B 20H , DOOS: DST-7000S Cu:SY SCR20S, VT-4B3, VT-4B3C, DOOS: DST-7000S	AL:SY SAR20H, SY SAR10S,Wazam HA88-T3, Boyu AL-01-B 20H, VT-4B2H, VT-4B5, DOOS: DST-7000S Cu:SY SCR20S, VT-4B3, VT-4B3C, DOOS: DST-7000S
5	Metal Base Thickness	0.4-3.2mm	0.4mm-3.2mm
6	Insulation Layer Thickness	50-150um	50-200um
7	Max Working Panel	600mm × 500mm	730mm × 550mm
8	Heat Conductivity	0.5W/mK-4.9W/mK	1W/mK、2W/mK、3W/mK、4W/mK、8W/mK
9	Hi-Voltage Test (vary according to minimum distance between trace and board edge)(VDC)	0.3mm：Voltage Resistance DC 600V/50UA 0.5mm：Voltage Resistance DC 1000V/50UA 1.0mm：Voltage Resistance DC 1500V/50UA	0.3mm：Voltage Resistance DC 600V/50UA 0.5mm：Voltage Resistance DC 1000V/50UA 1.0mm：Voltage Resistance DC 1500V/50UA
10	Breakdown Voltage (per different material type) (VAC) Ramp up 500V/S	4.0Kvac/4mil dielectric thickness	3.0Kvac/3mil dielectric thickness 4.0Kvac/4mil dielectric thickness

5. Introduction to UGPCB Metal Substrate Capabilities

No.	Item	MCPCB Capability	
		Mass Production	Sample/Development
11	Inner Layer Trace Width/Space	Min 0.1/0.1mm	Min 0.075/0.075mm
12	Outer Layer Trace Width/Space	Min 0.1/0.1mm	Min 0.075/0.075mm
13	Layer Registration	±0.05mm	±0.025mm
14	Copper Foil Thickness	HOZ,1OZ,2OZ, 3OZ,4OZ	HOZ,1OZ,2OZ, 3OZ,4OZ,5OZ
15	Min Finished Hole Diameter	0.70mm（≥Board Thickness）	0.60mm（≥Board Thickness）
16	Finished Hole Size Tolerance	NPTH:±0.05mm PTH: ±0.075mm	NPTH:±0.05mm PTH: ±0.075mm
17	Hole Position Accuracy(Compare with CAD)	±0.075mm	±0.05mm
18	PTH Wall Copper Thickness	≥20um	≥20-35um
19	Min Solder Mask Opening	0.075mm larger than hole per side	0.05mm larger than hole per side
20	Min Gap between trace and SM opening	0.05mm	0.05mm

6. Introduction to the Customer Base for UGPCB Metal Substrates

FORVIA

META SYSTEM

MARELLI

LEAR CORPORATION

asetronics

Honeywell
THE POWER OF CONNECTED

flex

JABIL

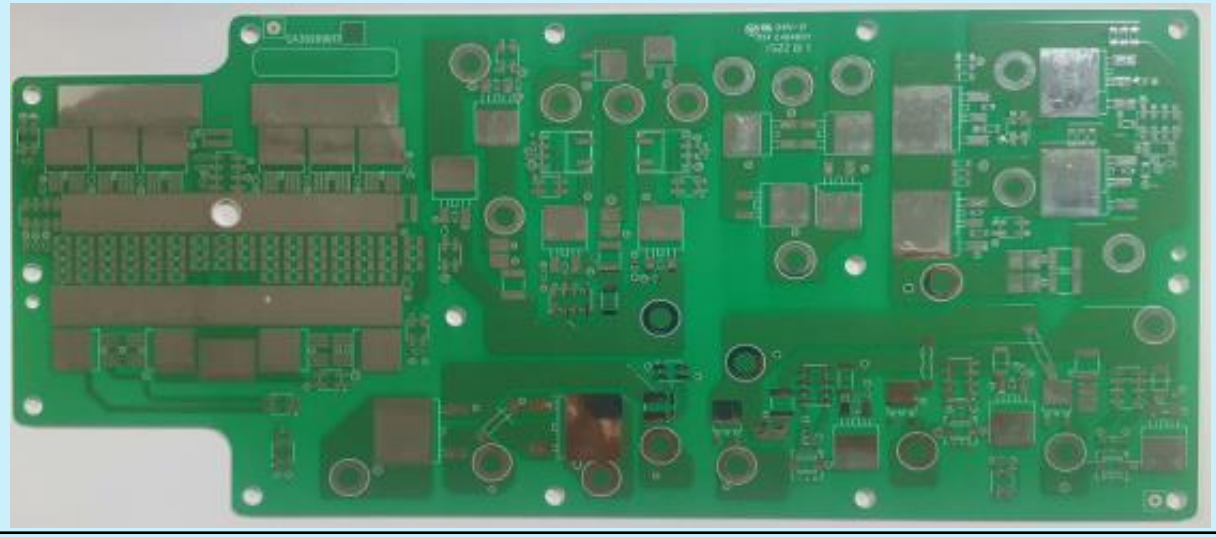
LUMILEDS

SNC 联域光电

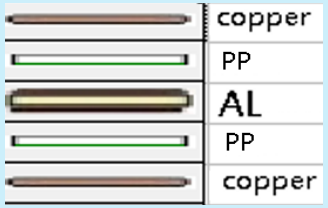
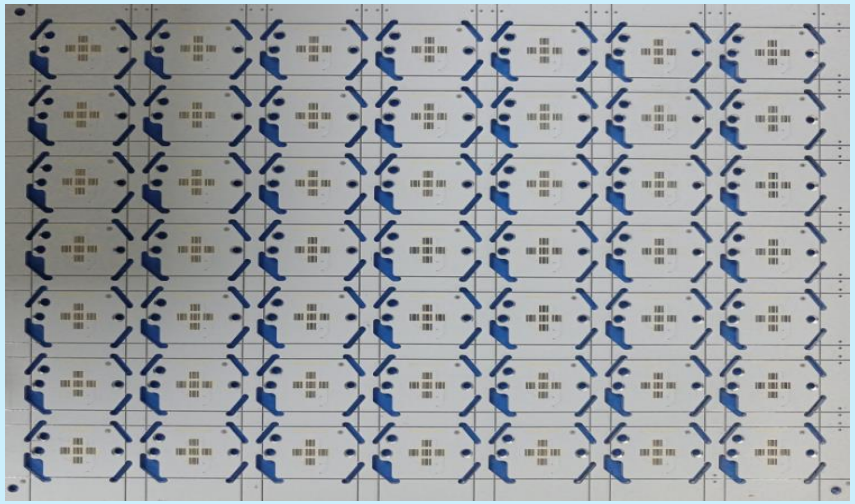
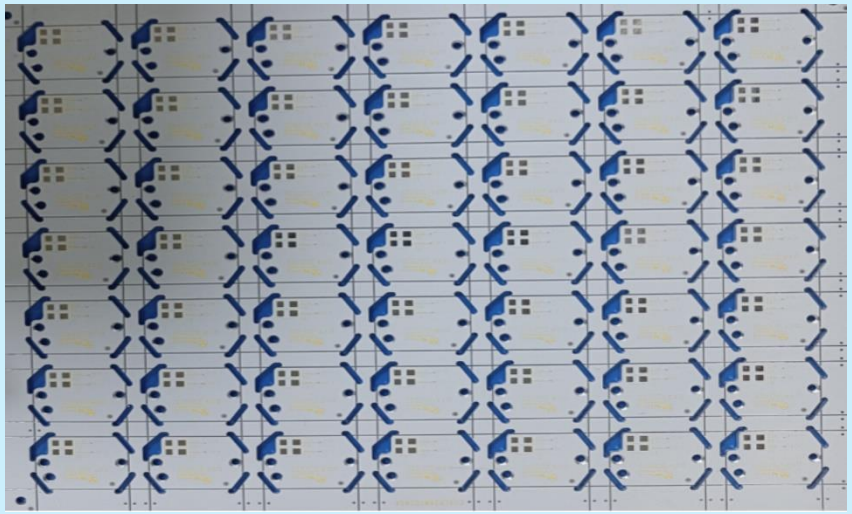
民爆光电® Up-shine Lighting

LatticePower (晶能光电)

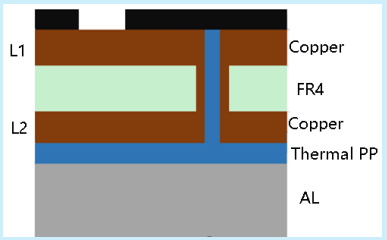
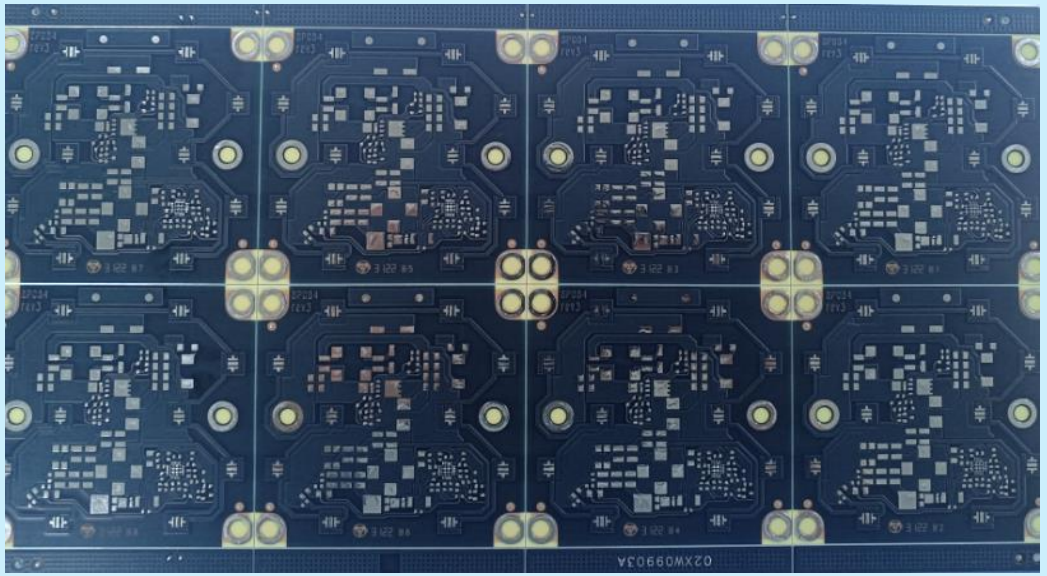
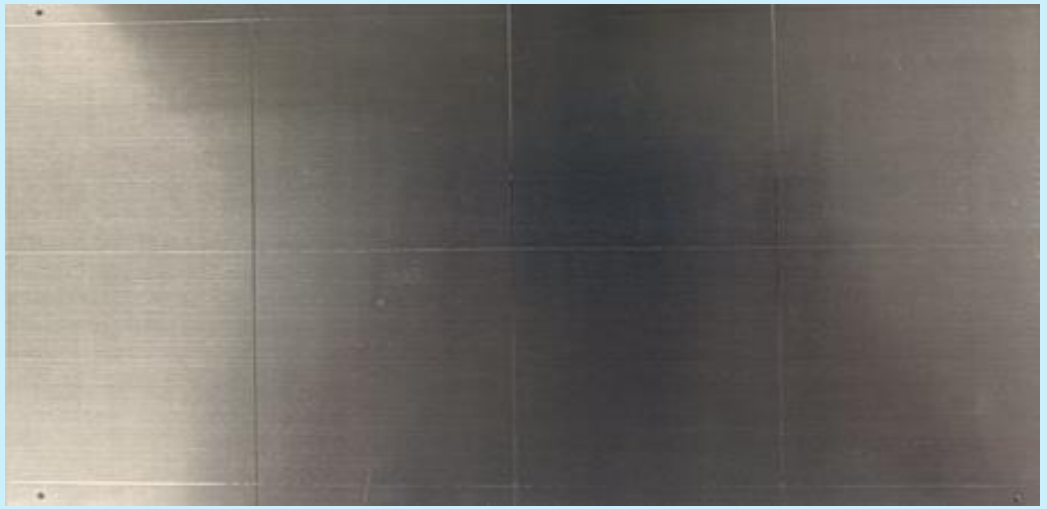
7. UGPCB Metal Substrate Product Display

Insulation Metal Substrate(IMS) PCB			
Layer Count	1 Layer, Al Base	TOP SIDE	
Application	Automotive lighting (Customer : Metasystem)		
Board Thickness	1.6mm+/-10% Al substrate 1.45mm		
Laminate type	Shengyi SAR20H	Bottom side	
Thermal Conductivity	≥ 2w/m·k		
Surface Finish	Lead free HASL		

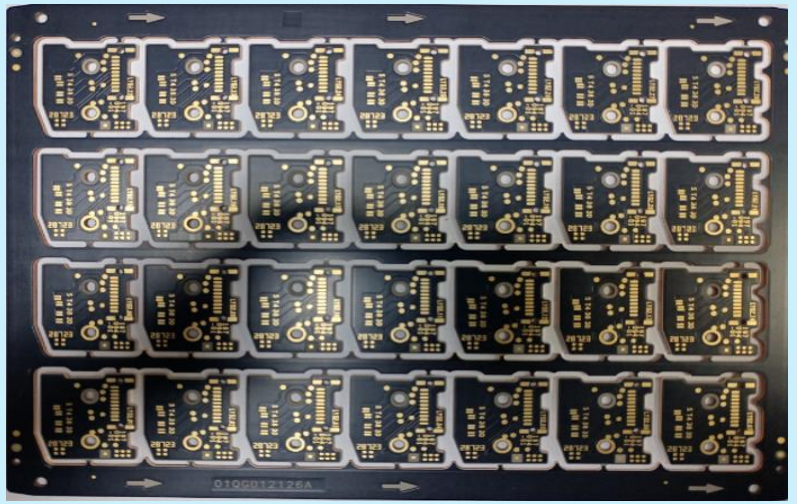
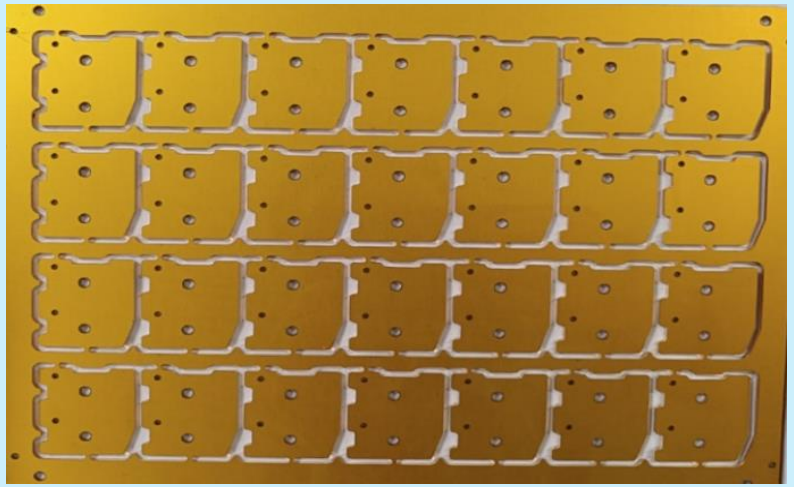
7. UGPCB Metal Substrate Product Display

Insulation Metal Substrate(IMS) PCB			
Layer Count	2 layer (Sandwich, Al Base) 	TOP side	
Application	LED lighting (Customer : Honeywell)		
Board Thickness	1.9mm+/-10%		
Laminate type	AL: 5020	Bottom side	
Thermal Conductivity	≥ 2w/m·k		
Surface Finish	Lead free HASL		

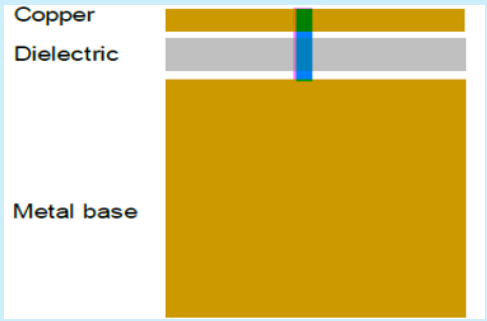
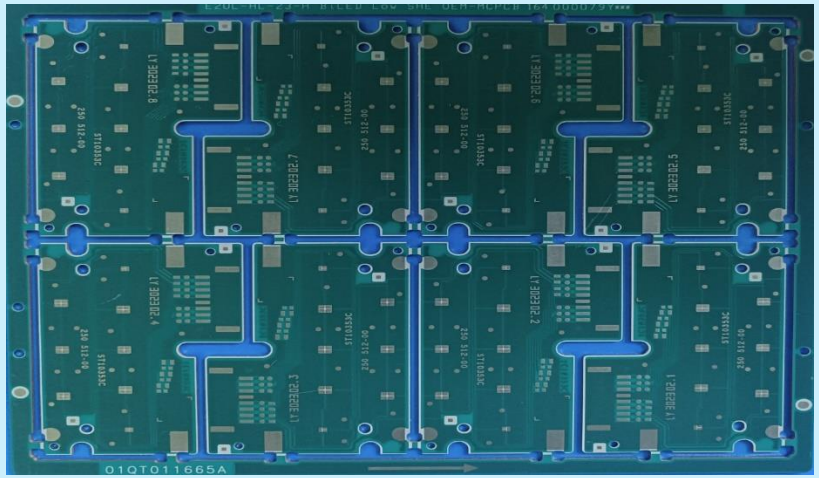
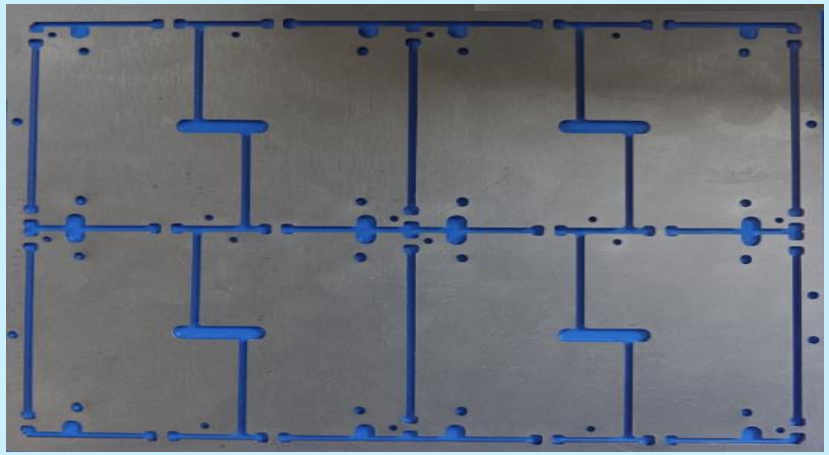
7. UGPCB Metal Substrate Product Display

Insulation Metal Substrate(IMS) PCB			
Layer Count	2 layer(Al Base) 	TOP side	
Application	Illuminating lamp (Customer : Jabil)		
Board Thickness	2.1mm+/-10%		
Laminate type	Polytronics pp + 5020 AL	Bottom side	
Thermal Conductivity	≥ 2w/m·k		
Surface Finish	Lead free HASL		

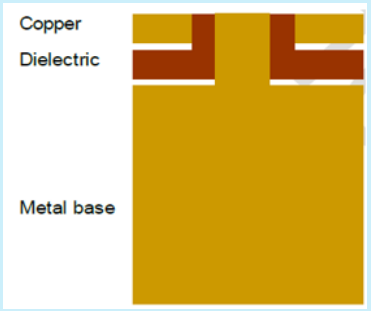
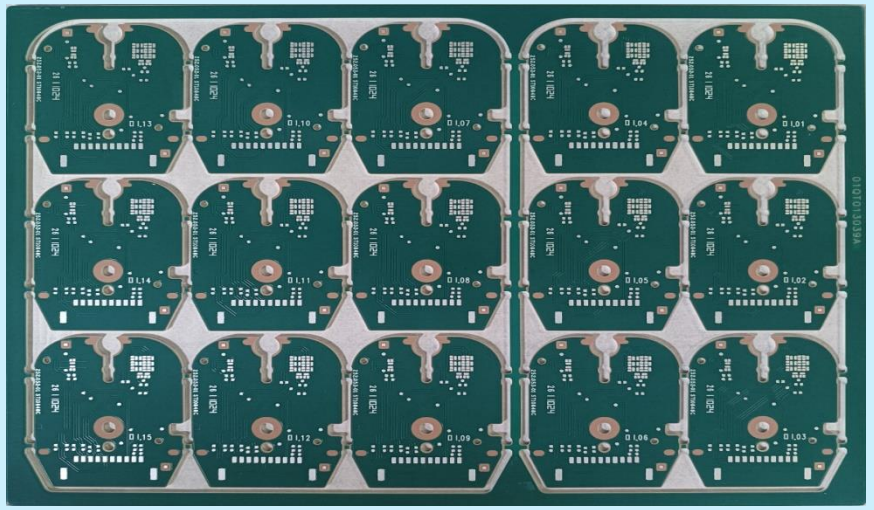
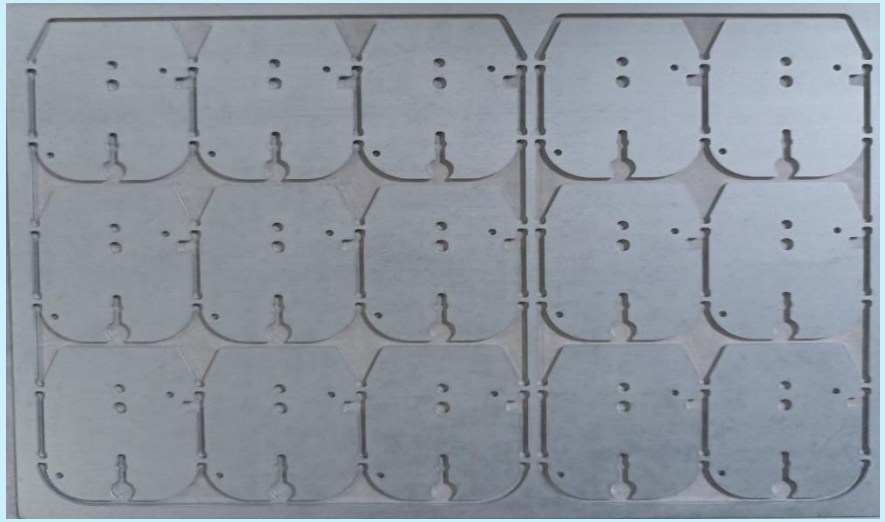
7. UGPCB Metal Substrate Product Display

Insulation Metal Substrate(IMS) PCB			
Layer Count	1 layer(Cu Base)	TOP side	
Application	Automotive light (Customer : Hella)		
Board Thickness	1.55mm+/-10%		
Laminate type	Shengyi SCR20S	Bottom side	
Thermal Conductivity	≥ 2w/m·k		
Surface Finish	ENIG		

7. UGPCB Metal Substrate Product Display

Insulation Metal Substrate(IMS) PCB			
Layer Count	1 layer (Cu Base, Laser drilling with filling plating) 	TOP side	
Application	Automotive light (Customer : Hella)		
Board Thickness	1.55mm+/-10%		
Laminate type	Shengyi SCR20S	Bottom side	
Thermal Conductivity	≥ 2w/m·k		
Surface Finish	Immersion Tin		

7. UGPCB Metal Substrate Product Display

Insulation Metal Substrate(IMS) PCB			
Layer Count	1 layer (Cu pedestal PCB) 	TOP side	
Application	Automotive light (Customer : Hella)		
Board Thickness	1.55mm+/-10%		
Laminate type	Base metal plate: C1100 Cu	Bottom side	
Thermal Conductivity	≥ 380w/m·k		
Surface Finish	Immersion Tin		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