

OREL**TECH**

# NEXT-GENERATION METALLIZATION

*Company & Technology Overview*

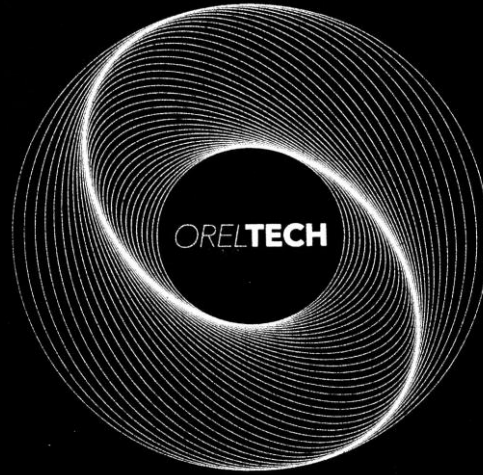
*July 2022*



[oreltech.com](http://oreltech.com)

## Who we are

OrelTech is a Berlin-based company founded in 2015 by scientists of the Weizmann Institute of Science in Israel. The core of the company's success is a proprietary, patented formula of nanoparticle-free metal inks that can take metallization to the next level.



## What we do

OrelTech helps its customers develop new products and solutions based on its unique conductive inks, which can be applied to almost any surface. OrelTech thereby enables innovations in

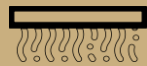
- printed electronics and OLEDs
- catalytic surface development and production
- decorative and protective metals coating

## What differentiates our technology?



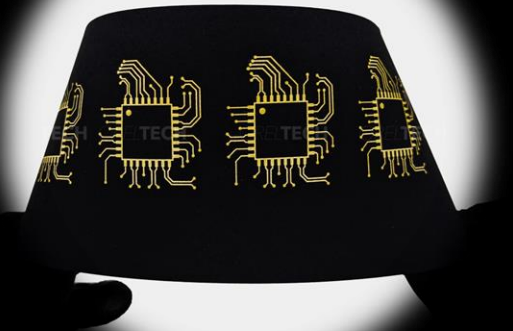
Our inks

Versatile and adaptable metal layers  
Thin, flexible and even transparent  
No nanoparticles, no material loss



Processing

Two simple steps: apply + cure  
Low-temperature plasma curing  
Safe, fast, environmentally friendly



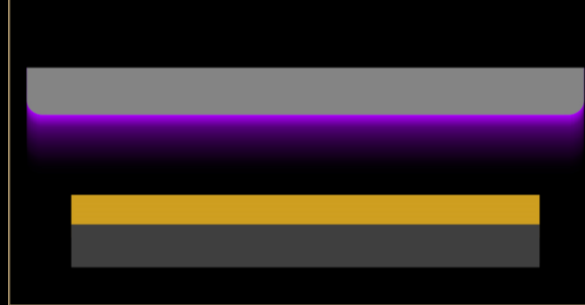
# OUR PROCESS

## Ink application



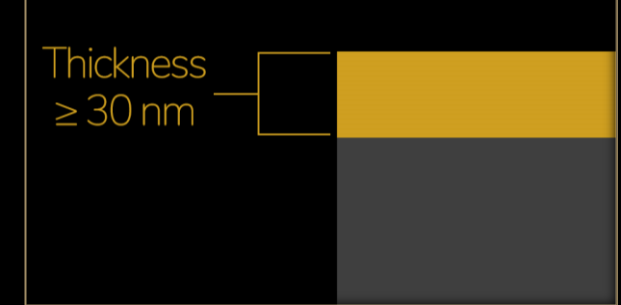
- Many deposition methods such as inkjet printing, dip dyeing, spraying
- Wide range of substrates incl. plastics, paper, fabrics, ceramics, other metals
- OreITech ink is non-toxic and easy to store
- No chemical waste

## Plasma curing



- Argon plasma treatment
  - Low temperature ( $<70^{\circ}\text{C}$ )
  - No vacuum needed, only slight underpressure
  - Fast (3–15 minutes)
- Off-the-shelf plasma machines available for roll-to-roll / stack-by-stack / sheet-by-sheet
- Green due to low energy use

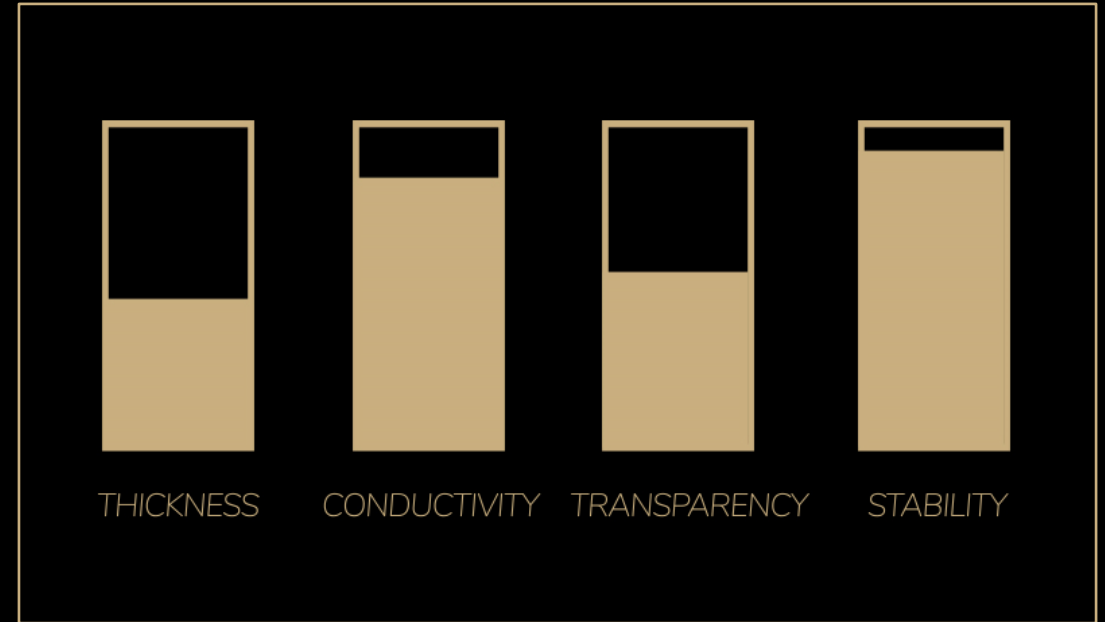
## Finished layer



- Solid metal layer
- Highly conductive
- Single layer thickness range of 30–2,000 nm
- Highly flexible and still durable
- High control over surface properties

# ORELTECH

Ag, Au, Pt, and Pd are standard inks - customization also possible



By varying the ink formulation, we can adjust the properties of the final metal layers to match customer requirements.



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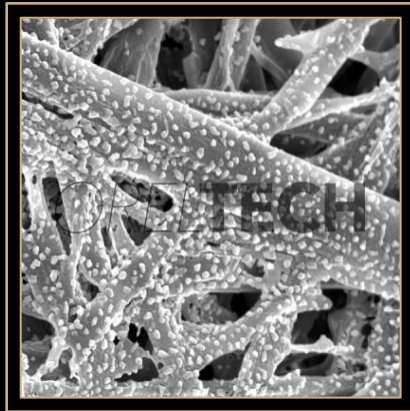
The technology has five areas of application - here focus on N° 1

**1** Printed electronics  
incl. flexible OLEDs



- PCBs
- Flexible electrodes, e.g. for biosensors
- OLEDs
- Capacitive sensors
- Chips on paper
- EMI shielding

**2** Catalytic  
surfaces



- Fuel cells
- Filters & cleaning catalysts (foams, meshes, powders)
- Batteries

**3** Plating  
(on plastics)



- Medical sensors
- Protective coatings
- Product copy protection
- Complex 3D shapes

**4** Fabrics and  
smart textiles



- Sensors on fabric
- Conductive fabrics
- Leather applications
- Other wearable applications

**5** Decorative  
applications



- Durable gold layers on textiles and leather
- Silver mirror surfaces

# ORELTECH

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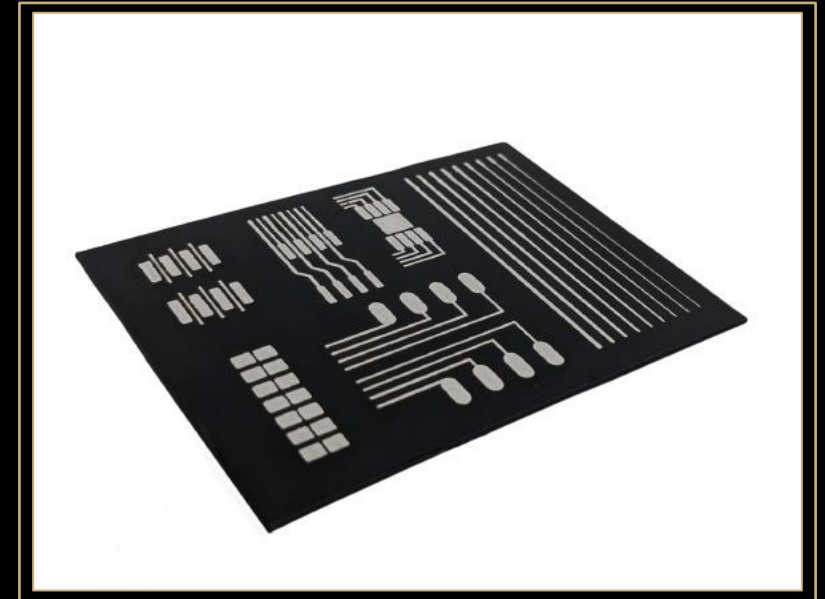
## Application: Ink-jet printed palladium seed layer for PCBs

### Challenge in industry

With electronic parts become smaller and smaller, the need for ever finer circuit patterns is continuing. The market-dominating processes (sputtering, masking) are not always up to the task, so the industry is testing purely additive printing approaches. Since printing copper directly leads to poor adhesion and stability, the desired solution is to print a palladium seed layer before electro/electroless plating a copper layer.

### OTech solution

OrelTech's printable Pd ink provides a novel solution for ultra-fine PCB production. The OrelTech particle-free ink can be inkjet printed with a line width of 25  $\mu\text{m}$  and as thin as 5 nm. With this "positive mask", the necessary conductivity is then achieved by plating a copper layer onto the palladium. The process is fast, simple, energy efficient, and *de facto* waste-free. The cured layer layers are immediately platable.



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## Application: Transparent flexible electrodes for OLEDs

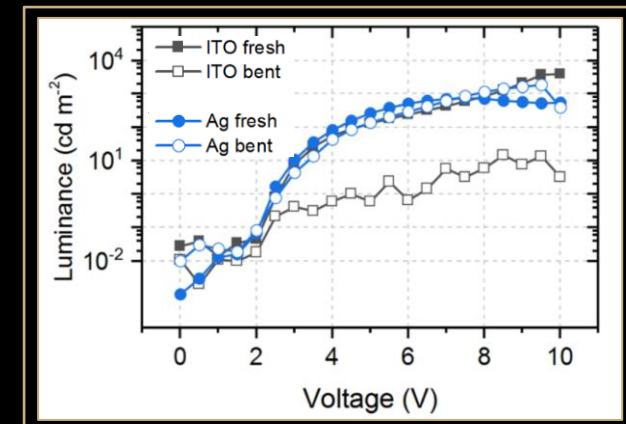
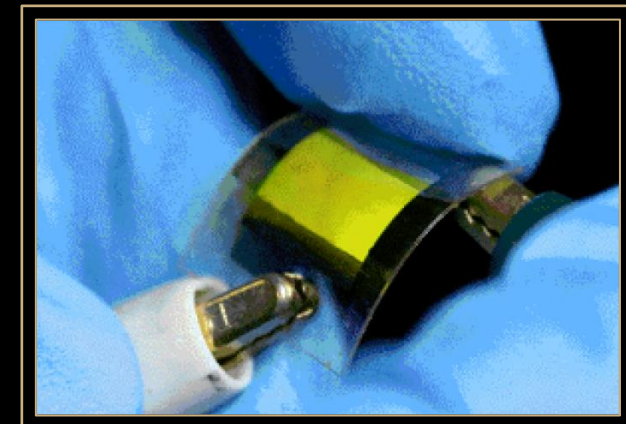
### Challenge in industry

A key challenge in producing flexible versions of light-emitting devices (LED, OLED) is keeping their level of light emission after many bending cycles. ITO-manufactured OLEDs perform poorly here.

### OTech solution

OTech T ink allows the production of transparent electrodes with high light output, combined with exceptional flexibility and durability.

In recent research by Humboldt University Berlin\*, an OLED made with OrelTech's transparent silver ink fully maintains its level of light emission even after 50,000 bending cycles.



Light output at different voltages comparing bent and unbent OLEDs made from ITO (grey) and OrelTech T ink (blue).

\* M. Hengge et al 2021 Flex. Print. Electron. 6 015009



# ORELTECH

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## Application: Pure gold and platinum electrodes for biosensors and bioelectronics

### Challenge in industry

The biocompatibility of the electrodes and printing precision are key challenges in biosensor design & production. Organic residues from many established gold and platinum inks often fail to comply with the required product standards. Moreover, nanoparticles in the inks make mass-production printing prone to errors.

### OTech solution

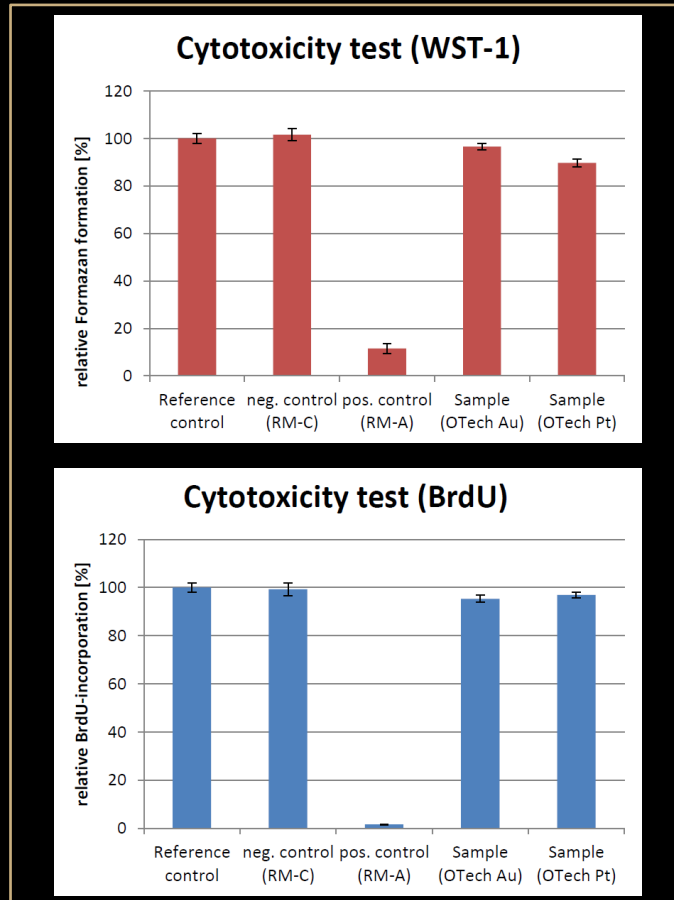
OTech Aurum and OTech Platinum inks allow precision printing (~50  $\mu\text{m}$  line width) of high-purity gold and platinum electrodes. OrelTech nanoparticle-free inks result in very thin layers (30 - 1,600 nm), which have been successfully tested for biocompatibility under the same conditions required by ISO 10993 standard.





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No cytotoxic effect of OTech gold and platinum layers according to ISO 10993 standard.

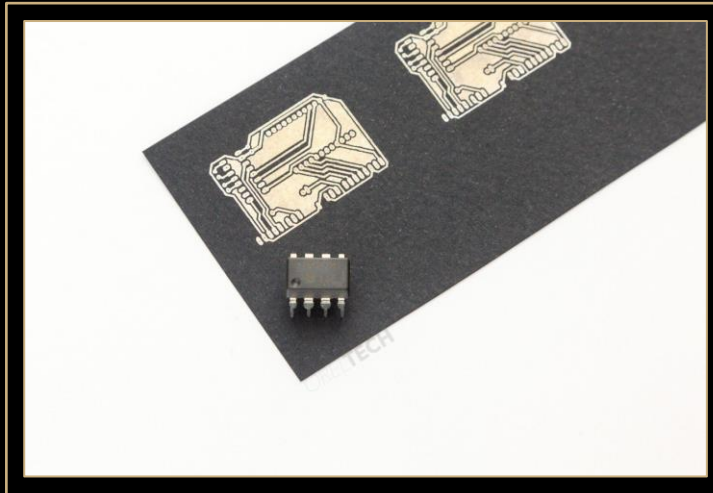


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## 1 Illustrations of printed electronics and OLEDs



Otech Aurum on fabric



Otech Jet on paper



Otech T on PET



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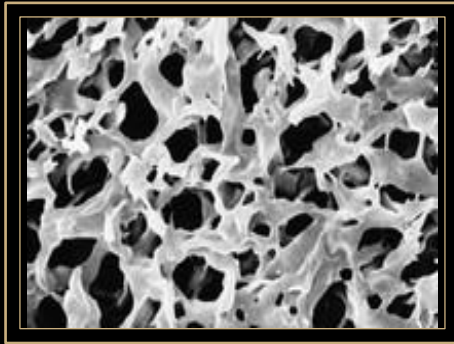
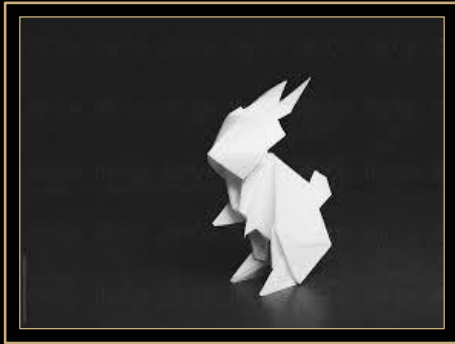
FURTHER INFO ON  
TECHNOLOGY



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# OUR TECHNOLOGY

Applicable on a wide range of materials and shapes



## Substrate material

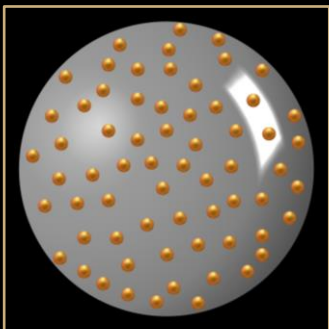
- *Plastics:* PET, PEN, Kapton, ABS, PU, PEEK, etc.
- *Metals:* Stainless steel, titanium, nickel, copper, etc.
- *Others:* fabrics, leather, paper, ceramics, etc.

## Substrate types and surface

- Sheets, rolls, smooth, porous, 3D objects, powders, complex shapes, etc.



# OUR TECHNOLOGY



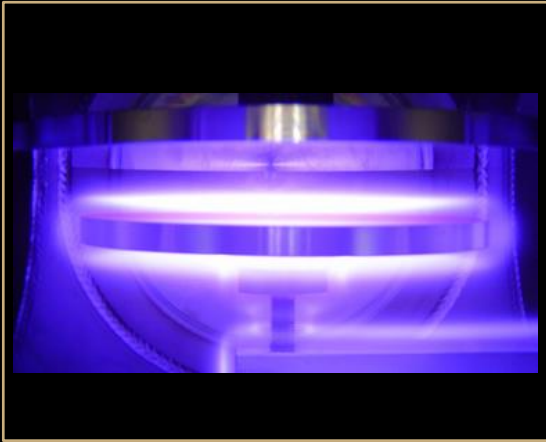
OrelTech inks allow full control over layer properties

- *Structure*: solid metal layer, high-surface area layer, particle coating
- *Thickness*: from 30 nm to 2,000 nm (single layer)
- *Appearance*: glossy, matte, transparent
- *Conductivity*: from 0.05  $\Omega$ /sq (depending on the type of substrate, type of metal and thickness)



# OUR TECHNOLOGY

## Plasma process



### Benefits of argon plasma treatment

- Low temperature (<math><70^{\circ}\text{C}</math>)
- No vacuum needed, only slight underpressure
- Fast (3–15 minutes)
- No solid or liquid waste
- Off-the shelf plasma machines for roll-to-roll / stack-by-stack / sheet-by-sheet
- No line of sight required
- Green due to low energy use



### Parameters necessary for all our inks

- Argon gas
- Generator frequency 40kHz–13.56 MHz
- Power 100–1,000 W



### Cold plasma process

Process time*	3–15 min
Temperature	25–70°C
Power consumption*	0.2–2.5 kW/h
Gas	Argon
Production volume	5–8,000 L
Device cost*	€ 10–200 k



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\* - Depending on the production volumes and chosen device

# OUR TECHNOLOGY

## Applying OrelTech inks using inkjet printing methods



### Benefits

- Precise patterning
- Ink economy due to minimal loss of ink
- Fast and scalable process on industrial (roll-to-roll) printers
- Easy test printing on low- to medium-invest printers



### Scalable initial investment

OrelTech inks work with a wide range of printers, ranging from refitted office printers (for test prints) to high-resolution R&D printers and in-line mass production printers (roll-to-roll, sheet-by-sheet, on-object printers).



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### OrelTech's experience and support

- OrelTech team has extensive experience with printing our inks using various types and brands of machines
- Selected print heads tested by OrelTech: Epson, Spectra, Konica Minolta, Dimatix, Ricoh, etc.

# OUR TEAM



## Dr. Klaus Mertens

As the CEO of OrelTech Klaus manages finances, market strategy and HR. He has several years of management experience in the pharma and real estate sectors. Prior, he worked as a strategy consultant. He has a management degree and a D.Phil. from Oxford University.



## Dr. Natalia Zamoshchik

COO of OrelTech, is an expert in organic and printed electronic materials. She developed the company's proprietary technology and holds a Ph.D. in Chemistry from the Weizmann Institute of Science in Israel.



## Dr. Konstantin Livanov

leads OrelTech's production and R&D as CTO. He is an expert in surface chemistry and composite materials with experience in nanoparticle synthesis and electron microscopy. He has a Ph.D. in Chemistry from the Weizmann Institute of Science.



## Marie Westphal

is coordinating all marketing and sales activities as Commercial Director. A chemist by training, she is enthusiastic about promoting new sustainable materials, products and processes and enabling entrepreneurship in the chemical industry.



## Dr. Kristina Lovrek

combines deep expertise in surface chemistry with being a digital native. Her role assumes activities around product development and production while also running OrelTech's communication and marketing tasks. She holds a Ph.D. in Chemistry from Humboldt University Berlin.





# ORELTECH

Our collaborations and partners:

## HÜTTENES<sup>3</sup>

INAM

מכון ויצמן למדע

PHINERGY



מכון ויצמן למדע  
WEIZMANN INSTITUTE OF SCIENCE



HySPRINT  
Helmholtz Innovation Lab



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