Technology for repairing broken metallic connections in thin film electronic circuits (open defect repair)

shaping global nanofuture

Market segments where open-defects are present

- solar cells
- displays TFT/LCD/OLED
- integrated circuits (IC)
- printed circuit boards (PCB)
- multichip modules (MCM)
- photolithographic masks

Current solution:

LCVD (Laser Chemical Vapour Deposition),
DLD (Direct Laser Deposition), FIB (Focused Ion Beam)

Current technology

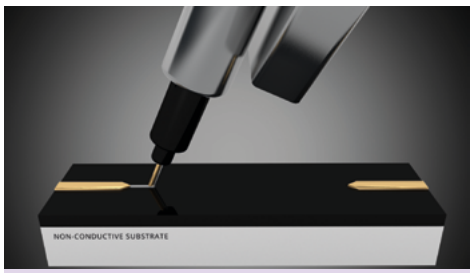
- extremely complex (LCVD, FIB)
- limited possibility to obtain 10 µm and less (LCVD, DLD);
- destruction of the active systems in integrated circuits (FIB)
- uses toxic and hazardous gases (LCVD)
- long processing time (LCVD, FIB, DLD)

Comparison with current methods used for open defect repair

Parameter	FIB	LCVD	XTPL* (initial lab results)	Impact on
Minimal feature size [um]	< 0.05	> 5	0.2 – 10	flexibility of process
Deposition rate [um^3/s]	0.05	10	50	throughput
Maximal line length	<100 um	mm range	cm range	flexibility of process
Vacuum chamber required	yes	yes	no	process cost and throughput
Toxic / dangerous gases / media required	no	yes	no	process cost and throughput
Surface damage	yes	yes	no	flexibility of process
Price	$$$ high	$$ medium	$ low	process cost

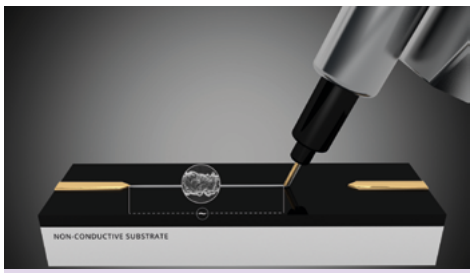
XTPL process for ultraprecise printing of conductive lines in nano-scale:

XTPL's solution has all the features of a so-called 'disruptive technology'. The printing system designed by XTPL makes it possible to precisely apply to the printing surface a special ink formulated for this purpose in the company's laboratories. Under the influence of an external electric field, the nanoparticles in the ink create conductive lines according to the specified parameters. As such, the thickness of the individual lines (even up to 100 nm), their length and the distance between them all vary depending on a specific application.



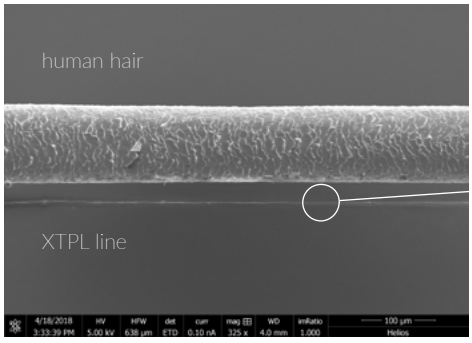
During the process of line formation, the printing head deposits a properly formulated ink - nanoparticles in a mixture of solvents - on a non-conductive substrate, in example such as glass or flexible foil.

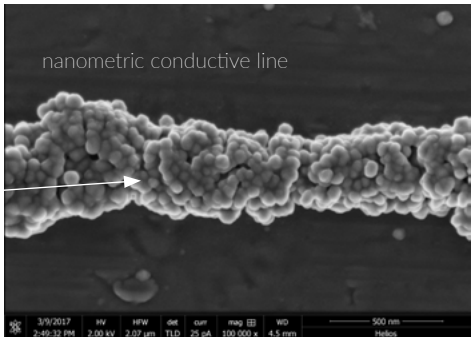
An external alternating electric field causes nanoparticles to assemble in a clearly defined and controlled way to form a line. The process takes place between a stationary and movable electrode.



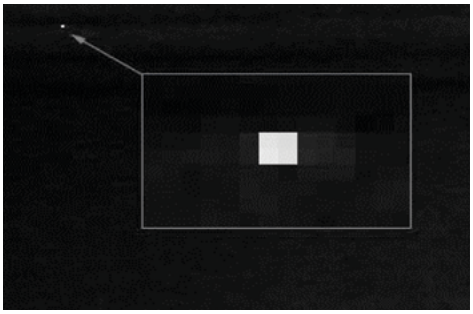
Movable electrode: guides the formation of the line, which becomes an extension of the stationary electrode. Finally, the printing head short-circuits with a metallic pad, and the line connects to the pad while the printing head takes in an excess ink.

The width of XTPL's conductive lines printed using the dielectrophoretic force range from even below 100 nm to 3 um. Here example of silver electrically conductive line compared to a human hair.





XTPL developed technologyfor repairing defects in electrical connections in micrometric & nanometric scale, which together with the optical detection systems already used on the market will provide a comprehensive solution to repair the broken thin conductive lines already in production stage, without complicated, slow and expensive vacuum processes.

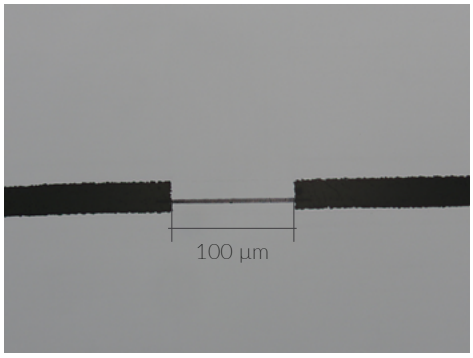


Initial achieved specification for open defect repair

Geometrical Requirements	
Width	0.35 – 3 µm
Thickness	0.35 – 3 µm
Length	20 – 200 µm
Electrical Requirements	
Resistance per unit length	2 Ω/µm
Electrical load test	withstand >1.2 mA
Mechanical Requirements	
Change of trace resistance after Scotch tape test	<0.005%/µm

Example of repairing open defect using XTPL printing method.

Here a 100 µm open-defect gap is bridged using the XTPL printing of <1 µm wide silver line.



Value Proposition

REQUIREMENTS

There is a demand for **a new technology** for repairing damaged conductive structures →

- increased total length of the conductive lines
- cost-effective repair of the severed lines
- reduced width of the printed conductive lines with concurrent reduction of the distances between them
- reduction of mechanical, thermal & electromagnetic stress during production & repair process

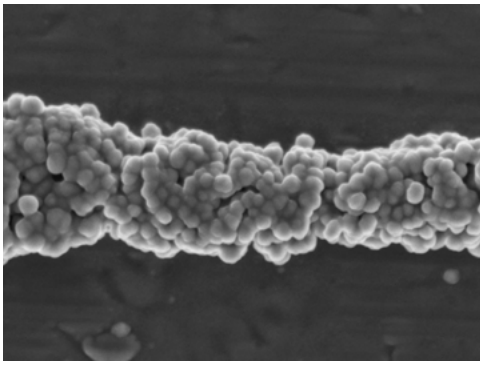
ADVANTAGES

XTPL'S TECHNOLOGY will address those requirements **by eliminating all the disadvantages of** current methods →

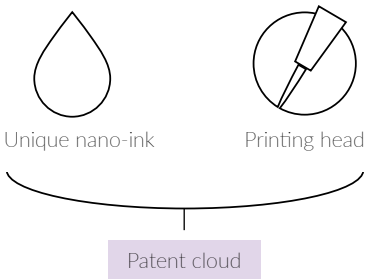
- allows for low cost repair
- does not require any toxic substances
- is aimed to ensure high efficiency for industrial use

Properties of XTPL lines

Functionality:	electrically conductive, optically, biologically & chemically active
Nanomaterials:	metallic & semiconductor
Line width:	from 100 nm to 15 µm
Line length:	up to 25 cm range
Aspect ratio:	1, in the single run of the printing head
Very low voltage applied:	5-30 V
Substrates:	i.e. glass, foil, PCB
Resistance:	5% bulk Ag, proof of concept manufactured featuring up to 40% bulk Ag



XTPL offers a complete solution for printing electrically conductive lines/structures in nano-scale. This includes proprietary technology, innovative printing-head and dedicated nanoinks (covered by the patent applications submitted in collaboration with the British law firm, Gill Jennings & Every LLP. The patent protection will be extended to around 30 countries) XTPL's method allows for repairing defects in electrical connections in micrometric & nanometric scale (<1 µm).



Open for cooperation:

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XTPL is constantly optimizing its innovative technology and adapting the process to different implementation requirements. XTPL aims to build partnerships and strategic alliances with well-established partners in selected sectors and cooperate in the form Joint Development.

Contact us on:
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Check us also on: