

NANO DIMENSION

3D PRINTED ELECTRONICS

Additive Manufacturing of Multilayer and Non- Planar Electronics

WISEEE18, Huntsville, AL

12th Dec. 2018

Simon Fried

Why Additive?

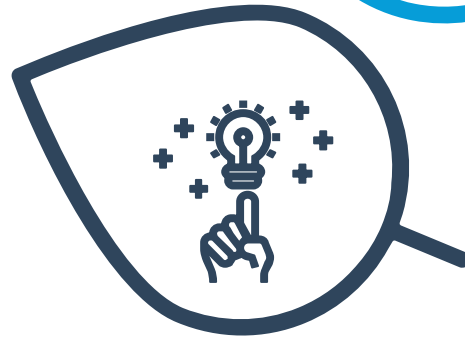
Accelerate
time to market



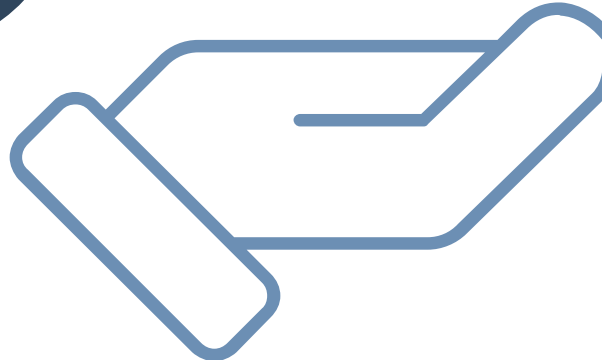
Protect
IP



Increase
design
possibilities



Improve
efficiency



Revolutionizing Electronics: Development to Manufacturing

High
Precision
Inkjet
Deposition

+

Multi-Material
3D Printing
Process

=

Digital
Manufacturing
Software

Co-Developed
Metal &
Polymer Inks

Traditional Planar
Electronics

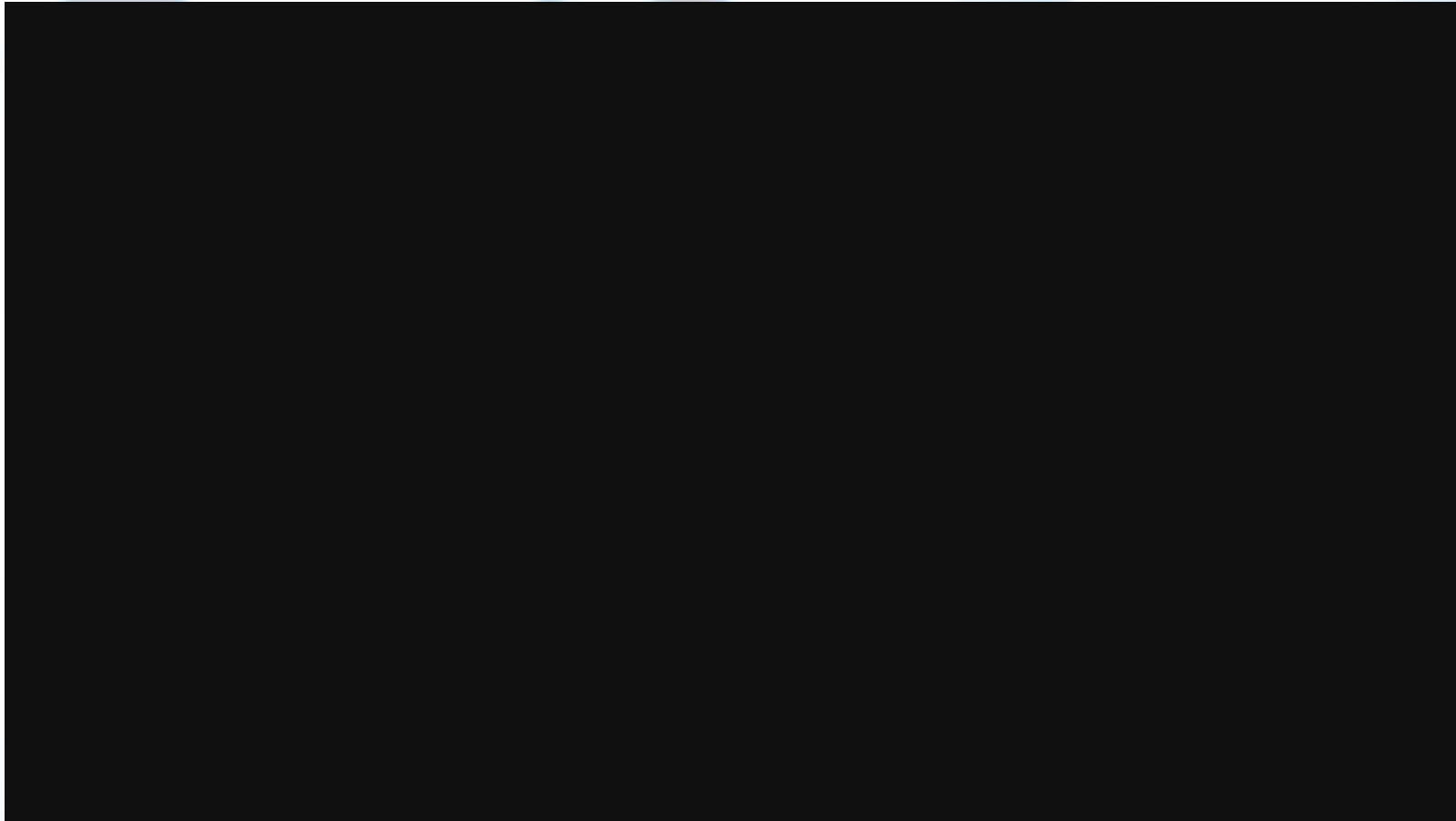
Save Time
Save Money
Protect IP

Non-Planar
Beyond PCB

Make the
unmakeable



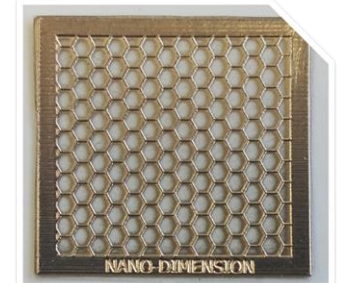
The DragonFly Pro™ System



AgCite™ Conductive Ink: Silver Nanoparticle

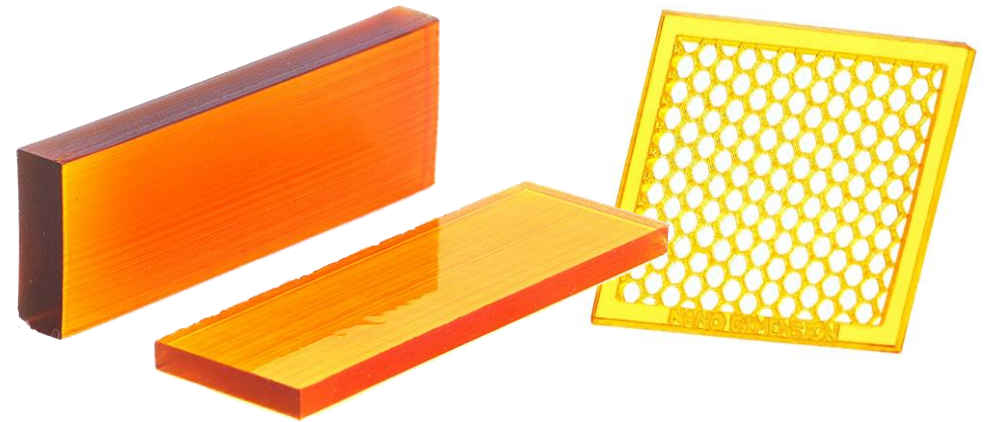
- Patent protected nanoparticle synthesis process
- Controls the size & distribution of Ag nanoparticles
- Optimized for
 - ✓ Inkjet 3D printing
 - ✓ Works with the dielectric ink
 - ✓ On-the-Fly sintering
 - ✓ Used for surface finish and annotation

Thickness		Trace Width		Space Width	
Oz/ft ²	um	mils.	um	mils.	um
1/3	12	4	100	5	125
1/2	17	4	100	5	125
1	35	4	100	5	125
2	70	5	125	6	150
3	105	6	150	6	200



Dielectric Ink

- Focusing on electrical properties
 - ✓ $D_k @ 1 \text{ GHz}: 2.9$
 - ✓ $D_f @ 1 \text{ GHz}: 0.02$
- Optimized for:
 - ✓ Inkjet 3D printing
 - ✓ Compatibility with Nano Dimension Conductive ink
 - ✓ On-the-Fly curing (no post-process)
 - ✓ Used for solder masking



○

Application Areas and Goals

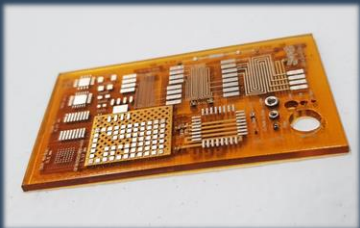
- Defense – rapid prototyping, distributed production, end use parts?
- Auto – rapid prototyping, saving weight, smart-parts
- Research – focus on non-planar and antennas
- Aero-Space – rapid prototyping, saving weight, low volume production, antennas/sensors
- Consumer – rapid prototyping, high-volume production?
- Medical – rapid prototyping, high-volume production?
- IoT – sensors/comms/structure, high-volume production?



Uses

Multilayer PCB

- Gerber + Excellon files
 - FR4-like
 - Multi-layer
 - Solderable



RF

- $\Delta 1\text{db}$ @ 5GHz



Non-Planar

- CAD files
 - Coils, Offsets, Cavities, Antennas, Encoders



Embedding*

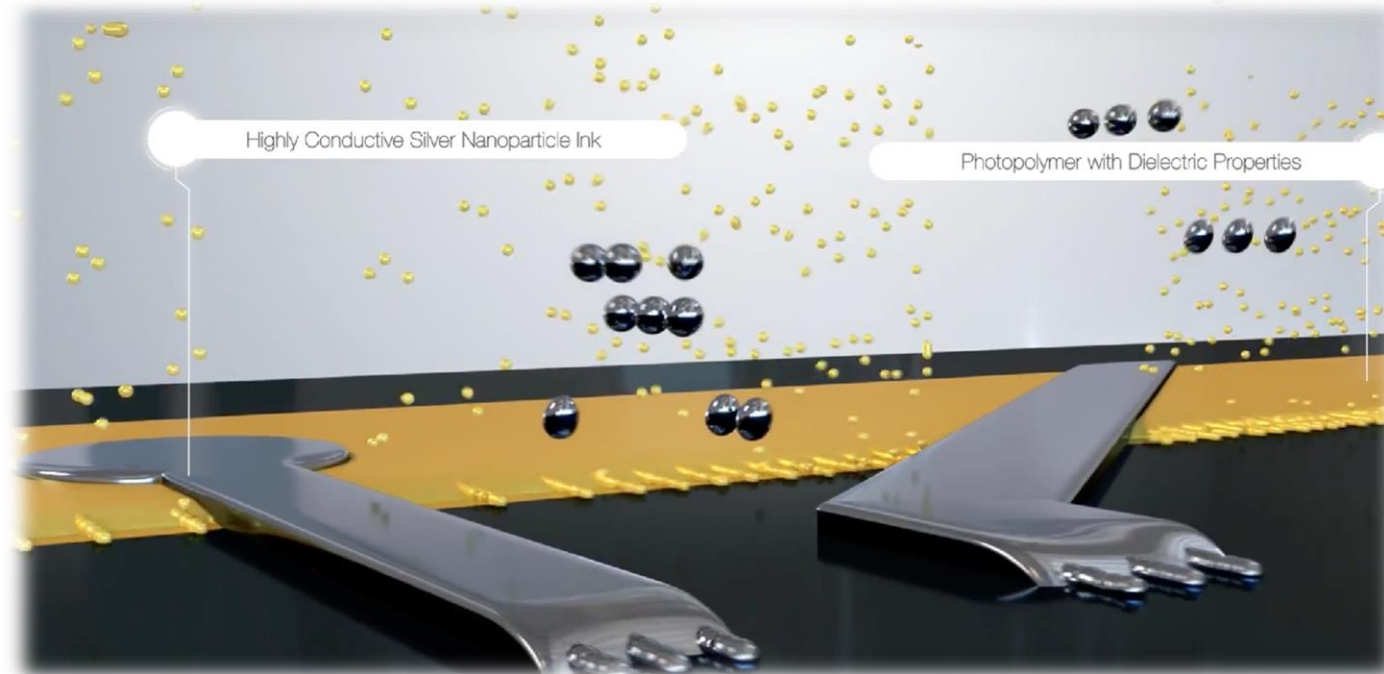
- Components placed during print (*in development)



Traditional PCB & RF

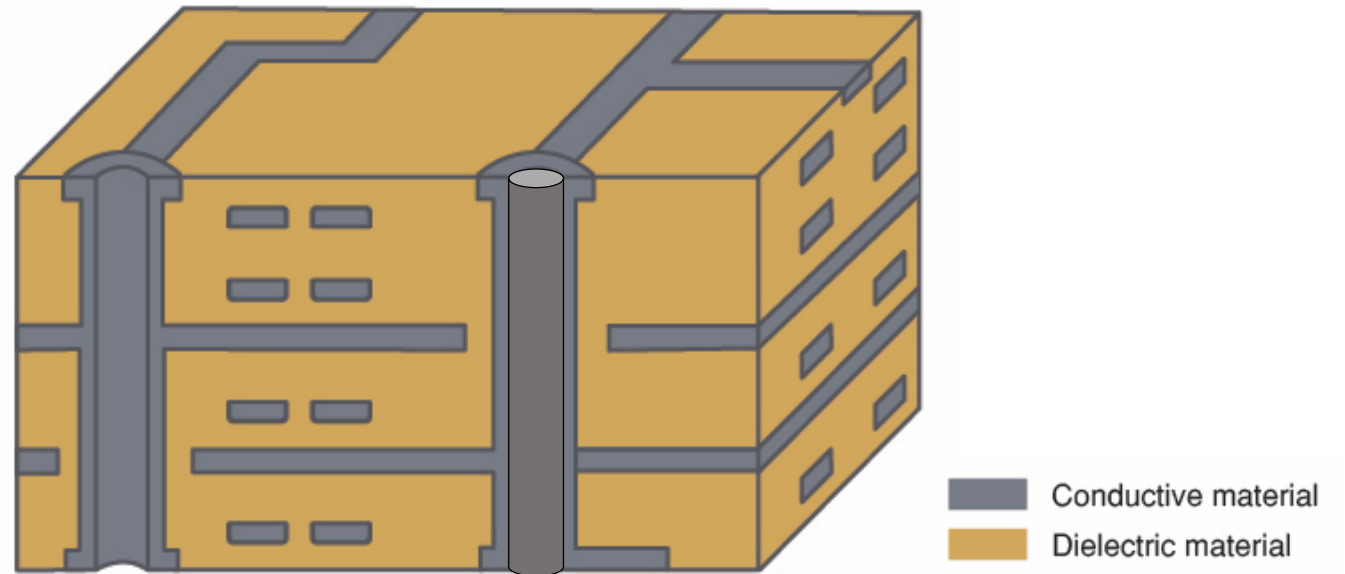
How it Works

- 2 printheads piezo inkjet both materials simultaneously
- Both conductor & substrate are printed – 100% fully additive process



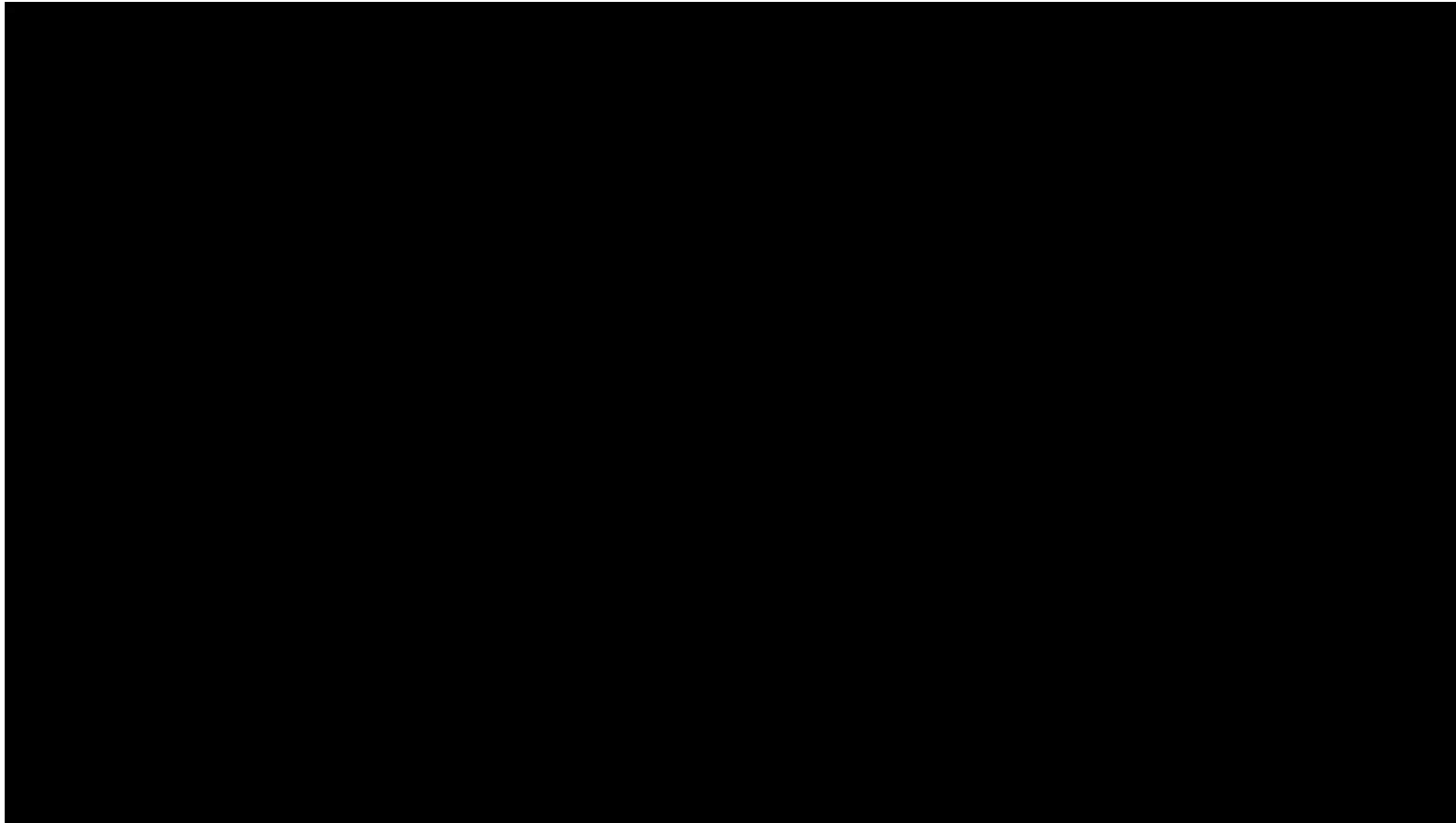
How it Works

- The object is built up, layer by layer
 - ✓ Conductive layers
 - ✓ Dielectric layers
 - ✓ Drills and vias
 - ✓ Soldermask
 - ✓ Annotation
 - ✓ Simplified process
 - ✓ No need for etching, pressing, electroplating and can print stencils..

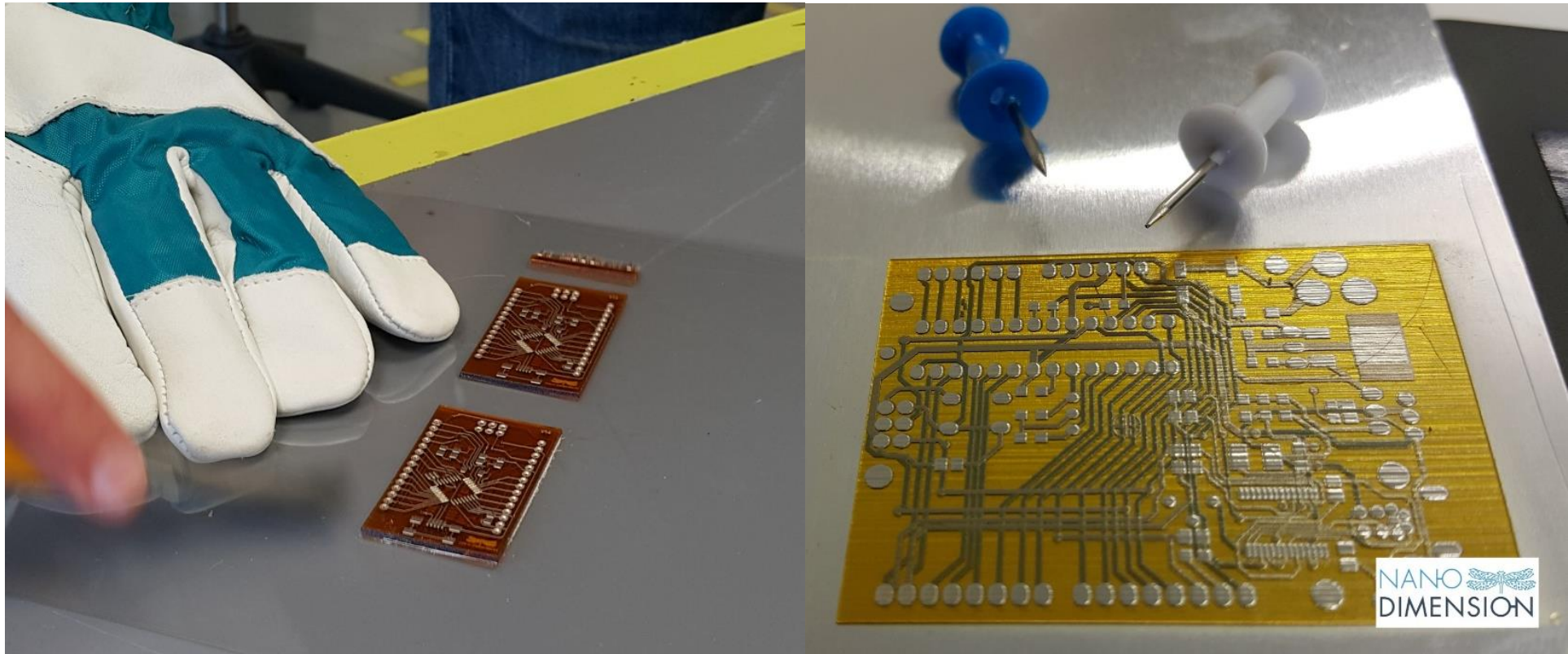


Switch – Print Editor

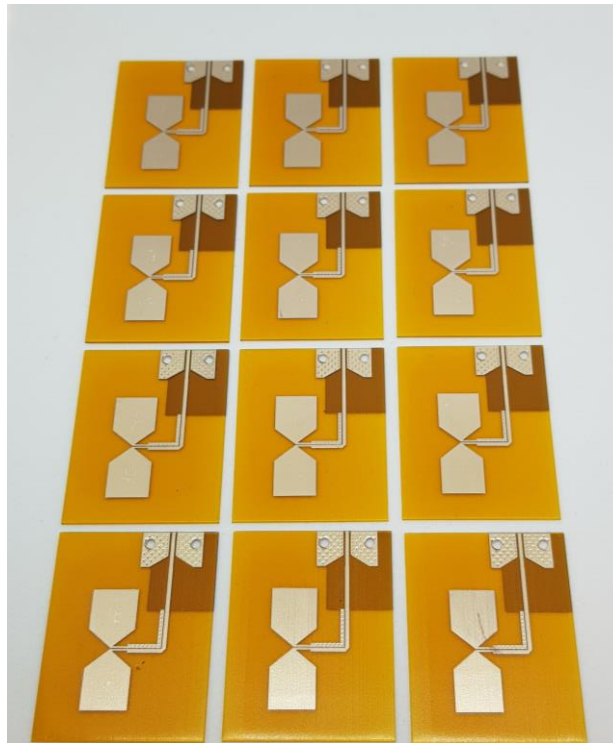
Traditional Gerber & Excellon Design to Additive Manufacturing



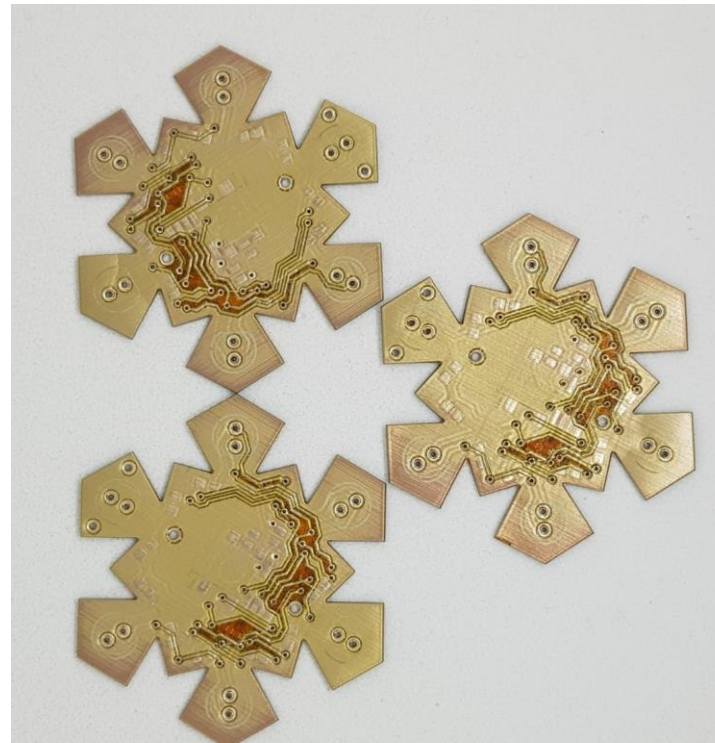
No Post-Process



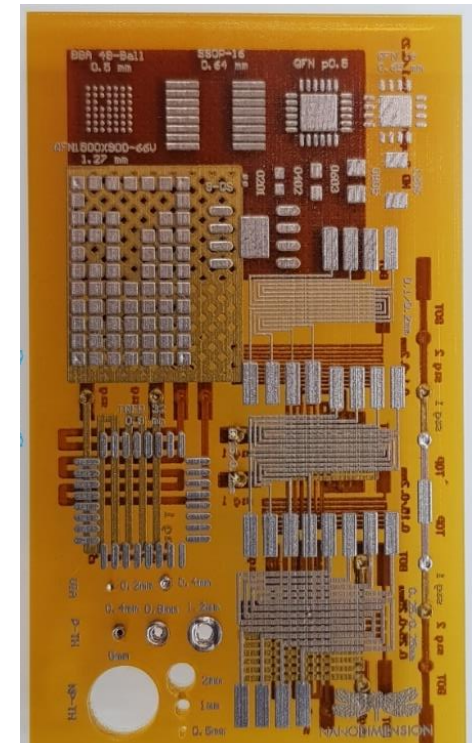
Planar: 100% Precision 3D Printed



5G Balun Bow-Tie Antenna



Complex (and seasonal) Routes

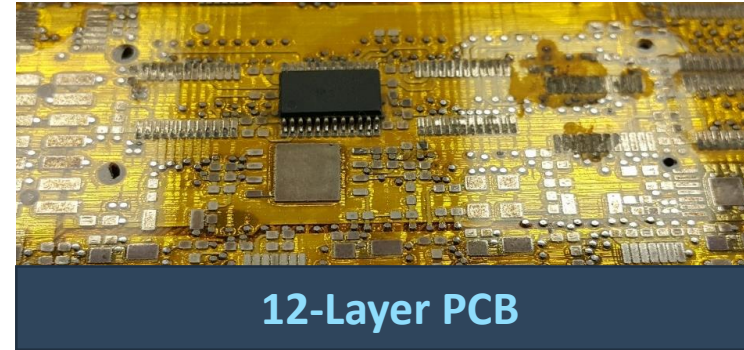


Design Rules Coupon

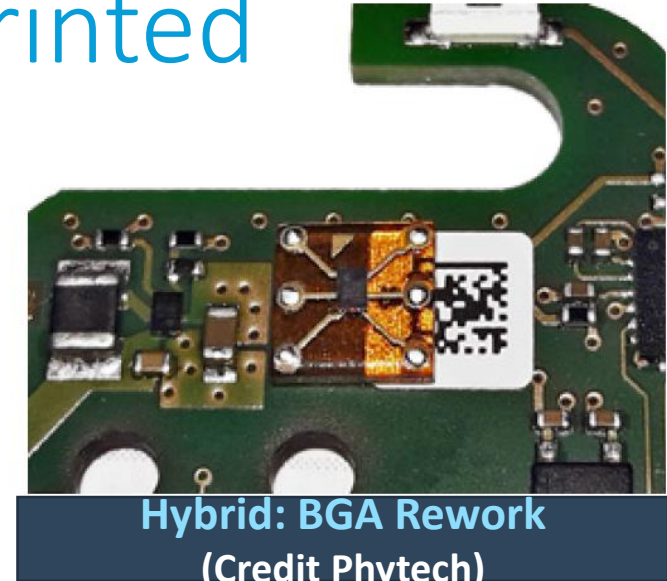
Planar: 100% Precision 3D Printed



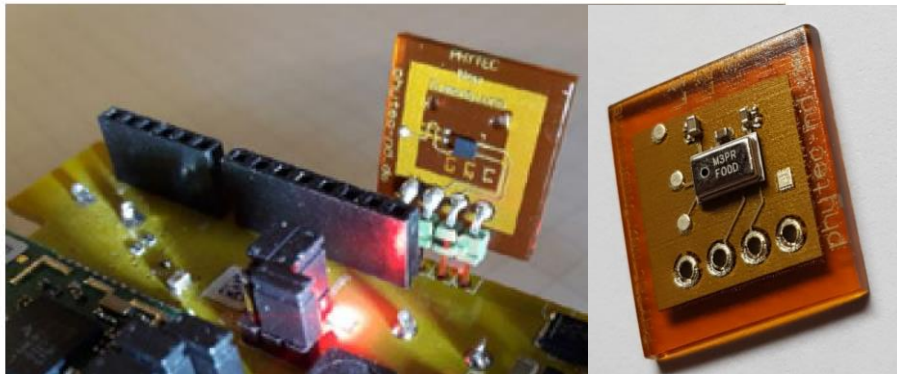
RF Amplification
(Credit: Harris Corp.)



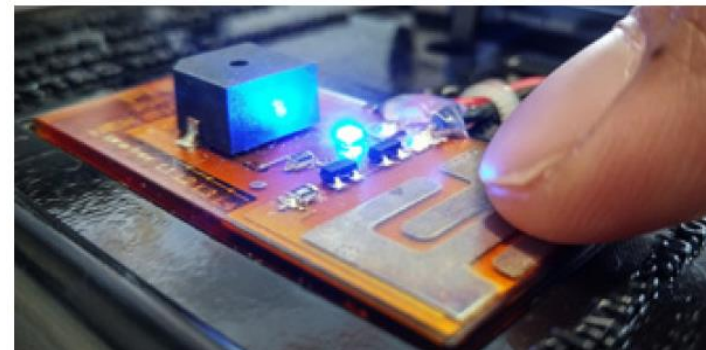
12-Layer PCB



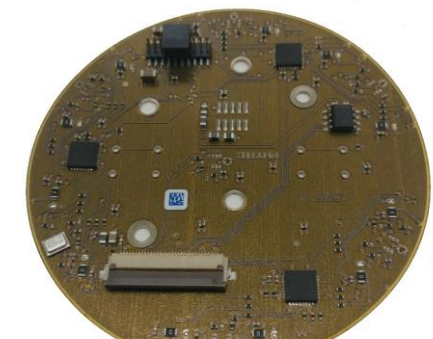
Hybrid: BGA Rework
(Credit Phyttech)



Temp. & Humidity Sensors

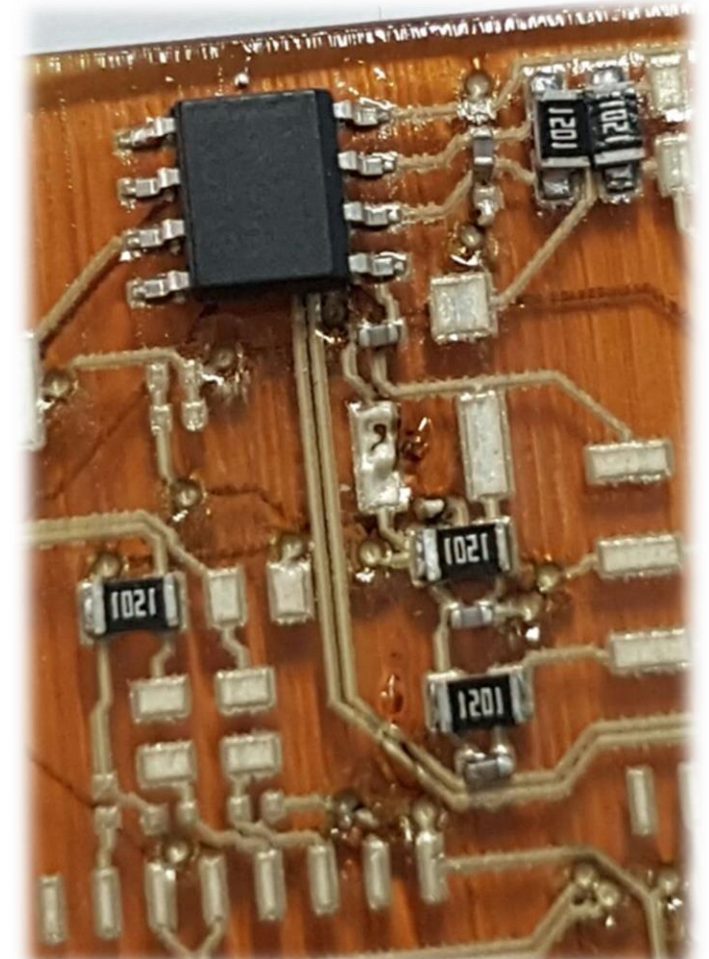
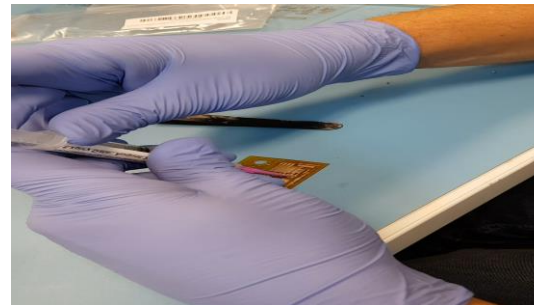
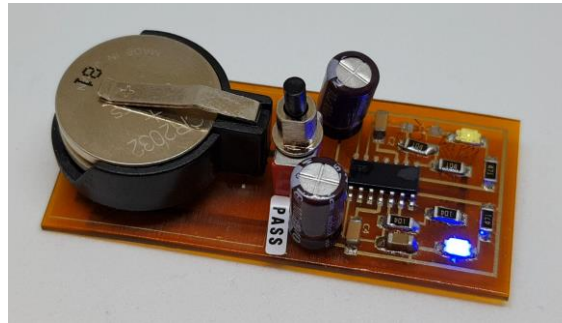
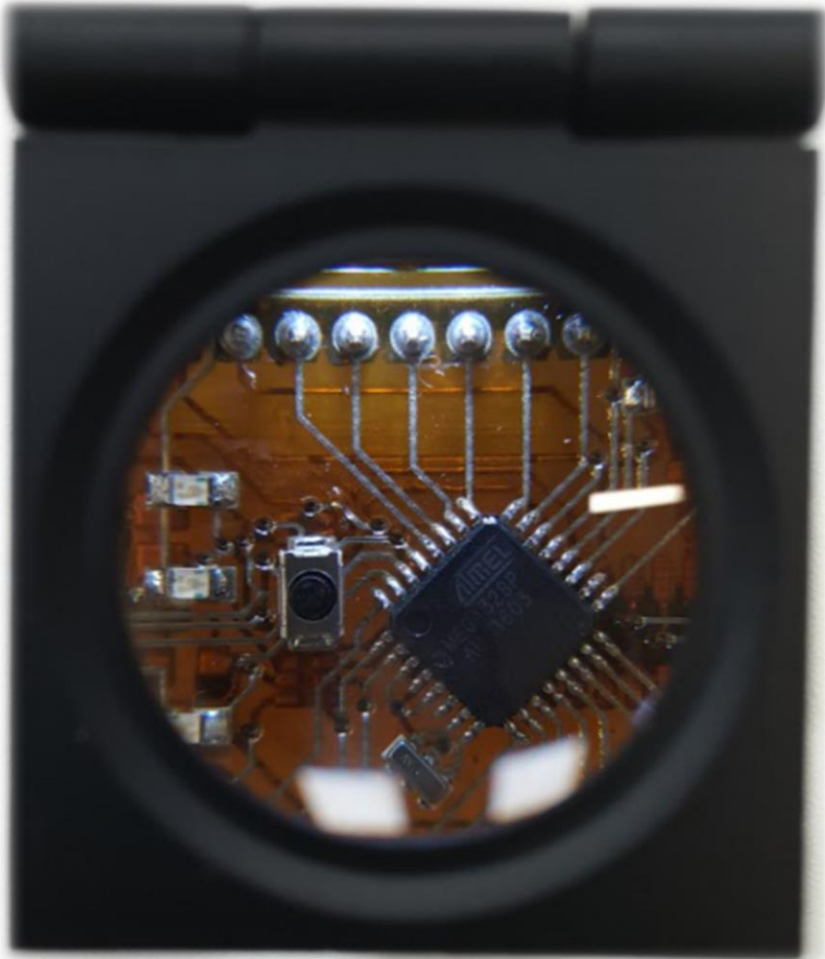


Capacitive Sensors



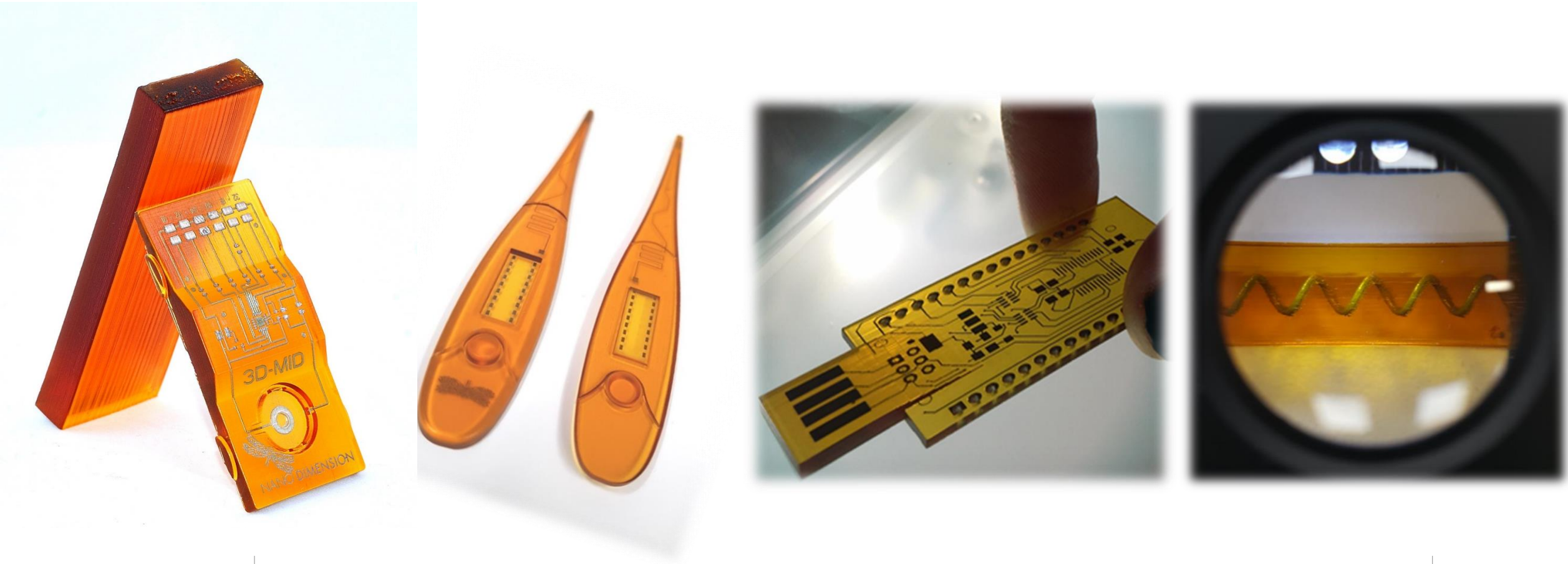
6-Layer PCB

Soldering To Printed Silver Ink

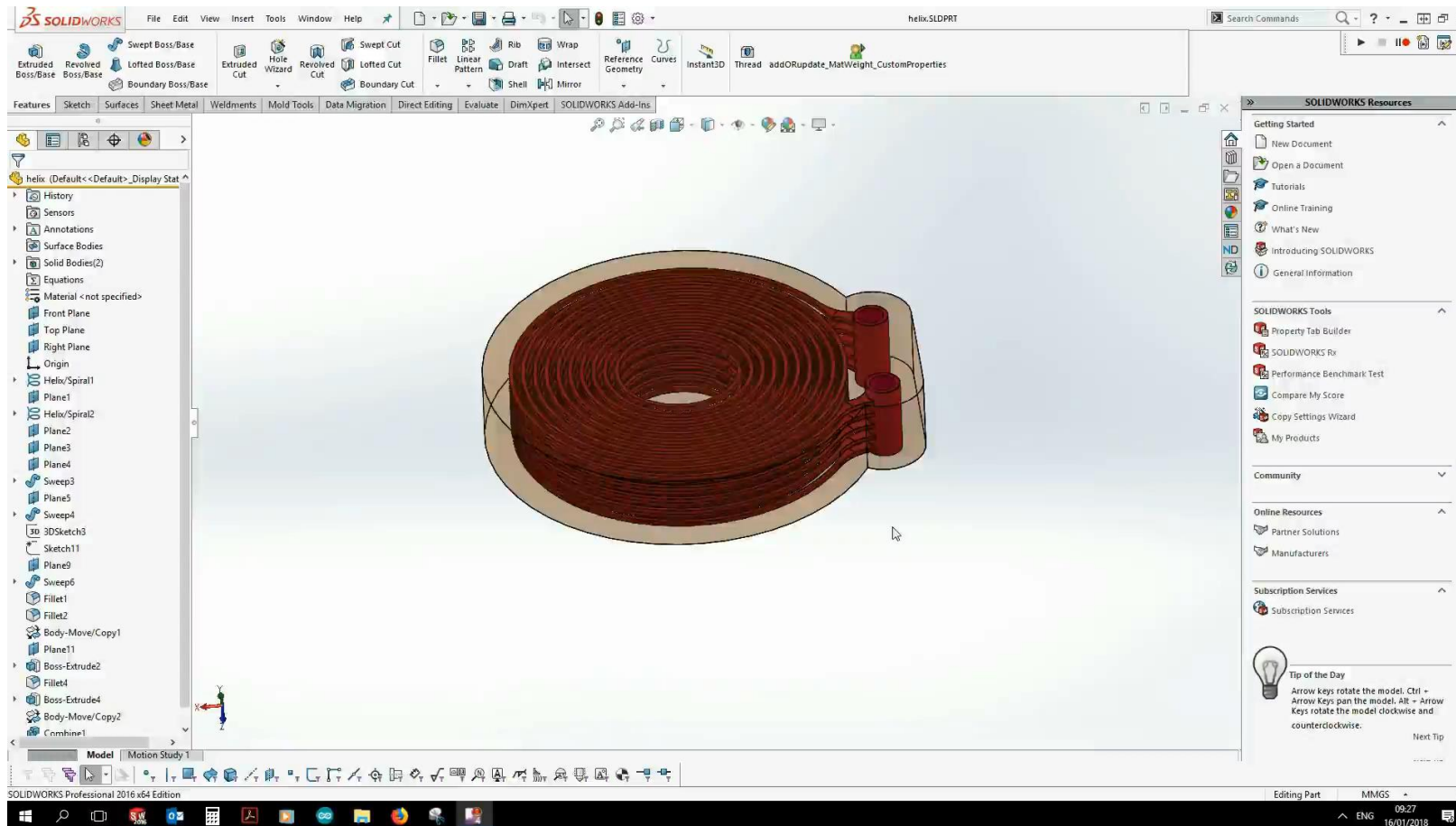


Non-Planar & Electromechanical

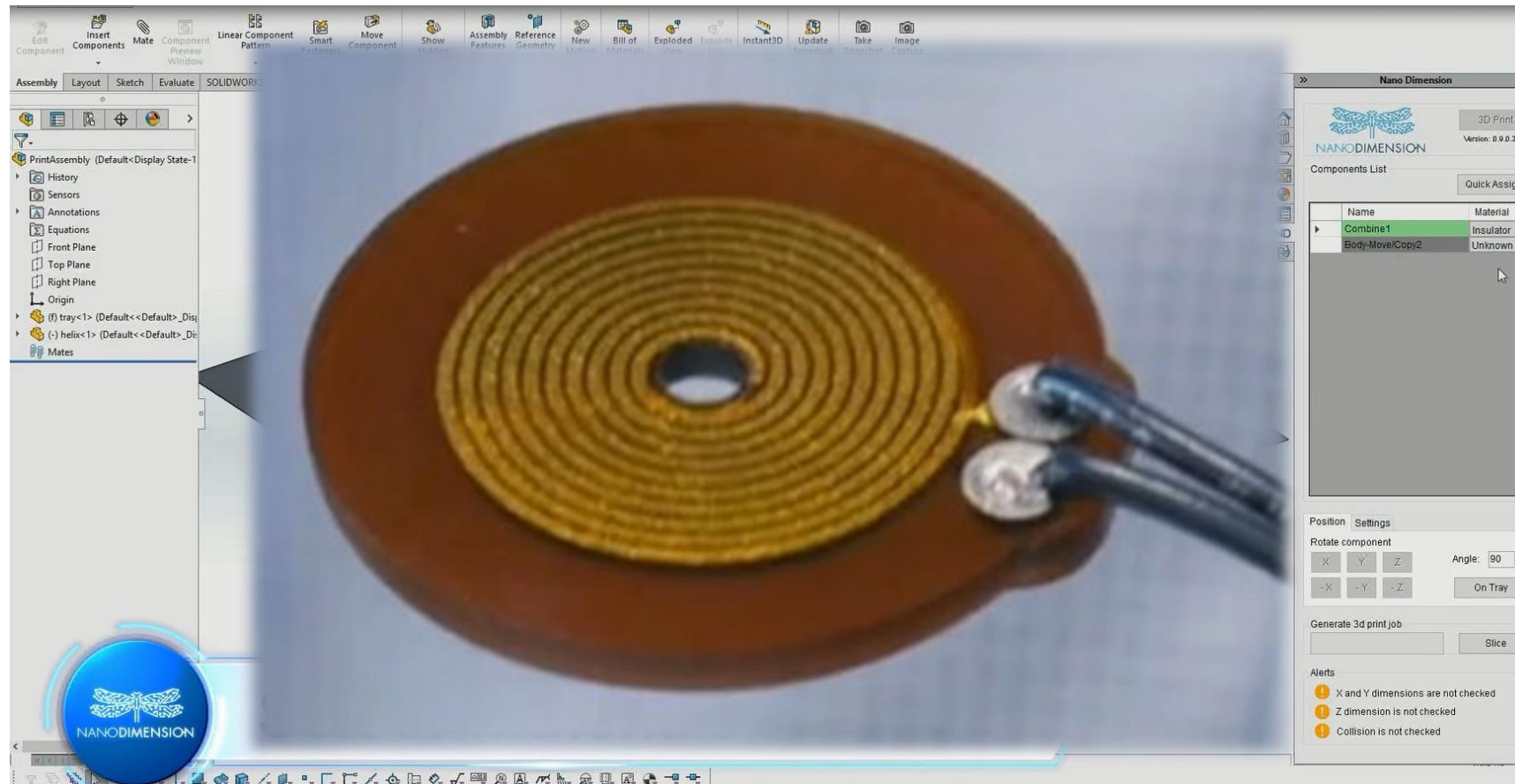
Structure & Function: Make the Unmakeable



From CAD to Electromechanical Part

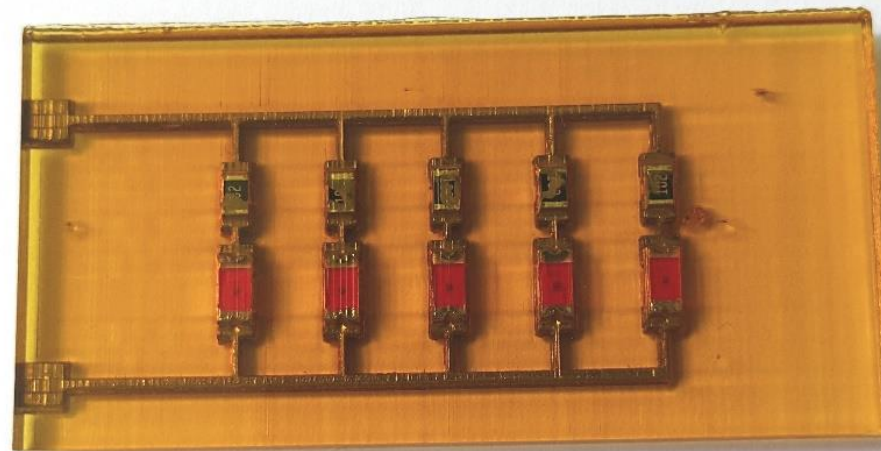
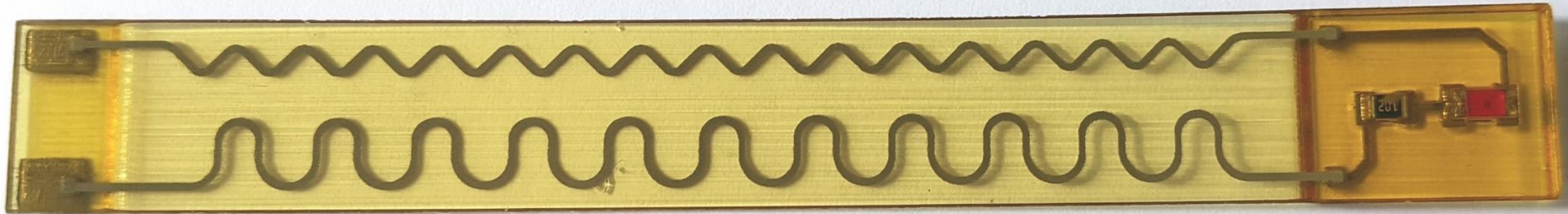


SOLIDWORKS Plug-In



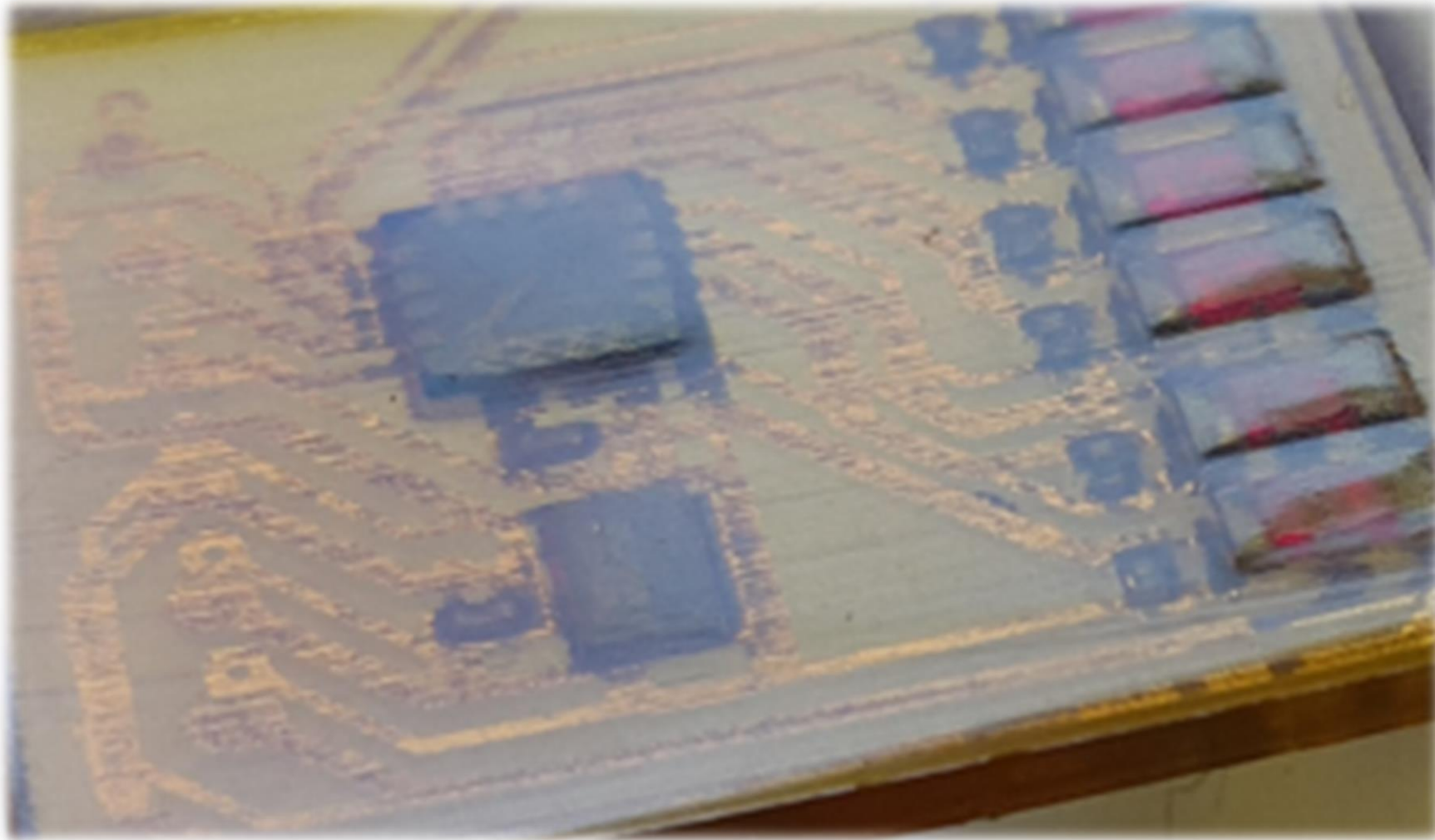
The Future of Form & Function

Rigid-Flex & Embedded Components



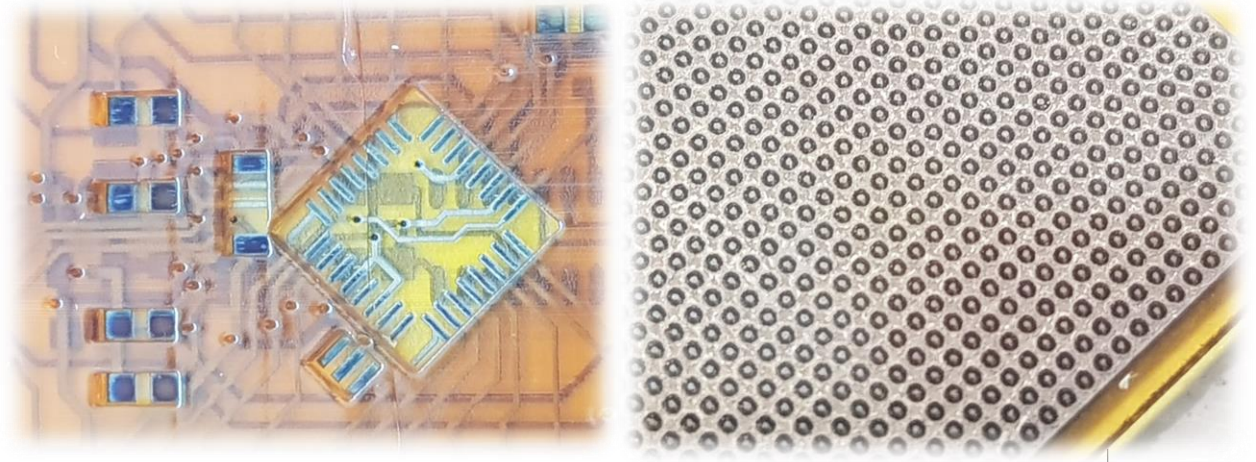
*Currently in development

Components: Flipped QFN, Resistors & LEDs



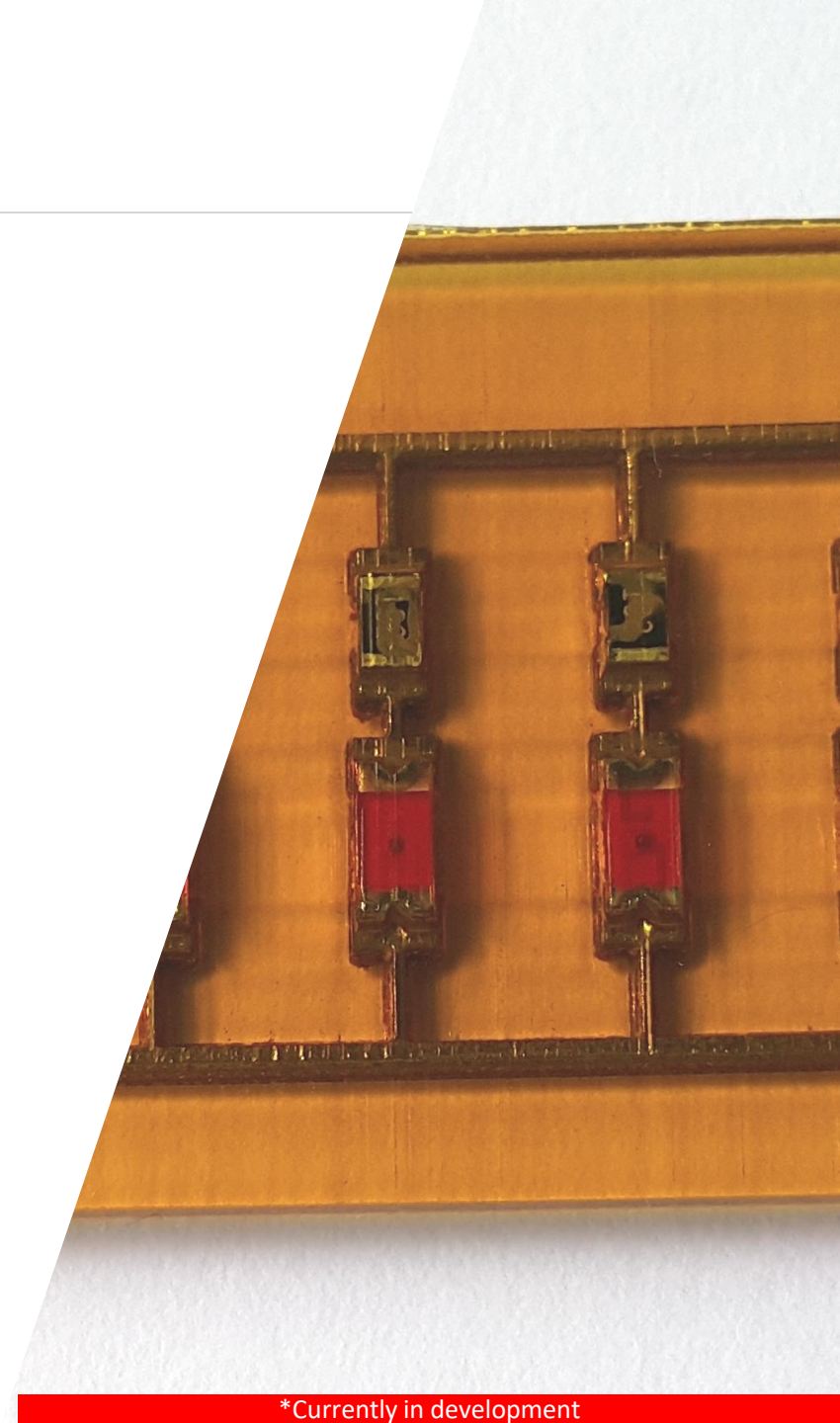
Future?

- **Materials**
Wider range of mechanical (rigid – flex), and dielectric (low - high) properties
- **Assembly**
Integrated assembly capabilities and use of digital components (e.g. printed passives)
- **Design**
Non-planar design, simulation
- **Security**
Traceability, unique/proprietary features, materials recipe, no inventory



Uses

- Traditional PCBs prototyping
- Low volume manufacturing of traditional PCBs
- Antenna prototyping and production
- Non-planar circuits and antennas
- Embedding of components*
- Electromechanical products*
- Combining all of the above?



THANK YOU



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