SUNWAY COMMUNICATION

The Global Leading One-stop RF Solution Provider

3D-MID @ Sunway Communication

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Content

3D-MID Capabilities

More than 20 years experience of global 3D-MID R&D and Manufacturing

Sunway Communication 3D-MID+ = Simulation, Design for Manufacturing, Tooling, Automation, Product Qualification, Manufacturing, Electronic Assemblies + Integration/connectivity to other components and mechatronic modules, like overmolding, inserts, bonding, cable connection, SMT, PCB, FPC, …

Industry Camera Sensor Frames	**Medical Device** Connectivity Module	**Secure Payments Terminal** Security Cover	**Pet Tracker** Connectivity Antennas	**Automotive** Conformal Antennas	**Smartwatch** Connectivity Antennas	**High-end Smartphone** 5G Antennas	**Laptop Computer** LTE MIMO Antennas	**Macro Base Station** 5G Antenna Array
T&R packaging SMT mounting	3D connector bumps Ø 0.15 mm vias >1000h @ 90°C / RH 90%	0.05 mm line+0.05 spacing 14 m plated lines >1000h @ 85°C / RH 85%	Device cover integration LoRa system frequencies O-shape clip antenna feed	TCU cover LDS integration Also FPC, sheet, PWB ant. Cell+WiFi+BT+GNSS+SDARS	Bluetooth+GPS Spring clip integration	Insert molding Laser welding PCR materials	Soldered cable SMT connectors PCR materials	Sub 6 GHz bands Radiator&transmission line Low weight vs. sheet metal
Part A: 3 x 3 x 3 mm Part B: 8 x 9 x 0.8 mm Part C: Ø 6 x 7 mm	15 x 10 x 1.5 mm	50 x 60 x 10 mm	25 x 25 x 5 mm	150 x 280 x 30 mm	Ø 35 x 4 mm	50 x 75 x 4 mm	250 x 8 x 5 mm	300 x 300 x 11 mm

3D-MID – Reliability and Costs

Robustness

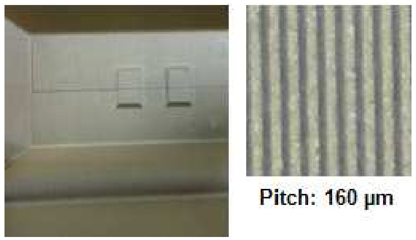
- High robustness of the circuits against environmental life tests was achieved. High adhesion of the metal layer. No circuit cracks.
- Qualified PEEK, LCP, PA, PPA, PET, PC/PET, PET/PBT and their blends for automotive application. Automotive test with 85°C/ 85% RH more than 1000 h passed without any cracks or delamination
- Reflow solderable material up to 260°C are available
- Materials for temperature cycling test -40 to 140 °C are available

Bondability

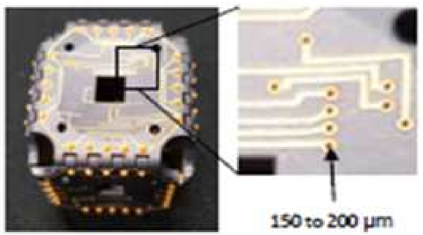
- Reliable bonding with 25 µm wires without any substrate pretreatment (achieved low roughness of the plated surface)

Cost efficiency

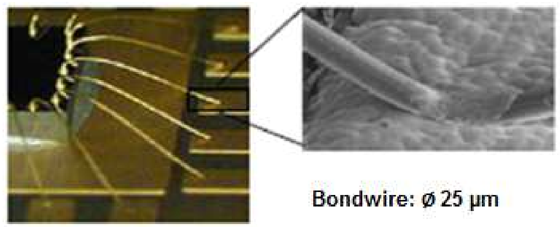
- Cost of MID went down due to sophisticated and automated processes with high yield rate and production in low-cost countries



Pitch: 160 µm



150 to 200 µm



Bondwire: ø 25 µm

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Selective Plating Technologies Used at Sunway

No		Description
1	POP	• Plating on Plastic • Used to plate big surfaces, e.g., for shielding, cosmetic etc.
2	2S (2K)	• Two Shot Moulding • Used for high volume series and big circuit structures (> 400 μm) • Mainly for antennas
3	LDS	• Laser direct structuring (LPKF-Process) • Used to create 3D circuits (line/spacing approx. 100 μm/100 μm) • Antennas, Sensors, Switches etc
4	LSS	• Laser Subtractive Structuring • Used for parts where the plated area of the part is bigger than the isolation area (in this case more economical than LDS)
5	LAP	• Laser – Activation (palladium) – Plating • Capability to plate circuits on non-LDS-Material (thermoplastics and thermoset materials which do not have additive inside). The costs for these materials is 2 to 8 times lower than LDS materials
6	LSCA	• Laser Structuring – Chemical Activation • Capability to plate circuits on thermoplastics, glass, ceramics, PET etc.

Other plating technologies: PVD Physical Vapor Deposition, Photolithograpy, Electroplating

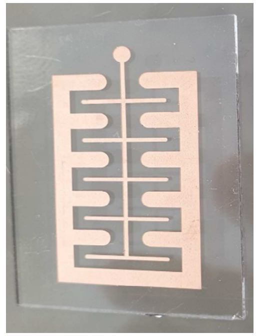
The LSCA Process

- LSCA (Laser Structuring Chemical Activation)
- New process for selective plating of non-LDS-materials
- Capable of plating on plastics, glass, ceramics etc.

Laser Structuring → Chemical Activation → Chemical Cu-Plating → Chemical Ni-Plating → Chemical Au-Plating

Specific process steps | Standard process steps

Plating on Plastics


Plating on glass

- LSCA vs other plating processes

	Substrate Materials						Structure		Geometry	Costs
Process	Biocom-patible	Trans-parent	Other plastics, resins	PET films	Glass	Ceramic	Surface Roughness	Line width	3D	Production cost
LDS	No	No	Yes (with additives)	No	No	No	20 to 30 µm	80 µm	Yes	Standard LDS
LAP	Yes (with limitation)	No	Yes	No	No	No	20 to 30 µm	80 µm	Yes	Lower than LDS
PVD	Yes	Yes	Yes	Yes	Yes	Yes	1 µm	10 µm	No	High
LSCA	Yes	Yes	Yes	Yes	Yes	Yes	2 to 3 µm	5 µm	3D	Similar to LDS

The LSCA process is not simply an improvement on the processes currently in use, but an obvious **Disruptive Technological Leap** in terms of the manufacturing of 2D and 3D substrates

Process main differences

Main production differences of the 4 processes:

1) **Lds**: Laser Direct Structuring. This is the standard LPKF process and is used for most 3D-MID parts. This process needs an additive in the plastic, and this additive is activated by laser, so that Cu plating can be initiated. Materials with LDS additive are more expensive than the same materials without additives (**cost factor 2 to 8 times more expensive**)

2) **Lap**: Laser-Activation-Plating. This process uses Palladium after laser structuring instead of additives inside the plastics in order to activate the laser structured area. The plastic material costs for this process is cheaper than for LDS (but the selectivity during the plating is not as good as LDS : non laser structured areas (if they are rough) could also be plated.

3) **Lsca:** Laser Structuring – Chemical Plating. This process is similar to LAP, but it uses a special chemical for the activation instead of palladium. The costs are similar to LAP, but the selectivity is better : no plating of non laser structured areas. And this process is able to create circuits also on **glass and ceramics substrates** (not only **non-lds plastics**)

4) **Pvd:** Physical Vapour Deposition. It is normally used for full coating. But it can be also used to create a circuit by using masking of the areas which should not be plated. This process is established since long time, but **it is expensive**

LSCA vs. PVD

PVD is used for full surface plating using different metals as coating layer (e.g., plating of a watch housing).

PVD can be used also to create a circuit on a substrate. In this case a masking of the non-plated area is required, this makes the process very expensive, and the 3D masking is difficult, so that it is used for 2D circuits only.

LSCA doesn’t compete with PVD when it comes to full surface plating, and when it comes to different metal coating layers.

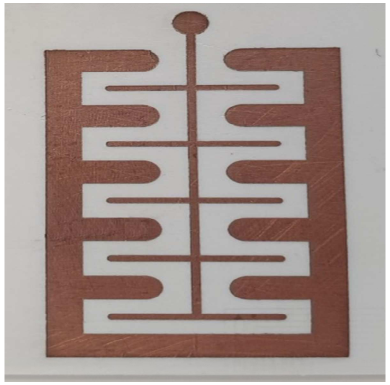
LSCA competes with PVD, when it comes to creating a circuit on 3D and even on 2D Substrates. The costs are in this case much lower than those of PVD. The first metal layer is always Cu. Other metal layers can be created on top of Cu (typically NiP plus Au)

Surface roughnesses (Rz) with the LSCA process are about 2-3 microns. The adhesion is very high (depends on the substrate, but 3 to 10 times higher than normal plating on PCB)

LSCA - Capabilities

The new process can achieve:

- Conductive traces on all thermoplastic materials incl. biocompatible and semi-transparent used in consumer electronics, automotive, medical devices
- Conductive traces on most thermoplastics and non-thermoplastic materials used in consumer electronics and automotive incl.:
  - **thermosets** -> for electronic chip packaging
  - **glass** -> invisible antenna patterns on displays or small windows
  - **PET** -> antennas and circuits on flexible substrates
  - **ceramic** -> circuits and electronic assemblies for high temperature applications
- surface roughness **2.5-3.0 µm** (surface roughness can be reduced to less than 1 µm if required)
- Trace width **5.0 µm**
- Vias diameter **Ø40 µm** (and lower if needed)
- Typical plating: Cu-NiP-Au

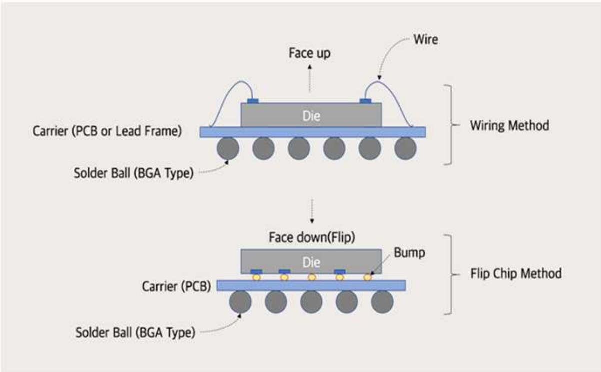
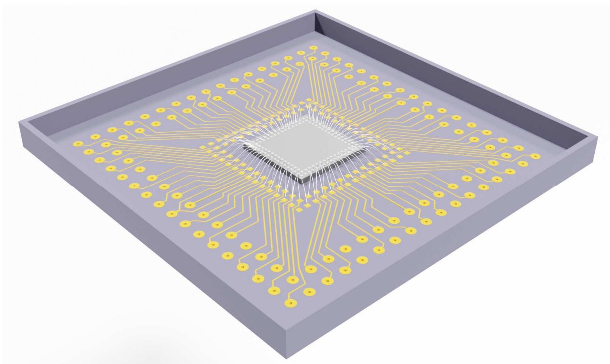
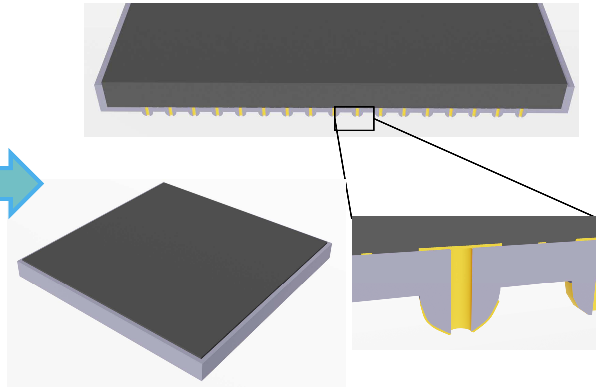


Plating on biocompatible Materials

Material	Adhesion in N/cm^2
LCP	1600
Glass	2700
Ceramic	728
PET	678

Requirement for standard PCB: 200 N/cm^2

Example – 3D-MID for Chip Packaging

	Die Attachement	Housing
Traditional Packaging		
3D-MID Packaging		

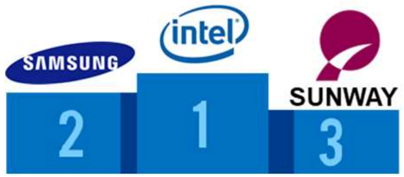
- Carrier (incl. Leadframe and solder balls or connecting pins) can be replaced by a single 3D-MID substrate
- The 3D substrate builds also the housing for the whole package (and can be overmolded with the same material/thermoset or thermoplast)
- The Housing can be also used to integrate additional functions without additional costs (e.g antennas, which can be structured and plated on the substrate/housing)

Sunway Communication – Overview

- Public company: Part of MSCI China (300136.SZ)
- Employees: 10,000 worldwide
- Revenues: USD 1 Billion
- Key certifications:

ISO 9001	Quality management
ISO 13485	Medical devices
ISO 14001	Environmental management
IATF 16949	Automotive quality management
ISO 17025	Testing and calibration labs
ISO 18001	Health and safety management
ISO 27001	Information security management

- R&D investments: 9%
- Patent applications: 1,583 (through 2020)



*Granted 5G Antenna Patents Worldwide**

** Source: Yole Développement/KnowMade report*

Acronym plastics

PCR = Post-consumer recycled

PEEK = Polyether Ether Ketone -> organic thermoplastic polymer

LCP = Liquid Crystal Polymer

PA = Polyamide

PI = Polyimide

PPA = Polyphthalamide -> high performance polyamide

PET = Polyethylene Terephthalate

PC/PET = Polycarbonate/Polyethylene

PET/PBT = Polyethylene/Polybuthylene

BIOCOMPATIBLE medical grades of PVC Polyvinyl Chloride , PET Polyethylene, PEEK, PC Polycarbonate, PEI polyetherimide , PSU Polysulfone, PP Polypropylene, PU Polyurethane, ABS Acrylonitrile Butadiene Styrene

Acronyms

3D MID = 3Dimensional Mechatronic Integrated Device

LTE mimo = long term evolution multiple input multiple output antenna

TCU = transmission control unit automotive

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Thanks!