



Conductive copper ink for additive electronics -
sustainable circuit boards

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Transforming the foundation of circuit boards

Copprint provides conductive copper inks, enabling additive fabrication of circuit boards.

Substituting incumbent technologies:

- Silver inks: 5-10x more expensive
- PCBs etching: hazardous, polluting, and more expensive



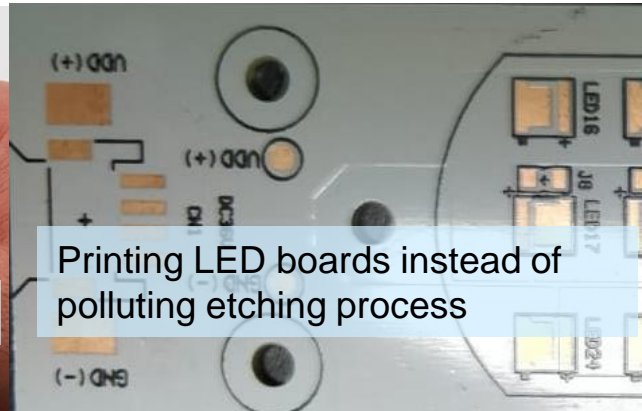
Proven fundamental technology – enabler for additive electronics



Nonpolluting PCB manufacturing
in US/Europe



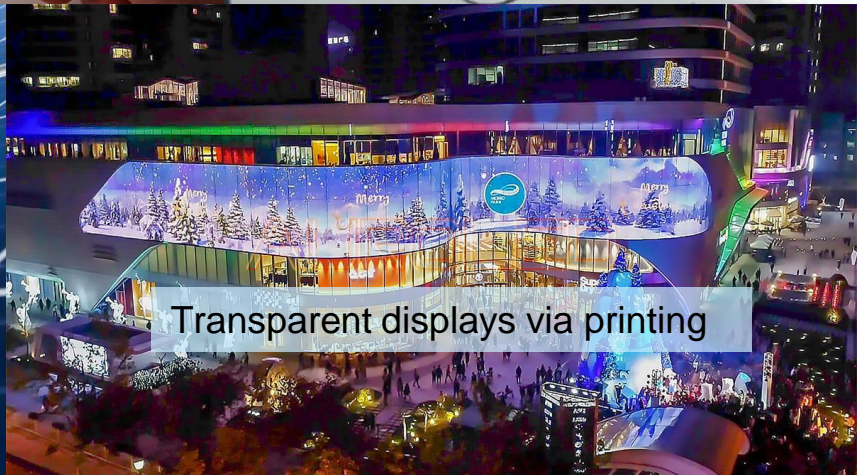
Compostable RFID antennas



Printing LED boards instead of
polluting etching process



20% less expensive Photovoltaic modules

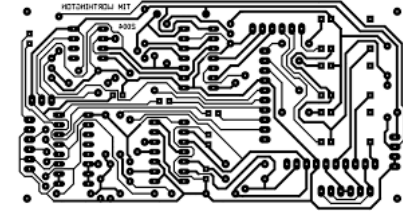
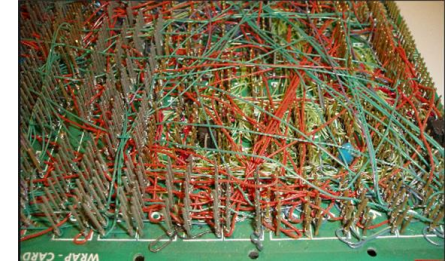
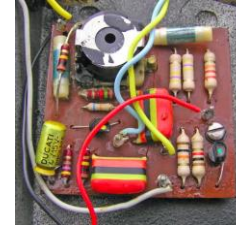


Transparent displays via printing

Conductive element is the basis of any circuit board

Base manufacturing process haven't changed for years:

- Up until 100 years ago the conductive element was wires
- 1920s - First PCBs (printed circuited boards) used **conductive Silver inks**. Printing = Additive Manufacturing
- 1950s - PCBs transition to **copper etching**.
Subtractive manufacturing process to chemically cut copper foils.
This is a highly polluting process.
- Today, PCBs evolved to multi-layers and high density
- ~90% of the PCBs are made in APAC.



Can we make **less expensive** circuit boards ?

Can we manufacture circuit boards in a **non-polluting way**?

Can we manufacture circuit boards in **Europe or USA**?



Copprint is transforming the foundation of circuit boards

>\$70bn PCB **etching** processes

Material Waste / Hazardous/ Limited Substrates/
Highly polluting/ mainly in China/Malaysia.

RFIDs
PCBs
Connectors
Displays
LED lighting boards

Subtractive Conductive Pattern + Material Waste



>\$3bn Printed Electronics

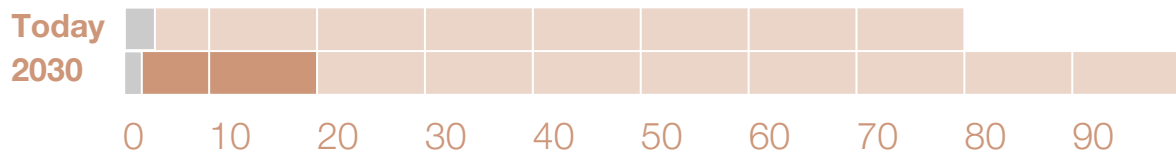
Currently - **Silver Inks:** Expensive & Hazardous

PV cells
Automotive Heaters
Sensors
Membrane switches

Additive Printing Conductive Pattern Only



Market \$B's



Copprint



Silver inks

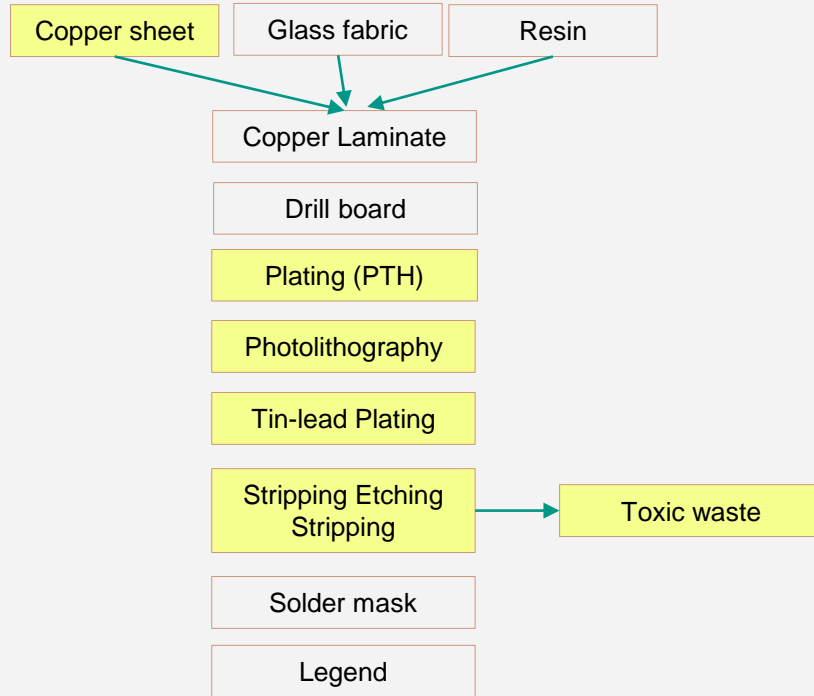


Copper inks

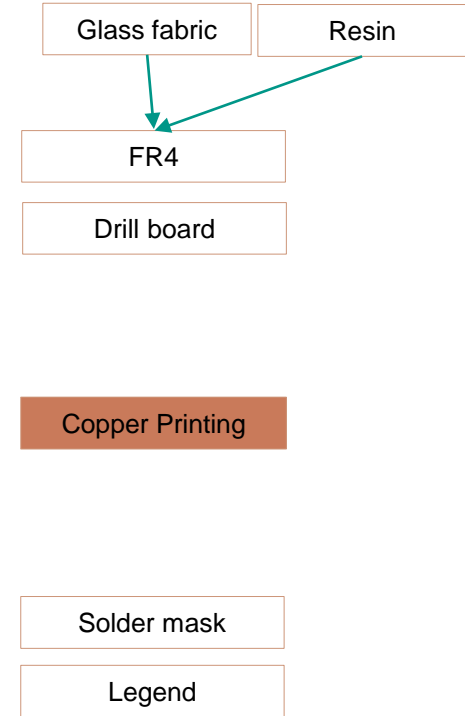


PCB's (Etching)

How 2-sided PCBs are made today - Subtractive



New paradigm - Additive



Additive Manufacturing of Electronics

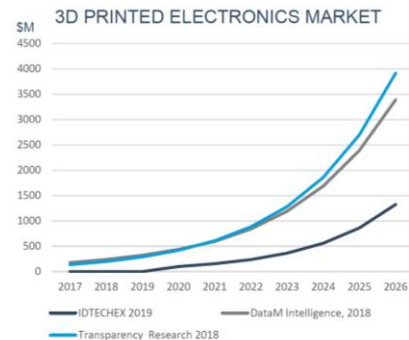
A new market of Additive electronics aka 3D printed electronics is evolving

Multiple technologies are used to print the conductive pattern:
From standard screen, flexo, gravure printing to digital technologies such as Inkjet, Extrusion, Aerosol jetting, LAD (Laser Assisted Deposition)

Key required features:

- **Fast** and **cost-effective** process
- **High resolution** – thin-lines
- Through via-hole printing. (for 2+ layers of PCB)
- **The right printing material** – high conductivity, inexpensive, solderable, good intermetallic connection

High conductive copper ink is the key to this market



Silver vs. Copper

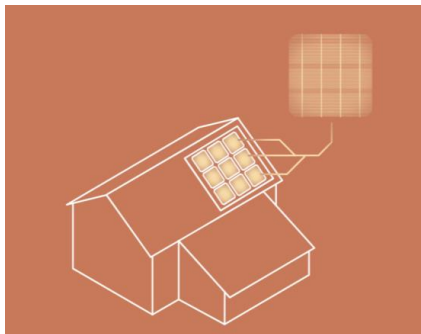
Conductive silver inks are used since 100 years ago for many applications:

E.g. Photovoltaics, Membrane switches, sensors, heaters and more

Silver is expensive and recently **surged >60%** relative to its 5-years average.

The cost of silver is a significant ingredient in various products:

- 10-30% of PV modules.
- >80% of membrane switches, flexible heaters, sensors.



Copper is a great alternative



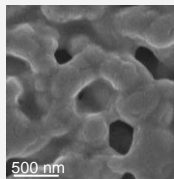
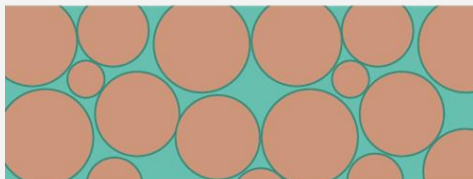
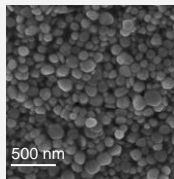
Raw material comparison:	Silver	Copper	Copper vs Silver
Price per Kg	\$850	\$8	100X cheaper
Conductivity	$1.59 \times 10^{-8} \Omega m$	$1.68 \times 10^{-8} \Omega m$	5% less conductive
Carbon footprint	155 kgCO ₂ /kg	3.97 kgCO ₂ /kg	40X better
Max level in drinking water (EPA)	0.1mg/litter	1mg/litter	10X less toxic

For many years people tried to print copper and failed

Motivation: raw copper is 100x cheaper than silver

Problem: **Copper oxidation** prevented conductivity

Copper Oxidation, Impeding Conductivity



Copprint Chemical Rapid Sintering

The Innovation

Copprint overcome the copper oxidation using a patented chemical sintering agent:

- Rapid low temperature Sintering which Prevents Oxidation
- Highly Conductive results
- Low Cost, Efficient (No Material Waste)
- Substrate Freedom
- Standard “Air” Printing Process & Equipment

Copper inks that outperform Silver

Anything you can print with conductive silver inks,

**Copprint can do better. Faster.
At a fraction of the cost.**

Copprint screen-printing pastes for a range of substrates:

LF-300 – paper substrate

LF-350 – PET substrate

LF-360 – Low temp for PET/PC

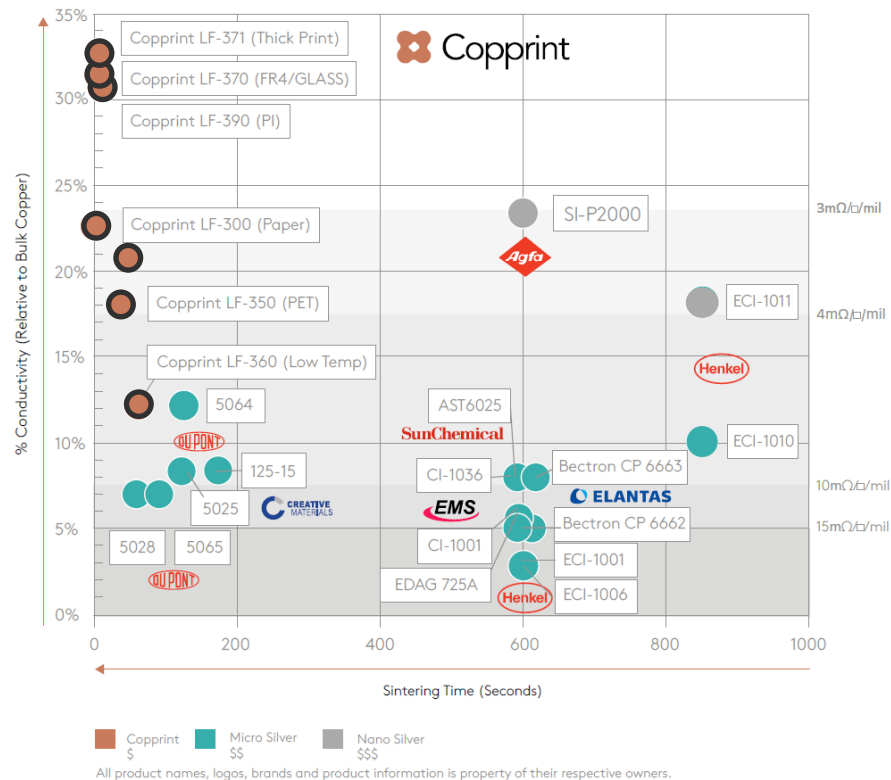


LF-370 – FR4 substrate

LF-371 – Thick printing (FR4, PV, Glass)

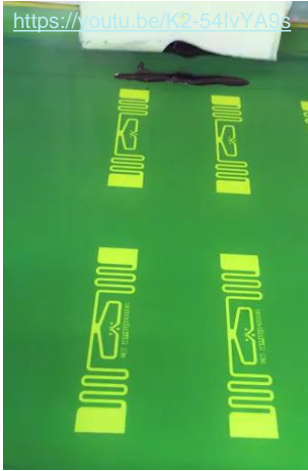
LF-390 – PI substrate

Additional substrates: Alumina, Aluminum, PEN, CFRP, Tesline



Really Simple Fabrication (Prototyping, Short Runs)

1) Print



Screen printing in
few seconds



2) Dry



Drying oven/conveyor/UV
Oven/Conveyor: 30-120 sec at 70-150°C
NIR/UV lamps – 1-5 seconds

3) Sinter



<https://youtu.be/Hd5vRxigODs>

Standard hot-press/contactless Laminator
140-300°C
Laminator – 3-12 sec dwell time
Hot-press – 30-240 sec

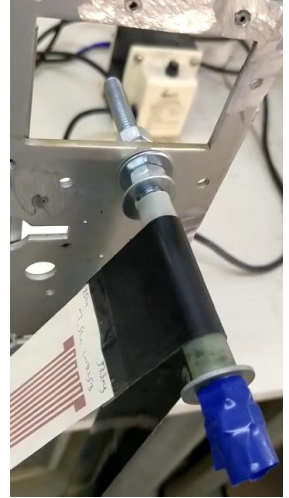
Muhlbauer APS tailored to Copprint ink

Industrial Scale Antenna Printing Solution



Durable printed patterns on multiple substrates

- ✓ Paper, PET, PI, Teslin, Aluminum, Alumina, FR4, Glass, PV cells
- ✓ Accelerated durability tests (90°/60%, 85°/85% tests)
- ✓ Excellent adhesion
- ✓ Crosshatch test – 4-5b
- ✓ Bending tests (25x rolls over 5mm radius rod, <10% change).
- ✓ Solderability



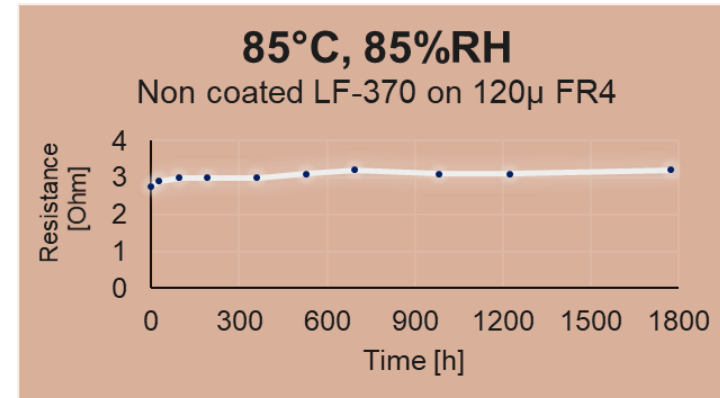
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LF-350 on PET

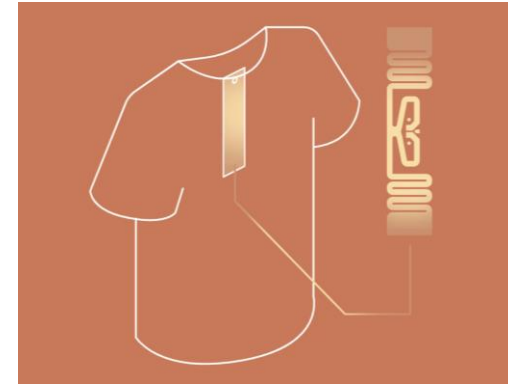


LF-370 on anodized aluminum



Example 1 - Printed RFID antennas on paper

- RFID antennas are the simplest and largest by number PCBs -
- ~23B units in 2020
- Today: Etched antennas: polluting manufacturing process leading to non-eco-friendly tags (Plastic + Aluminum).
- Copprint: **Compostable and less Expensive** printed RFID antennas
Paper + Copper



RFID	Etched Aluminum on Plastics (PET) (>90% of the market)	Copprint Printed Nano Copper on Paper
Manufacturing	Highly polluting (China and Malaysia)	Simple printing
Turnaround	6 weeks	1 week
Tag disposal	NON recyclable: Plastics, Aluminum High volume, small pieces	Compostable, Green RFID Paper, Minimal copper traces
UHF antenna cost	0.2-0.6¢	Up to 30% cheaper (depending on geometry/volume)
NFC antenna cost	1¢	<0.4¢

Example 2 – Printed heaters on PET

Application:

Seat heaters, interior panel heaters, battery heaters, defoggers

Today – most heaters are made using silver inks.

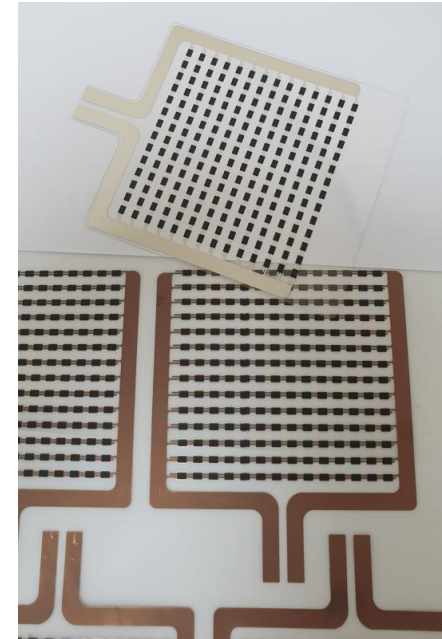
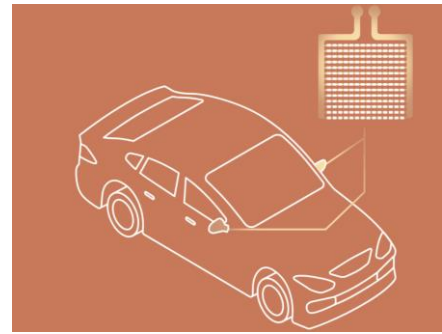
With copper:

Same design

Better electrical properties -> less material

Same performance

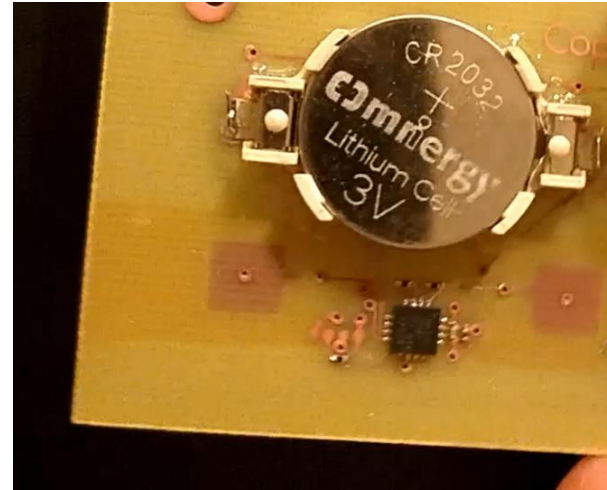
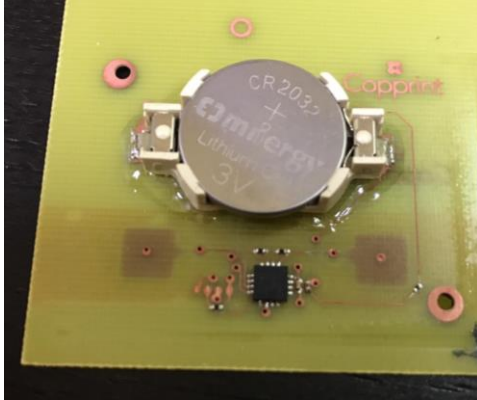
5-10x less expensive



Example 3 – Simple production of 2-sided PCB Printing Copper on FR4

Instead of polluting etching process:

- Screen Print through the via-holes
- Screen Print side 1 ; Screen print side 2
- Short drying
- Sintering via hot-press



<https://youtu.be/mnsLalBA5iA>

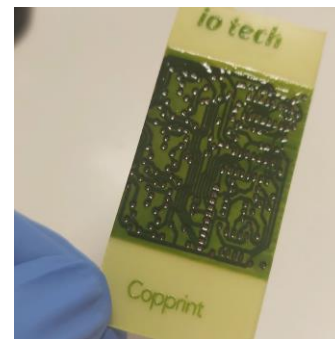
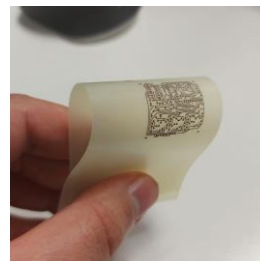
Example 4 : 2-sided PCB using Laser Assisted Deposition

- Collaboration with ioTech www.i-o-tech.com
- High throughput – 7x7cm 2-sided PCB on FR4 <15 min.
- Via hole printing
- Multi-material & multi-layer
- Solder paste deposition
- High resolution - 60 μ lines @25 μ height
- Digital direct-writing & post-processing



Beta testing 2021

Availability 2022



2-sided PCB on FR4 + solder mask
3x9cm <3 min print time



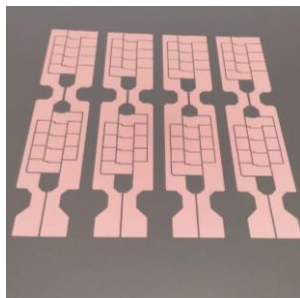
Example 5 – Printing copper on Glass for LED transparent display boards

Instead of polluting etching process:



Example 6 – Printed copper traces on anodized Aluminum for LED- baseboard

Instead of polluting etching process:



Pre-cut anodized aluminum

Copper printing

SR Printing

LED SMT

Assembly

Testing



ipss.co.kr



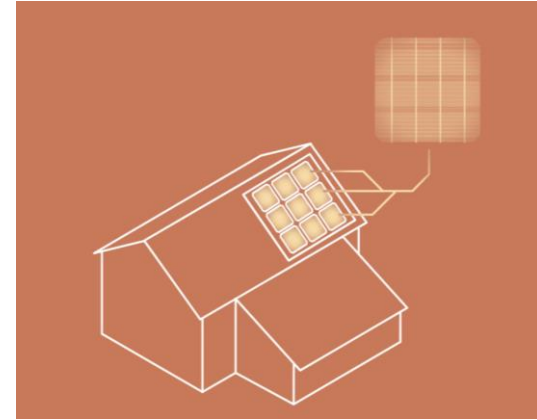
Example 7 – Printed copper traces on PV wafers

Silver inks used in PVs are made comprise 20-30% of the PV module cost

Copprint already demonstrated high-efficiency working HJT and IBC (23% efficiency) PV cells with >10% \$/watt cost saving per module!

Passing DH2000 (85°/85%, 2000 hours) , TC400 (-40°:+85° x 400 cycles)

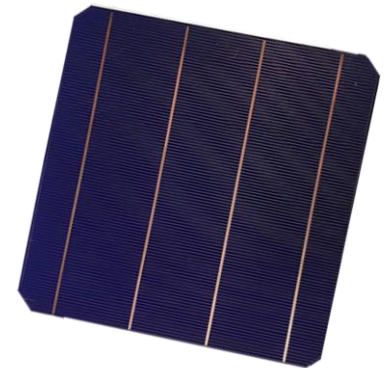
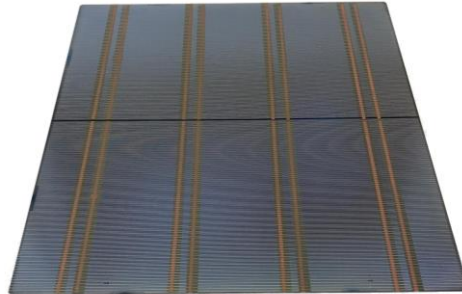
Dramatically reducing cost / Accelerating green energy sources.



IBC cells in collaboration with:



International Solar Energy
Research Center Konstanz



Why Copprint inks are so attractive?

Focus on price/performance.

Example: comparing two pastes with similar solid-content

	Sheet resistance ($\text{m}\Omega/\square/25\mu\text{m}$) ↓	Price per Kg ↓
Copper paste	3	€310
Silver paste	8	€900

Cost performance ratio is $(900 \cdot 8) / (310 \cdot 3) = 7.7X$



Conductive paste parameters:

Cost ↓

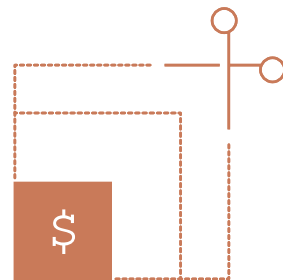
Conductivity ↑ (sheet resistance ↓)

Solid content ↑

Minimum layer thickness ↓

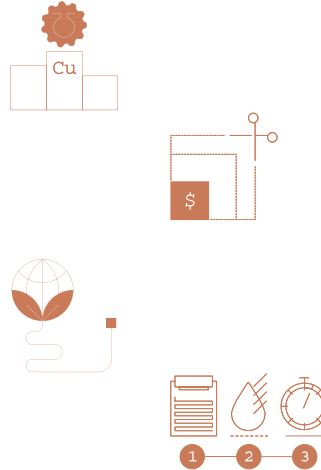
↓ - lower is better

↑ - higher is better



Summary - Conductive copper paste

- Higher conductivity
- Less expensive
- Higher sustainability
- Simple fabrication



Make the switch before your competitors do !

For orders and further information: www.copprint.com



Copprint Strategic Investors

Founded: 2016

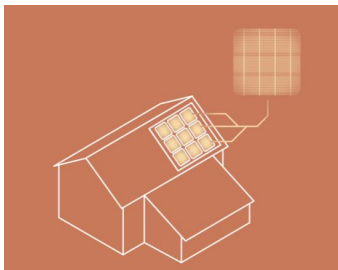
All product are available in stock
Annual Production capacity >12 Ton



TATSUTA

In 10 years Copprint products will be:

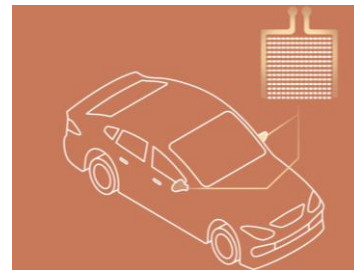
On every roof...



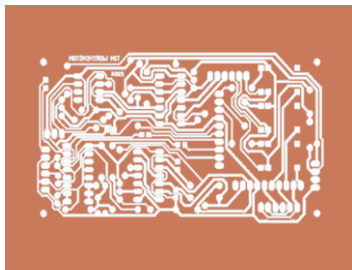
On all merchandise...



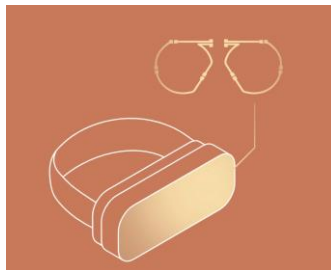
In every car...



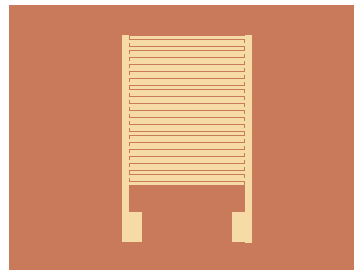
In every circuit board...



In every gadget...



In every sensor...





Thank you.