# 2. Summit research, innovation and standardization

Leo Schranzhofer, 25. März 2021

FROM **RESEARCH**
TO **PRODUCTION**

WWW.PROFACTOR.AT

# Outline



# Who is PROFACTOR?

## A short introduction

FROM **RESEARCH**
TO **PRODUCTION**

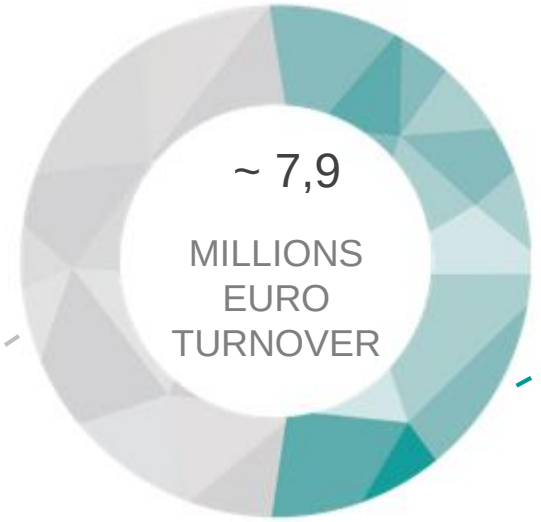
WWW.PROFACTOR.AT

# Profactor GmbH – Some Facts and Figures

Since 1995

2 LOCATIONS:
STEYR and VIENNA

~75
EMPLOYEES




~ 3,0
MILLIONS EURO OPERATING REVENUE IN INDUSTRIAL PROJECTS

~ 4,9
MILLIONS EURO OPERATING REVENUE IN FUNDED PROJECTS

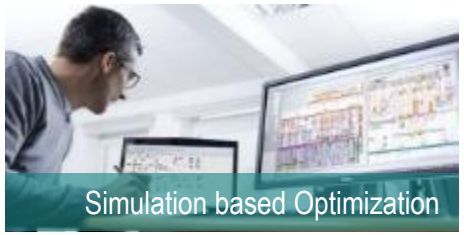
# Our profile

**Research**

Solutions










# Functionalization | Decoration | Structuring

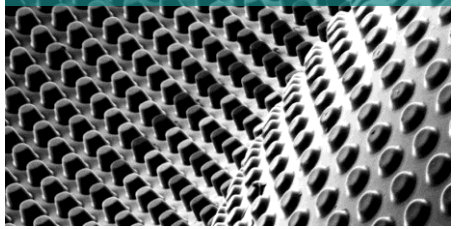
## Research/Processes

**Additive Nanoimprint Lithography**
Focus on: Multimaterial, Multilayer, Freeform Substrates, Large Area and Volumes, Digital

**Additive Inkjet Printing**
Focus on: Multimaterial, Multilayer, Freeform Substrates, Print Resolution

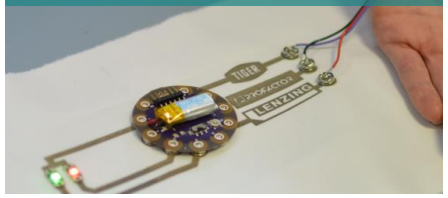

## Solutions/Applications

**Micro and nanostructures**



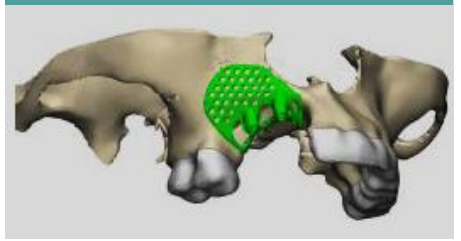
**Products and Tools**

**Inkjet Printed Electrics and Electronics**



*We do things by NIL, which others don´t dare to do!*

**3D printed inplants**

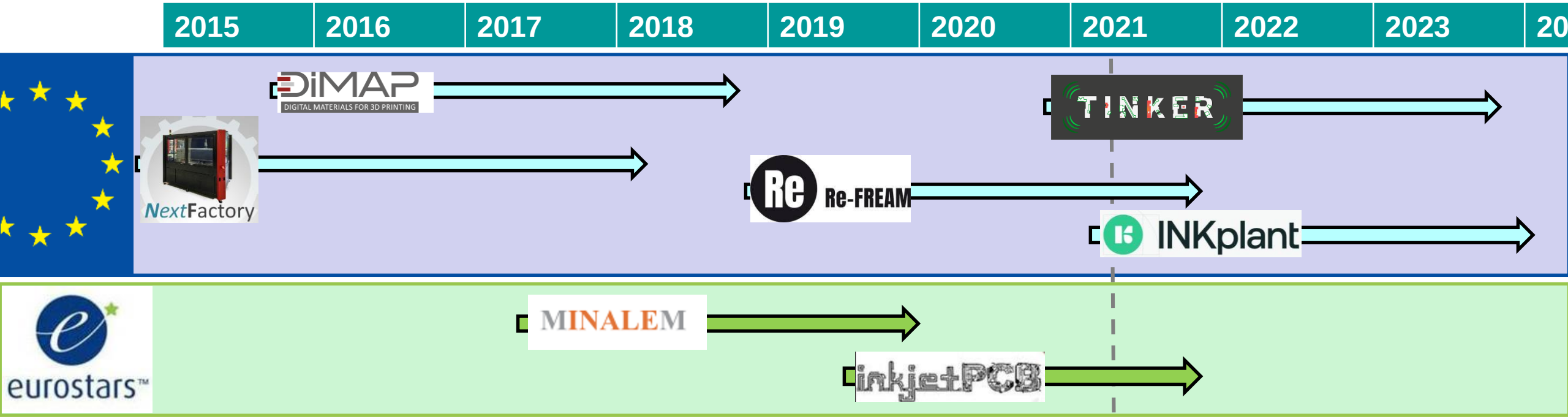


**Digital Printing on freeform objects**

*We are process experts!*

*Others produce, we customize!*

# Examples of european projects @PROFACTOR



PROFACTOR®

eurostars™

Co-funded by EUREKA member countries and the European Union Horizon 2020 Framework Programme

# inkjetPCB

## Inkjet-based fabrication of multilayer printed circuit boards with embedded printed passive elements

Project duration: 11/2019 – 10/2021

LEADING
**INNOVATIONS**

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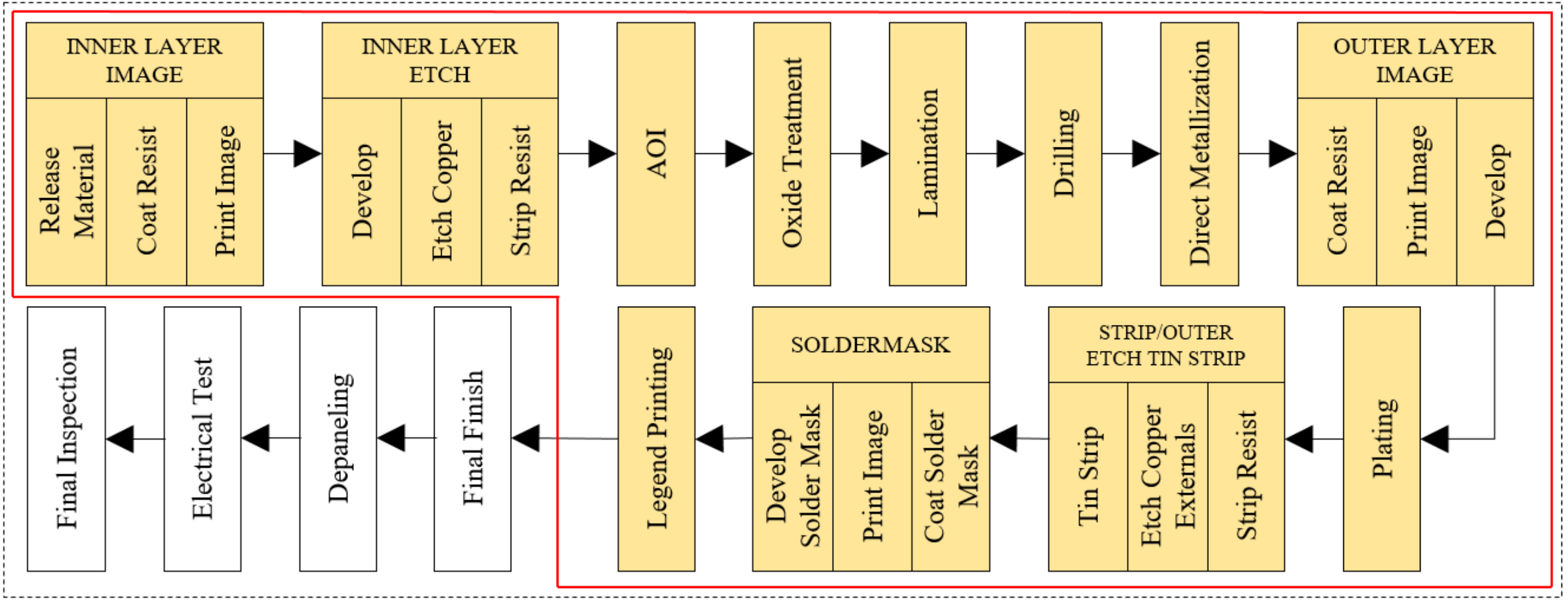
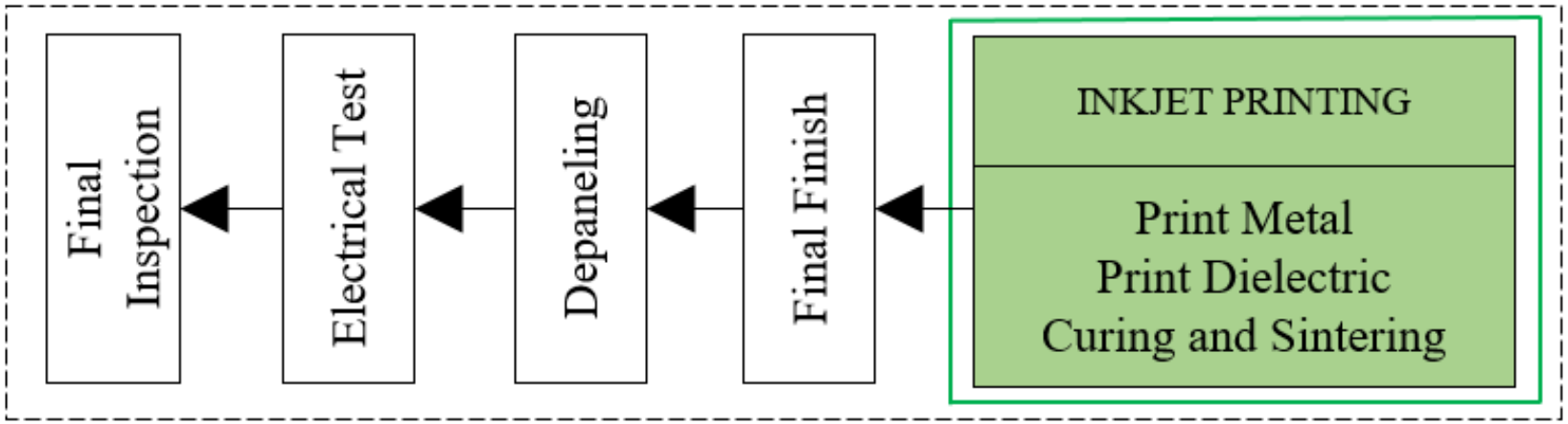
# Standard PCB industrial manufacturing process




**Complex, multi-stage, material intensive, costly, high waste production, environmentally aggressive, SUBTRACTIVE.**

# InkjetPCB!

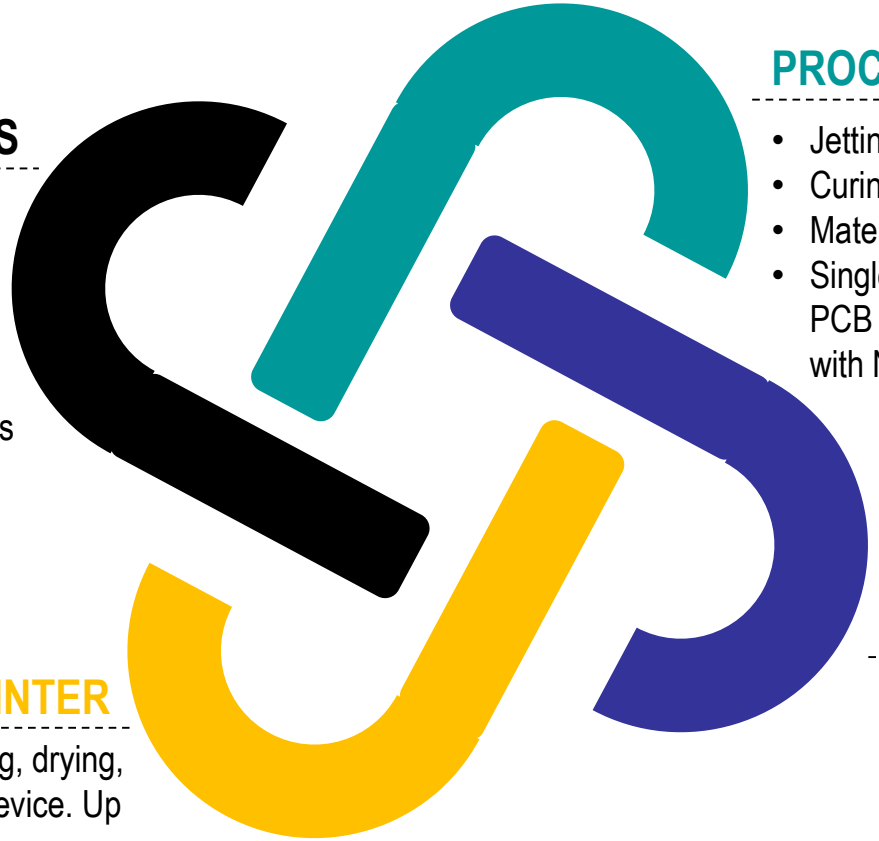



- **Cheaper** in terms of processing operations, materials involved, capital investment, workforce employed, waste management.
- Potentially **faster** (exploiting high throughput equipment).
- **Increased functionalities**: flexibility, passive component embedding, reduced dishomogeneities deriving from plating and etching high or low density patterned areas, etc.
- The **low capex** allows **high parallelization** in order to increase the throughput.
- **Environmentally friendly**: no hazardous material employed, additive manufacturing.
- Drastic **reduction of factory floor plan area** from 200m$^2$ in the current state-of-the-art process to 60m$^2$ maintaining the same throughput.
- **Digital** advantages: product singularization, smart production planning, change on the fly, cheap and fast prototyping.
- **Non-contact** process: embedding of PCBs onto 3D objects, printing of fragile substrates.

# Partners and roles

## MATERIALS

- Copper and Silver solvent-based inks
- UV curable Ag and Cu inks for vias
- UV and thermally curable dielectric inks:
  - Enhanced acrylic-based dielectric ink
  - High performance polyimide dielectric ink
  - High-k BaTiO3 ink for passive components



## PROCESS

- Jetting and printing process development
- Curing and sintering process development
- Material compatibility, eventual pre-treatments
- Single layer PCB, vias, passive elements and multi-layer PCB printing with embedded printed passives (together with NOT, SCIO and FEL).

## PRINTER

- DemonJet printer for prototyping. Printing, drying, sintering, curing and inspection in one device. Up to 10 inks printable in parallel.
- n.jet printer from NOT for low-mid volume production to be developed during the project.

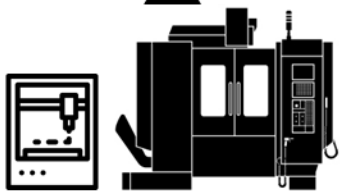
## PCB EXPERTISE

- Definition of industrial requirements
- Demonstrators design
- Prototyping and fabrication of demonstrators
- Real market examples
- Technology benchmarking
- Standardization and certification
- Testing soldering, assembly, reliability, tolerances, electrical performance, etc.

# Project objectives and envisaged results

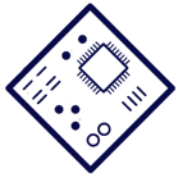
1. Conductive and dielectric inkjet inks

2. Low- and mid-volume inkjet printers



3. PCB process guidelines

4. Prototypes and use cases



5. Certifications and conformity to standards


6. Intellectual Property

# PCB Expertise: R&D and Commercial

- Definition of industrial requirements.
- Prototyping and fabrication of demonstrators (incl. assembly and inspection).
- Real market examples, use cases.
- Technology benchmarking.
- Process reliability and performance testing: Adhesion, Electrical performance, Migration, Thermal management, Fatigue tests, Topography, Solderability, etc.
- Need for standardization of production and testing.

IPC Association Connecting Electronics Industries

### IPC Printed Electronics Initiative

**IPC's members are actively engaging in global printed electronics efforts through the development of industry standards. To date, the IPC Printed Electronics Committee has published:**

- IPC/JPCA-2291, *Design Guideline for Printed Electronics (2013)*
- IPC/JPCA-4591, *Requirements for Printed Electronics Functional Conductive Materials (2012)*
- IPC/JPCA-4921, *Requirements for Printed Electronics Base Materials (2012)*
- *NEW!* IPC/JPCA-6901, *Application Categories for Printed Electronics*
- *NEW!* IPC-6903, *Terms and Definitions for the Design and Manufacture of Printed Electronics (Additive Circuitry)*

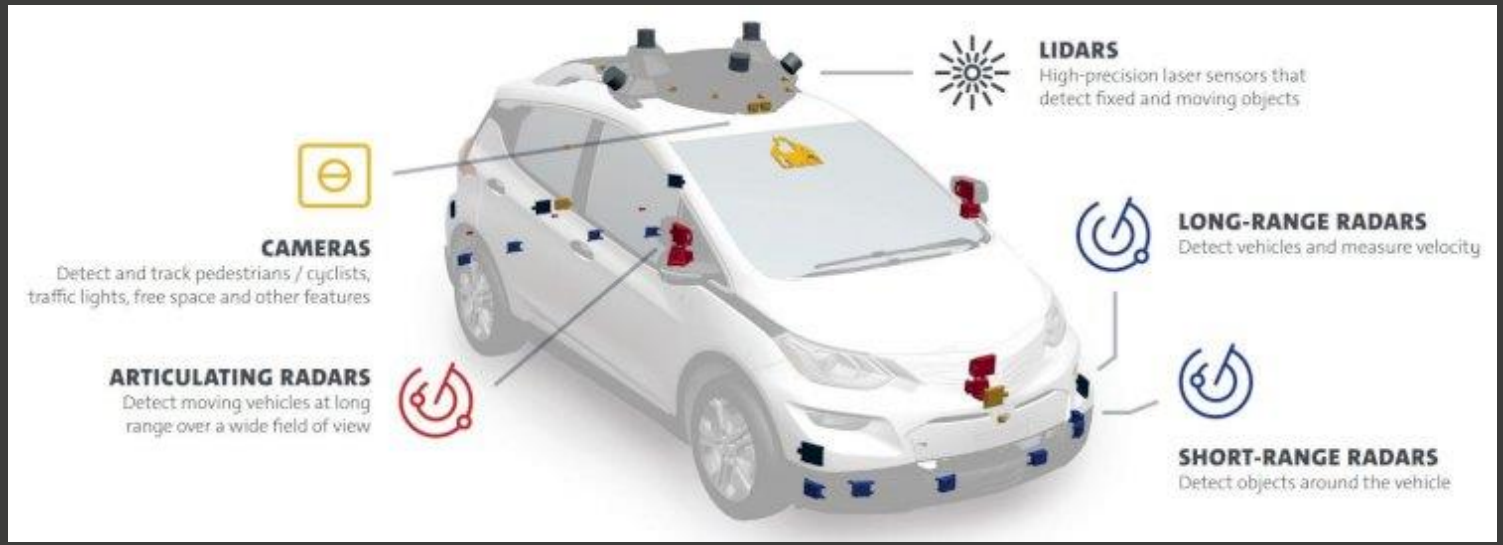
### Seeking Your Involvement in Draft Standards

**The IPC Printed Electronics Committee seeks your company's input into the following draft standards. These documents are all in the early stages of development.**

- **IPC-4591A, *Requirements for Printed Electronics Functional Conductive Materials***
- **IPC-4921A, *Requirements for Printed Electronics Base Materials***
- **IPC-2292, *Design Standard for Printed Electronics on Flexible Substrates***
- **IPC-6902, *Qualification and Performance Specifications for Printed Electronics***


# Sensor package fabrication via additive manufacturing for automotive sector

# Sensors in cars




https://www.thegeospatial.in/uploads/images/image_750x_5cfe4adb0d535.jpg

# Levels of autonomous driving


https://www.autodrivetech.com/solutions/automotive-oems/

SELBSTFAHRENDE AUTOS

**Teslas Self-Driving-Modus ist offenbar nicht auf autonomes Fahren ausgelegt**

In Nachrichten an US-Behörden stellte der Elektroautobauer klar, dass vollständig autonome Funktionen noch länger nicht marktreif seien

12. März 2021, 08:11 190 Postings

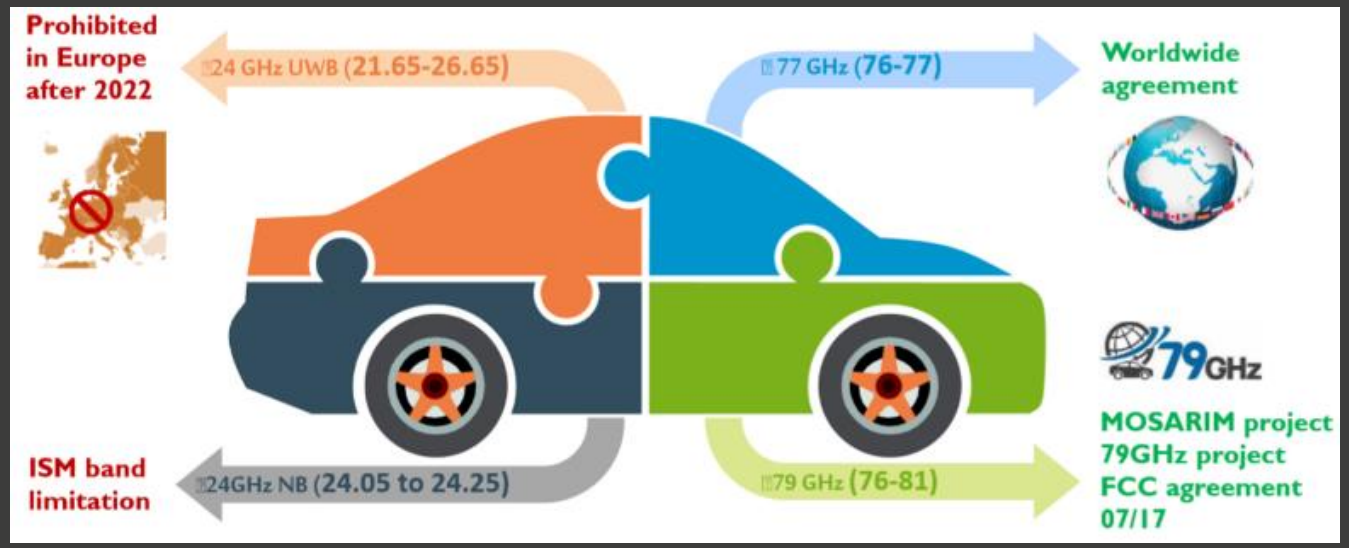
Teslas Software für autonomes Fahren soll weniger weit fortgeschritten sein als behauptet.

Foto: Reuters/Aly Song

https://www.derstandard.at/story/2000124972287/teslas-self-driving-modus-ist-offenbar-nicht-auf-autonomes-fahren

# Motivation

- **Market need (sensor packages)**
  - Lowered weight
  - Lowered power consumption
  - Improved performance and reliability
  - Improved safety of ADAS systems
  - Improved resolution and precision
- **Industrial pull**
  - Improved miniaturization level

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**Standards:**

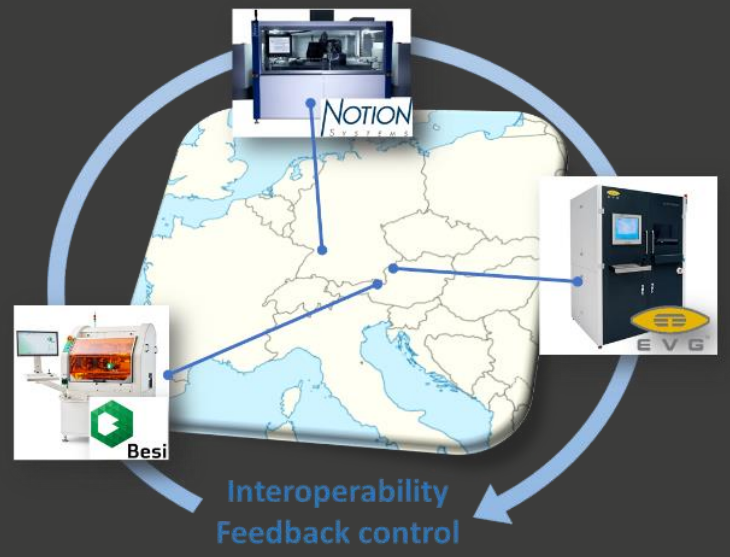
Transport and Traffic Telematics (TTT) –

- 24 Ghz: ESI EN 302 288
- 77Ghz: ETSI EN 302 264

# Goals

- **TINKER pilot platform**
  - Improving **speed**, **accuracy** and **reliability** of **pick and place assembly** techniques
  - Improving **automation level**, **process reliability** and **lowered rejection rate** via **feedback control**
  - Improved **miniaturization level**, **fabrication time** and **efficient use of resources** enabled by **additive manufacturing**

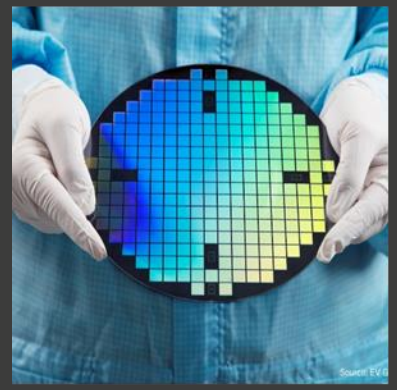
- **Manufacturing of RADAR and LIDAR sensor packages**
  - Miniaturization level
  - Improving functionality
  - Improving cost efficiency




https://link.springer.com/referenceworkentry/10.1007%2F978-3-319-12352-3_17

# Concept

## PILOT PLATFORM



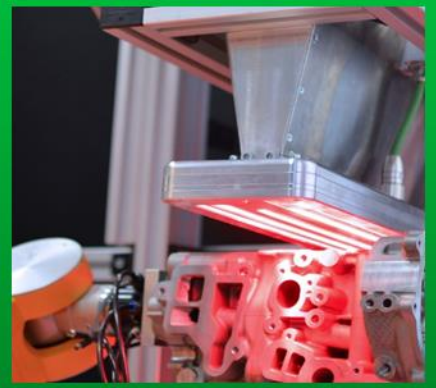
**Bare die**

- LIDAR
- RADAR

**ASSEMBLY**

Pick & Place

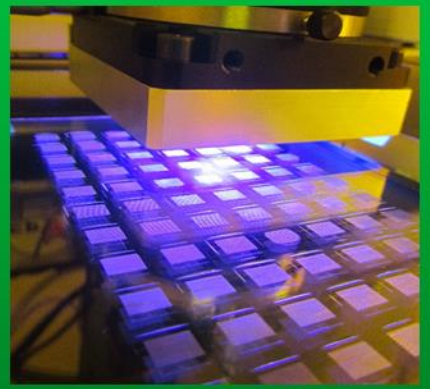
Bonding



**FEEDBACK CONTROL**

Inspection

Compensation



**ADDITIVE MANUFACTURING**

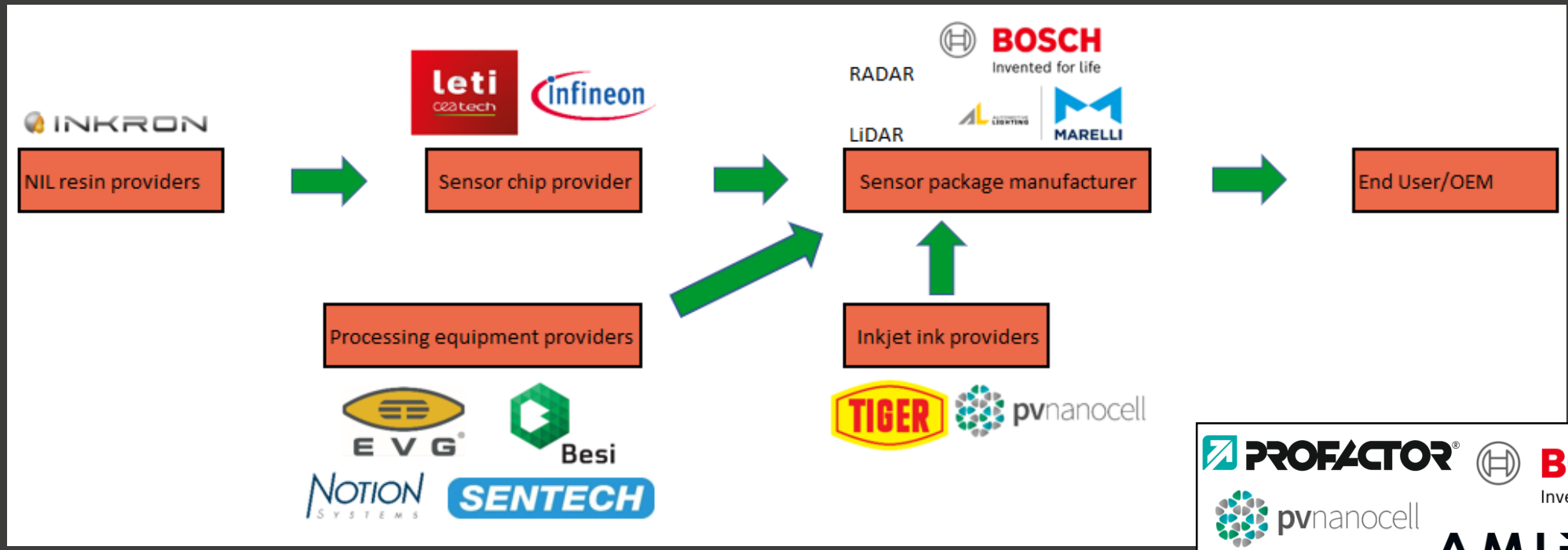
Inkjet printing

Nanoimprint lithography

**Sensor package**

- LIDAR
- RADAR

# TINKER partners and value chain

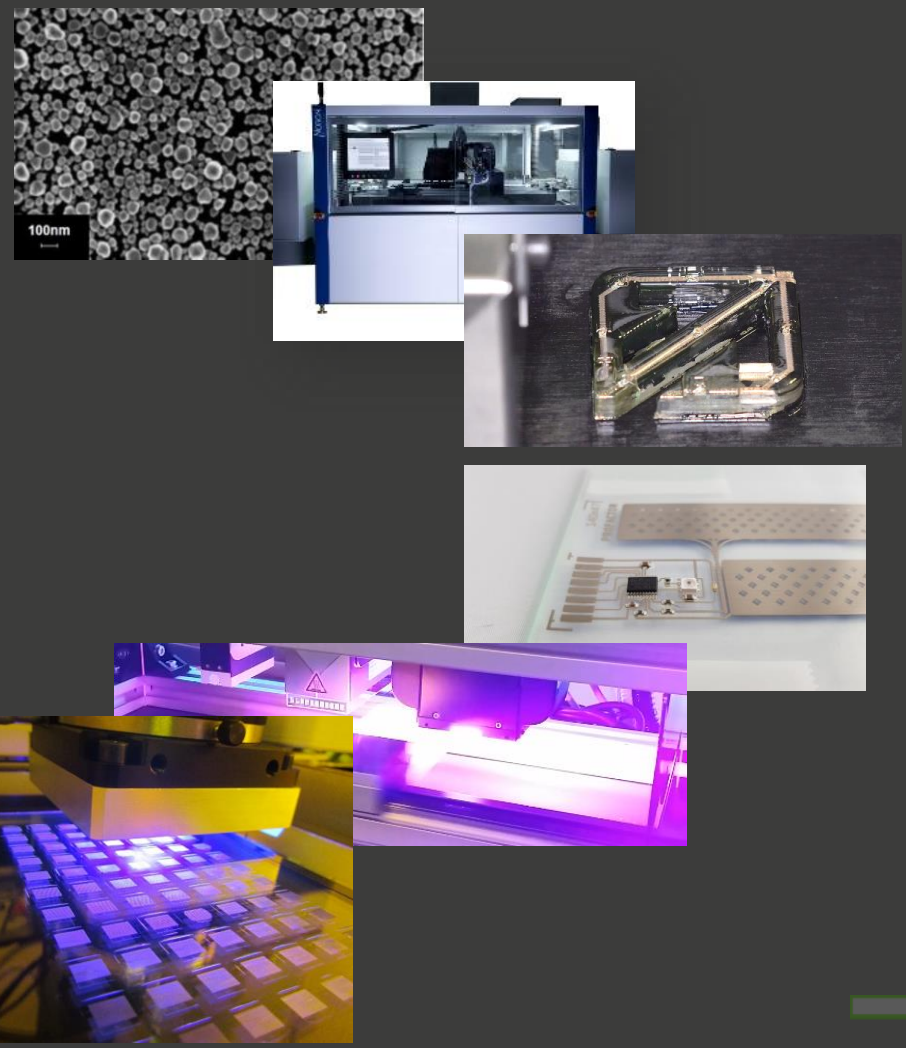



# How to achieve our goals?

# Additive manufacturing - Inkjet

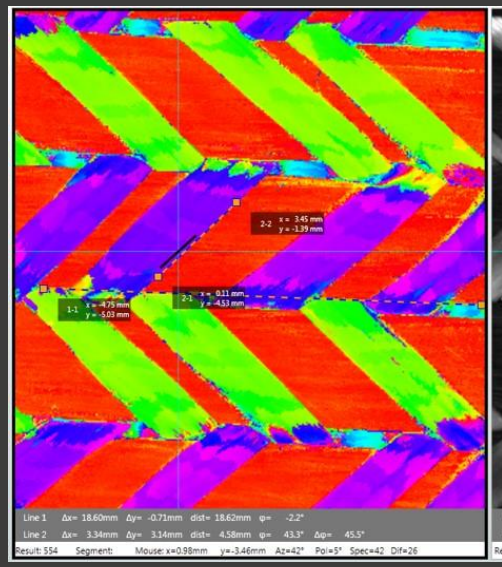
- **AM approach**
  - Material development
  - Machine (inkjet, NIL) development
  - Process development

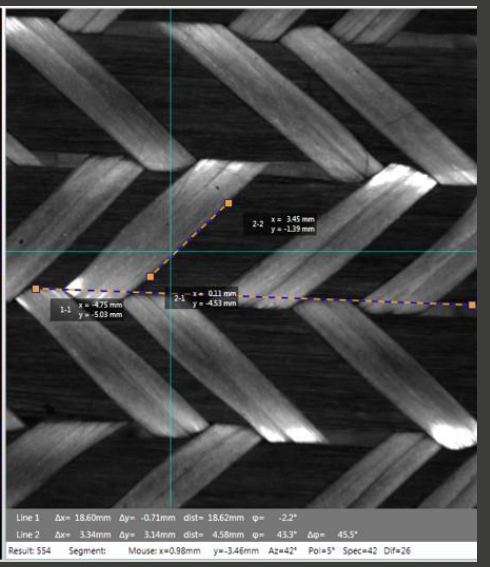
- **Applications**
  - Direct integration of sensors assisted by inkjet printing
  - (multilayer) PCB fabrication
  - PIC fabrication
  - Dedicated post processing



# Feedback control

- **Approach**
  - Inline inspection
    - Spectroscopic
    - microscopic
  - Machine learning
    - Data processing and prediction
- **Application**
  - Self repair within pilot line
  - Quality control
  - Zero waste



# Assembly

- **Approach**
  - Inline inspection
  - Error measurements
  - Prediction
- **Application**
  - Automated self correction of the process

# Standards and standardization

- **Strategy within TINKER**
  - Austrian Standards as interface to respective **working groups**
  - **Knowledge transfer** to and from working groups
  - **Gap analysis** to support post project phase and enhance industry and market uptake

- **Example standards relevant for TINKER**
  - ISO 17296, Additive manufacturing -- General principles;
  - ISO/ASTM 52902, Additive manufacturing -- Test artifacts -- Geometric capability assessment of additive manufacturing systems;
  - ISO/ASTM TR 52905, Additive manufacturing -- General principles -- Non-destructive testing of additive manufactured products;
  - ISO/ASTM 52915ff, Specification for additive manufacturing file format (AMF), Work Programme of ISO/TC 261, Additive Manufacturing;
  - ASTM Committee F42 on Additive Manufacturing Technologies;
  - IEC/TC 119 Printed Electronics;
  - ISO/IEC JTC1/WG 12, 3D Printing and scanning
  - IPC/JPCA-2291, Design Guideline for Printed Electronics (2013);
  - IPC/JPCA-4591, Requirements for Printed Electronics Functional Conductive Materials (2012);
  - IPC/JPCA-4921, Requirements for Printed Electronics Base Materials (2012);
  - IPC/JPCA-6901, Application Categories for Printed Electronics;
  - IPC-6903, Terms and Definitions for the Design and Manufacture of Printed Electronics (Additive Circuitry),
  - IEC/TC 119 Printed Electronics

# Thank you for your attention

https://ruben.verborgh.org/images/blog/boring.jpg

# Further information and contact

https://www.project-tinker.eu/
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twitter.com/project_tinker

https://www.pvnanocell.com/eurstarstrade-inkjetpcb.html


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PROFACTOR®

***Functional surfaces and Nanostructures***

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