



Neotech AMT

Advanced Manufacturing Technologies for 3D Printed Electronics

3D Printed Electronics for Mechatronic Systems

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22.05.2019 - 32. Chemnitzer Seminar

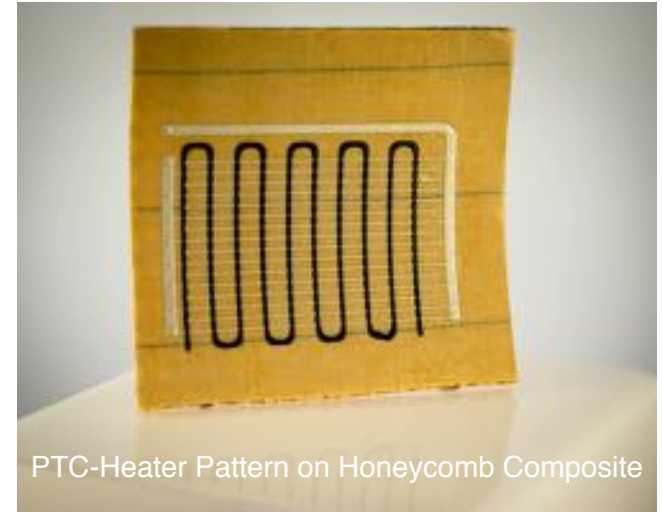


Agenda

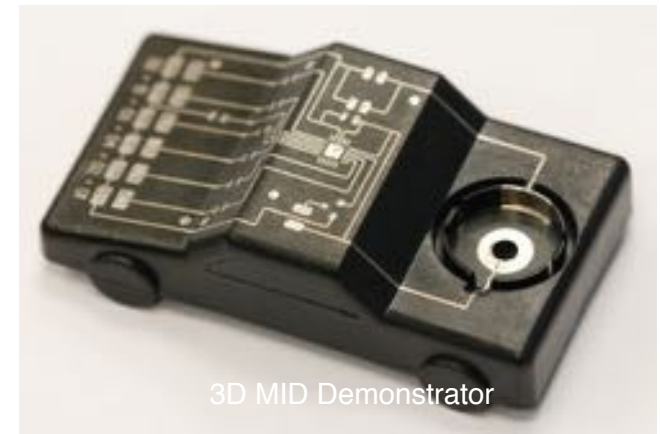
- 1. Company Overview*
- 2. Designing a 3D Printed Electronics Process*
- 3. Application Examples*
- 4. Beyond Simple Circuits*
- 5. 3D Print Systems*

Neotech AMT GmbH

- Neotech manufactures system for 3D Printed Electronics.
- Pioneering 3D PE development since 2009.
- First 3D capable system installed in 2010.
- First mass-production capable system of type 45X built 2012. EU/US/CN patent granted 2015.
- 1st commercial sale & install of mass production system in Q3 2013.
- 1st commercial mass production started on Neotech systems in Q3 2015.



PTC-Heater Pattern on Honeycomb Composite



3D MID Demonstrator

Market Need for 3D Printed Electronics

Design Flexibility

Integration of Mechanics-
Electronics-Optics

Flexibility of Shape

Minaturisation

New Functionality

Economics

Reduced Part Count

Shorter Process Chains

Reduced Materials Use

Increased Reliability

Environmental

Reduced Materials Mix

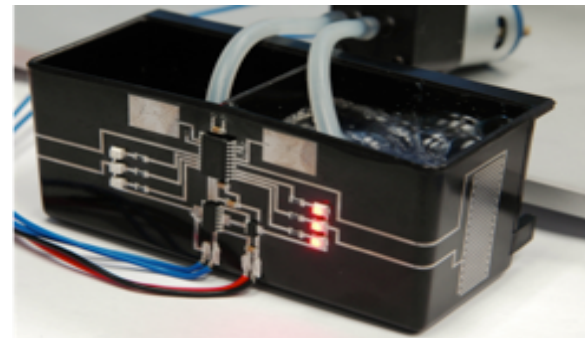
Simplified Recycling &
Disposal

Reduced Material Quantity

Reduced Parts Tourism



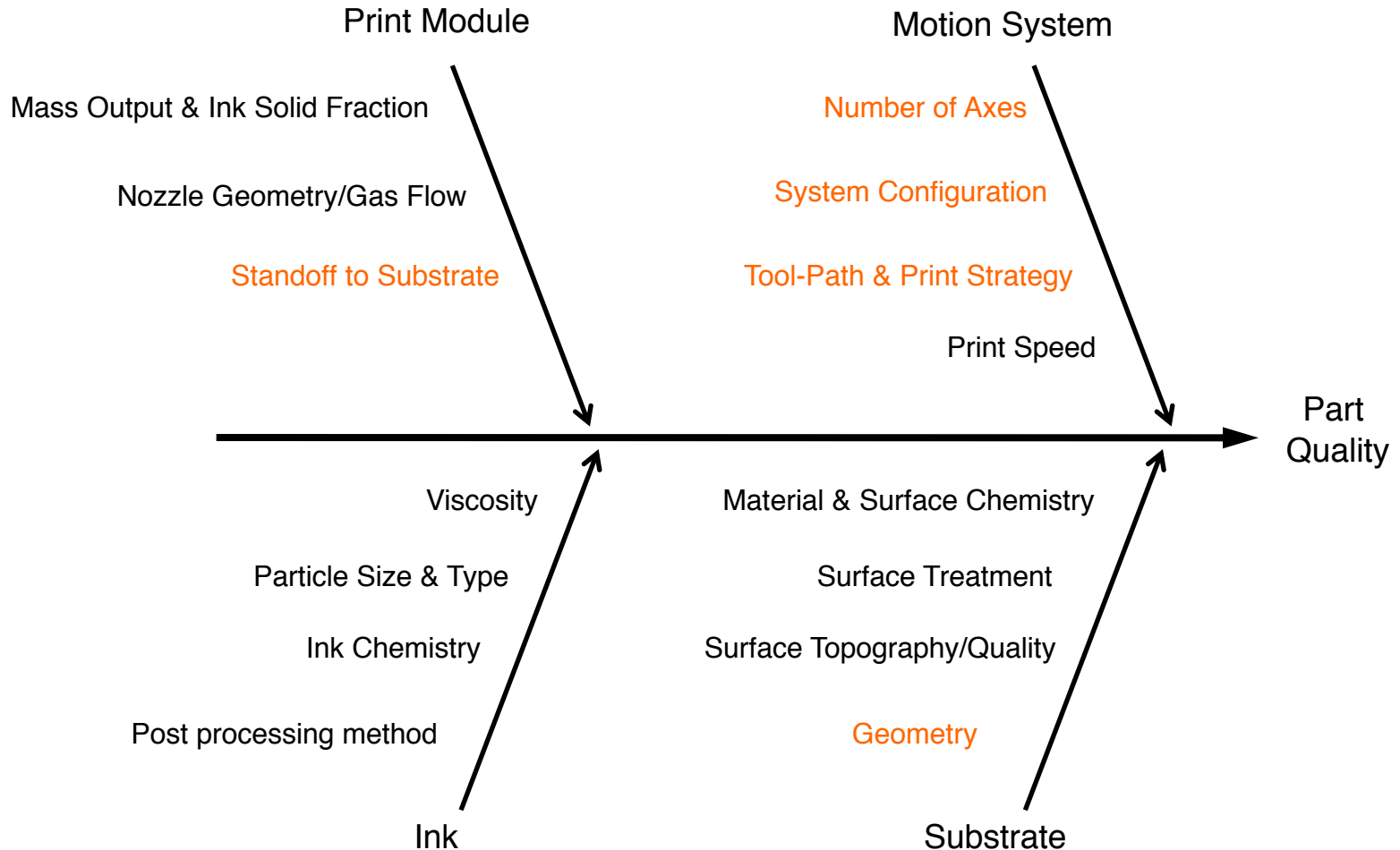
Multi-station Printing
at LITE-ON Mobile Mechanical SBG



Tank Filling Sensor
Automotive

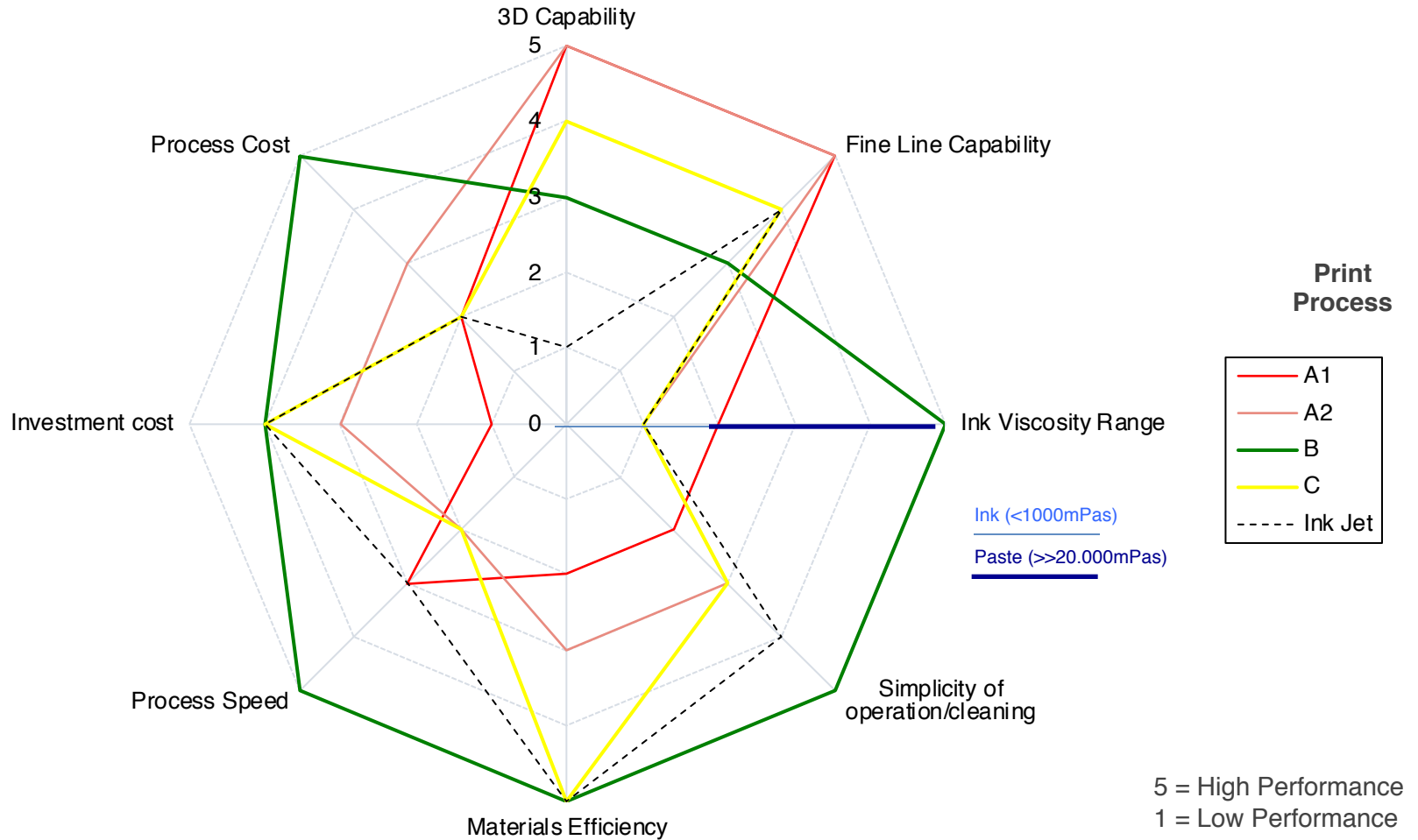
Enabling a 3D Printing Process

Key Process Variables



Print Head Selection

Each print process has a unique combination of characteristics
 Process selection driven by application requirements:



A1 = Aerosol Process 1, A2 = Aerosol Process 2, B = Piezo Jetting, C = single nozzle InkJet

Dealing with complex geometries

Motion 3D CAD/CAM Tool-path Generation Software

CAD/CAM package that seamlessly interacts with the print platform to enable the printing of highly complex 3D circuits:

Simple process flow for 3+2 indexed to 5 axis simultaneous printing

Optimised cycle times via free definition of the print sequence

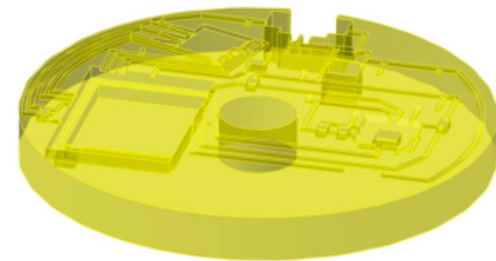
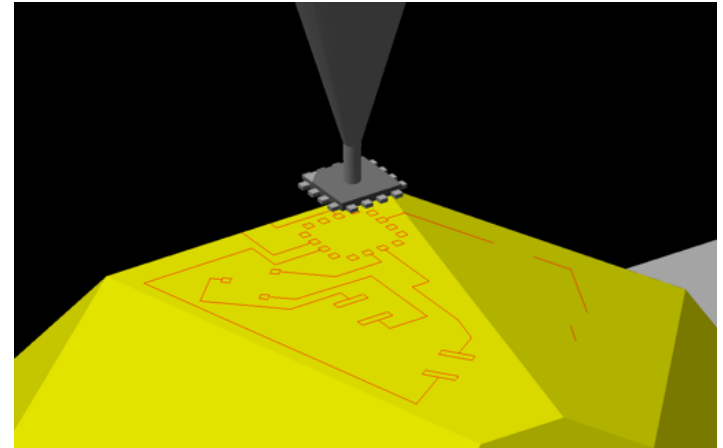
Machine motion simulation & collision detection

Look ahead function for accurate start/stops of the print process

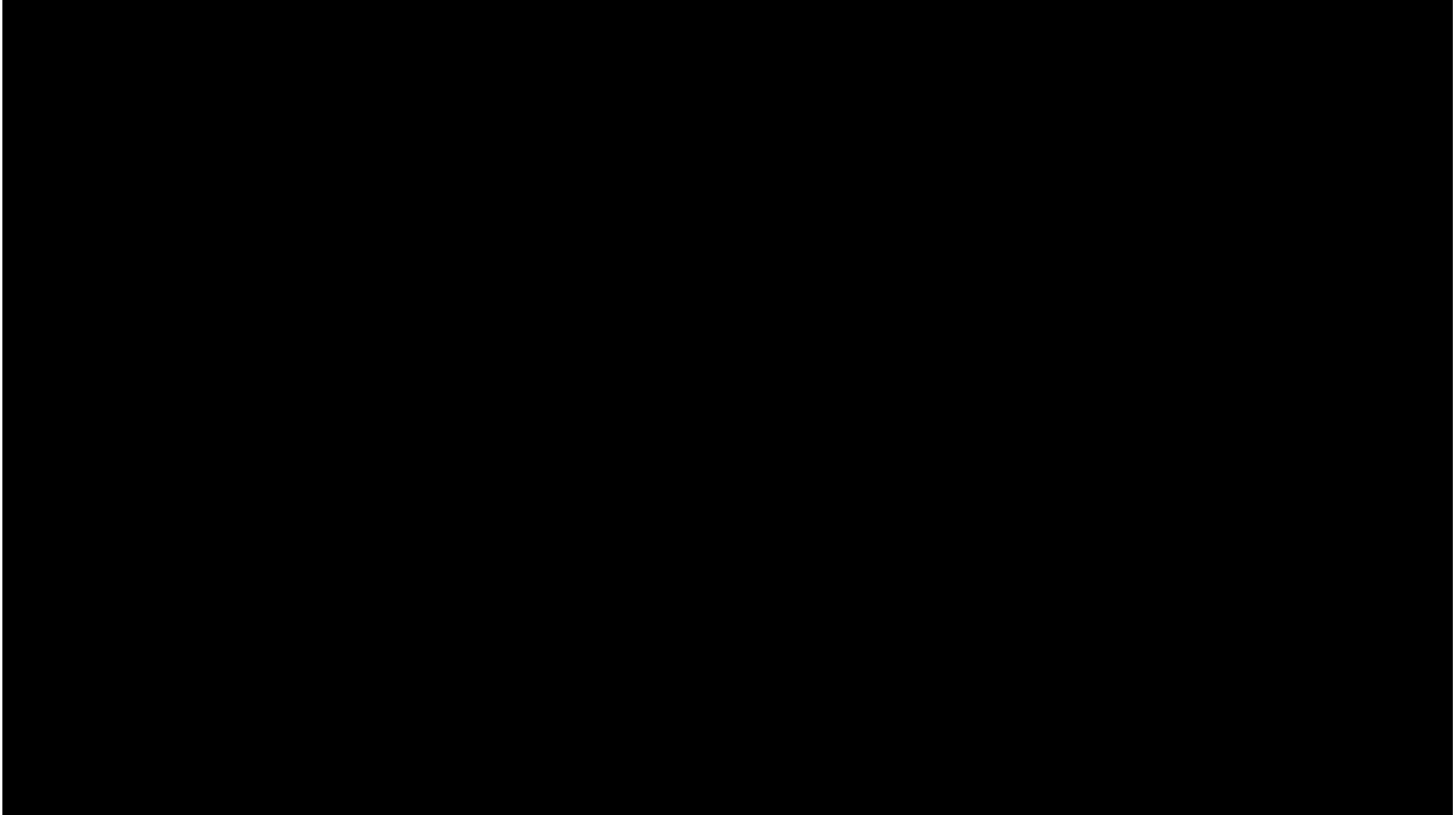
CAM Check Function – check programmed tool-path vs. machine process limits (point to point time, acceleration and axis speed)

Machine specific ISO Standard G-Code post processor

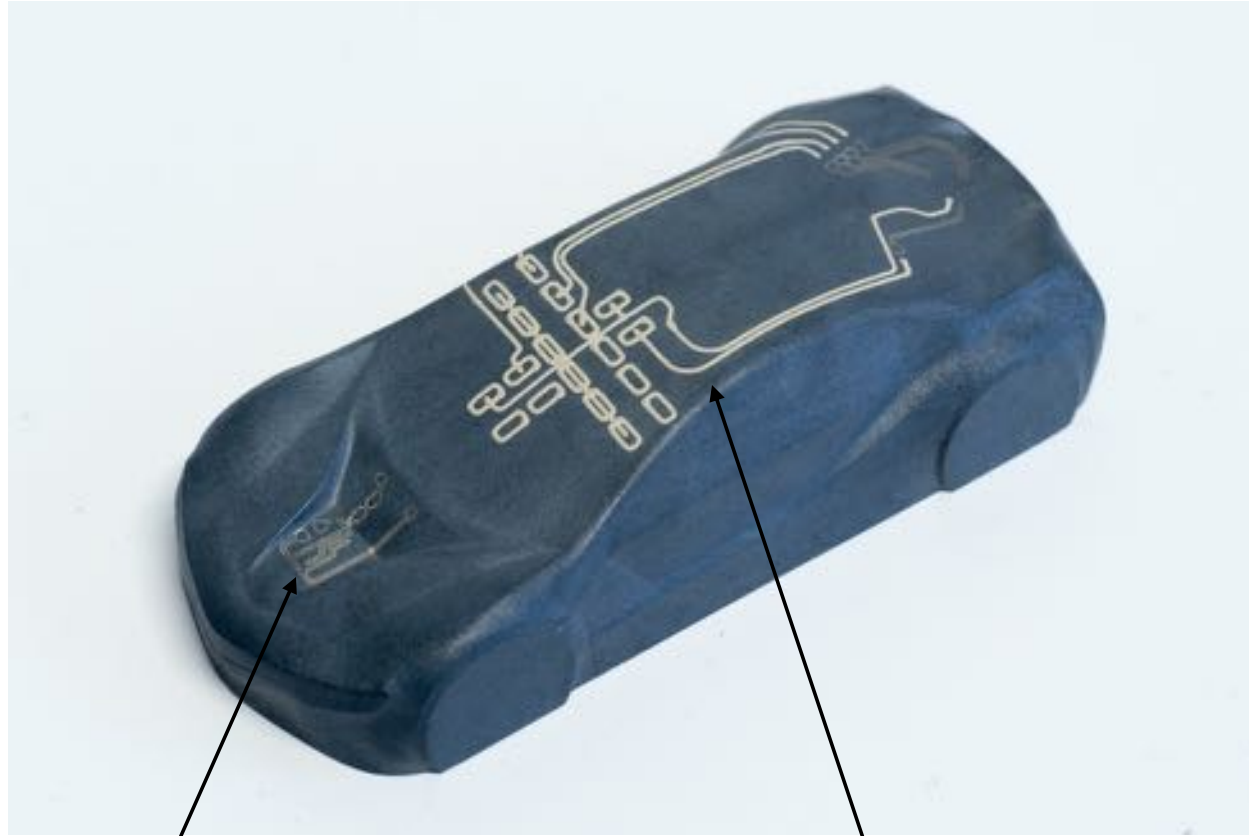
All process steps (3D Print, 3D Circuit Print, SMD Pick & Place, Pre-/Post-processing) in single machine code



5 Axis Print Demonstration



Example of Dual Print Technologies



NanoJet

Fine Line (ca. 60um)
Ag Nano-particle Ink
Viscosity: 20mPas

PiezoJet

Medium Line (300um)
Ag Ink with particles D90 ca. 6um
Viscosity ca. 70.000mPas



Current Applications

Printed Antenna/Circuits

1. Current Process Route: Printing Ag inks on filled PA resins and oven sinter
2. RF Performance: matches industry standard
3. Low temperature inks for PC/ABS
4. Production Costs: specific antenna designs show cost reduction of compared to current manufacturing techniques



Demonstration Antenna
Courtesy: LITE-ON Mobile Mechanical SBG



Multi-station Printing.
Courtesy: LITE-ON Mobile Mechanical SBG

Switch Paddle Circuit

Automotive

Proof of Concept study

Target higher level of integration & cost saving

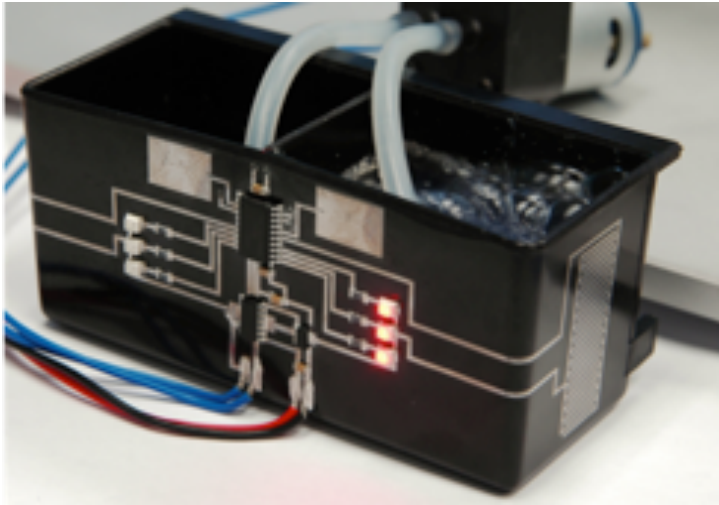
Circuit printed directly on switch paddle body – remove PCB

Next step replace connector cable with printed circuit/interconnect – cost saving

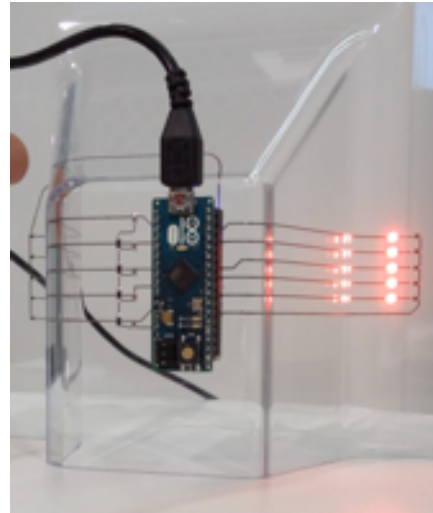
Courtesy:



3D Printed Sensors



Tank Filling Sensor
(Capacitive)



Touch Sensor on
moulded PC
(Capacitive)



Strain Gauge on 3D
Printed PLA
(Fraunhofer IFAM)

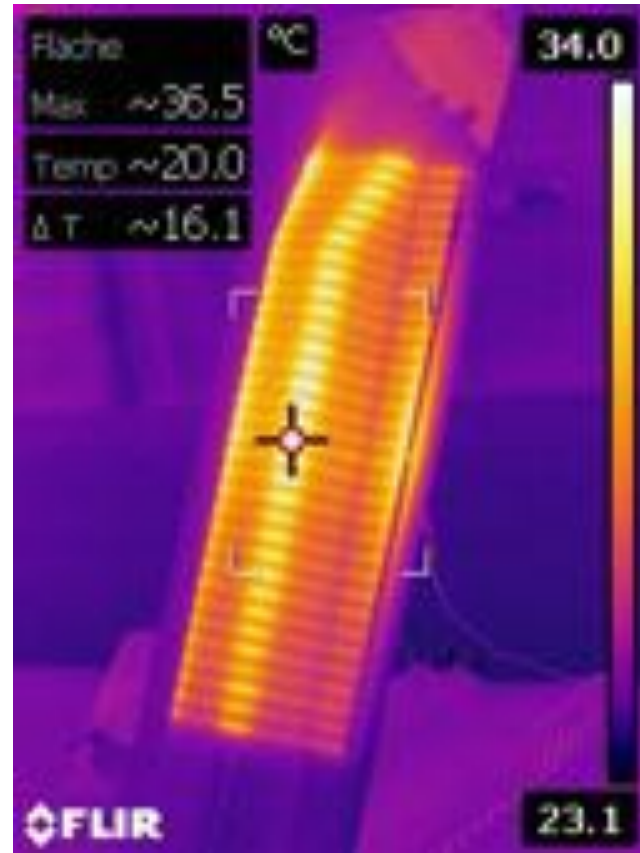
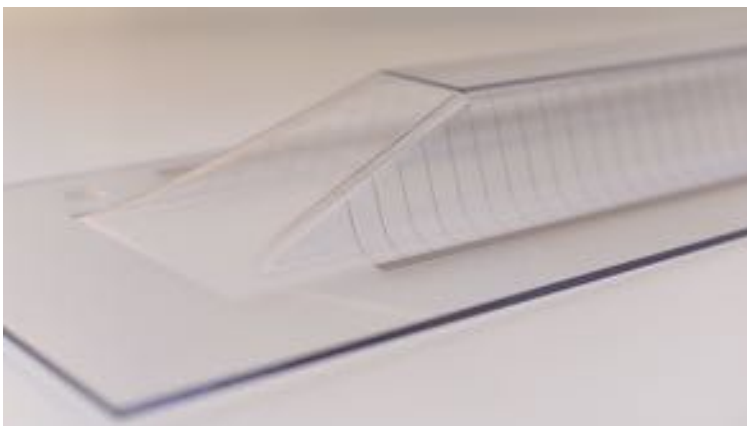
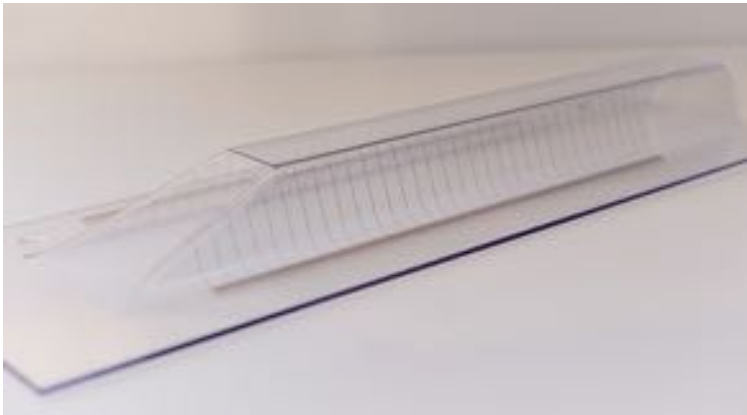
3D Heater Patterns on PC

Automotive Glazing

Ag heater circuits printed on large PC part: 750 x 250 x 170mm (x-y-z)

Heating 18W (3A/9V) – tune print process to increase heating capacity

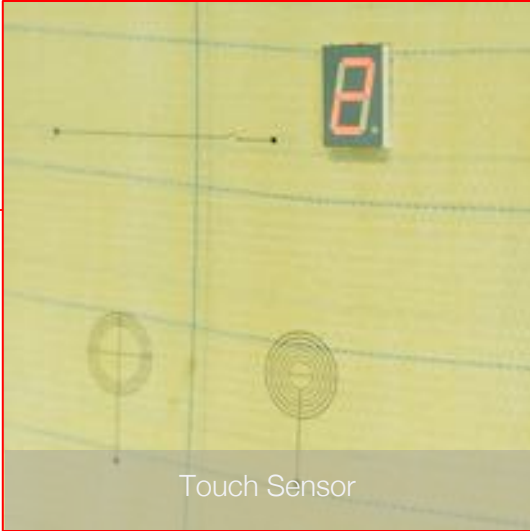
Parts to be coated with protective anti-scratch/anti-UV layer



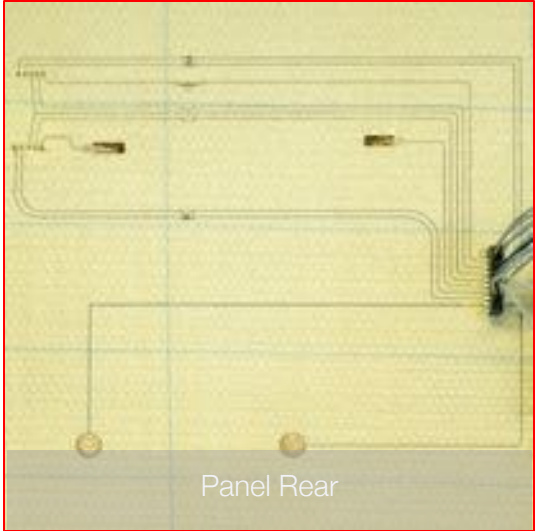
Smart Cabin Panel



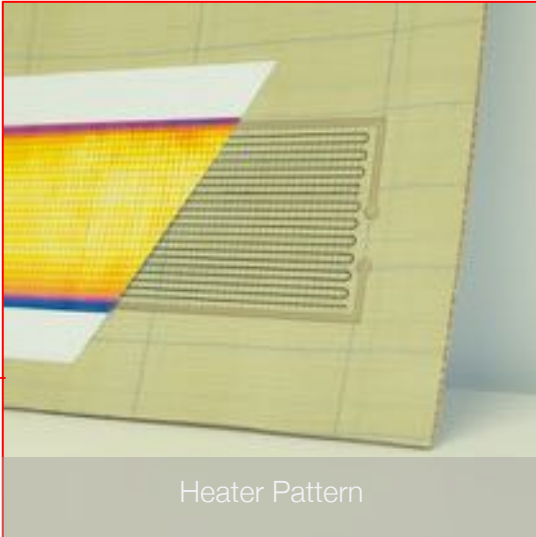
3D Printed Electronics
on Lightweight Honeycomb Panels
(FeVedis)
Heetsch 701
Fraunhofer



Touch Sensor



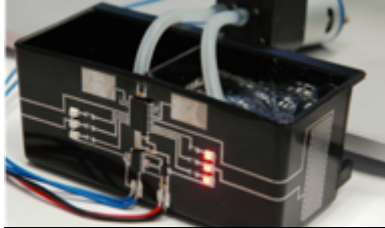
Panel Rear



Heater Pattern

Additional Functionality for 3D Printed Electronics

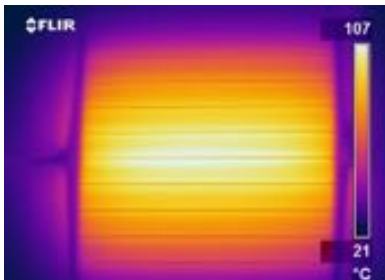
3D Today



Circuits & Sensors

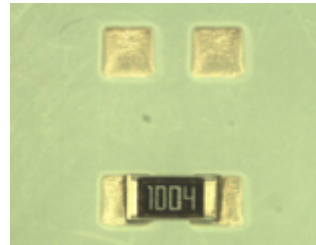


Antenna

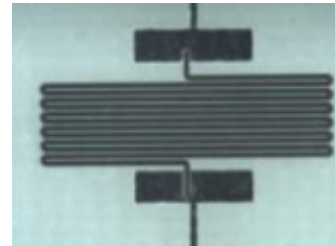


Heater Patterns

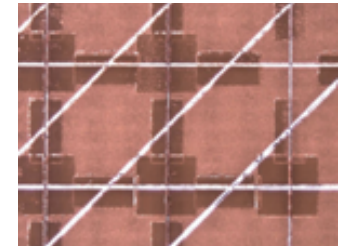
Printed in 2 to 2½D Today -> Future in 3D?



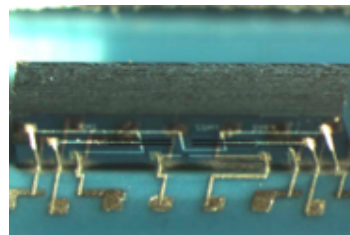
Chip Bonding¹



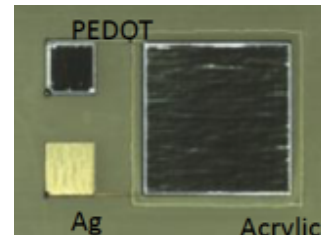
Resistors¹



Multilayer Circuits¹



3D Interconnects²



Capacitors¹



Transistor Circuits¹

¹ Courtesy Optomec Inc.

² Courtesy Fraunhofer IKTS

Chip Interconnection SMDs

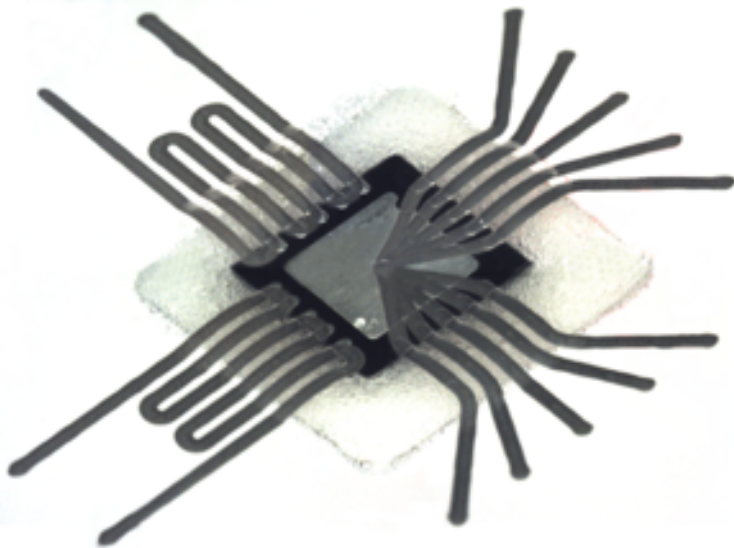
Concept: SMD fixed with adhesive on/in part surface, then direct print of circuit and interconnect

Benefits:

- Low temperature route, no soldering
- Simplified material mix, simplified re-cycling
- Simplified processing
- Extremely robust package, especially when embedded

QFN (Quad Flat No-lead) Microcontroller

Interconnect/Circuit 230 μ m in Ag, Fixed with 2 Component Epoxy



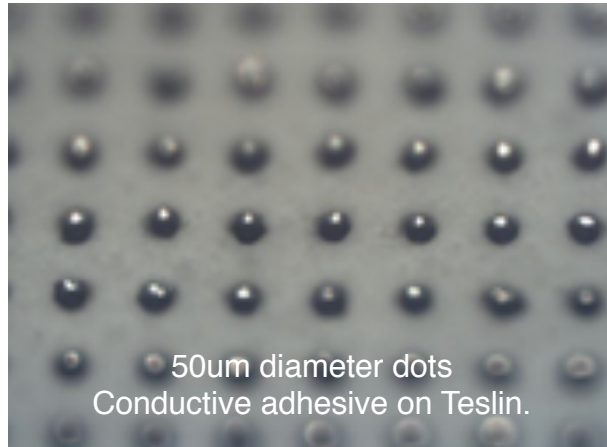
Embedded in PC



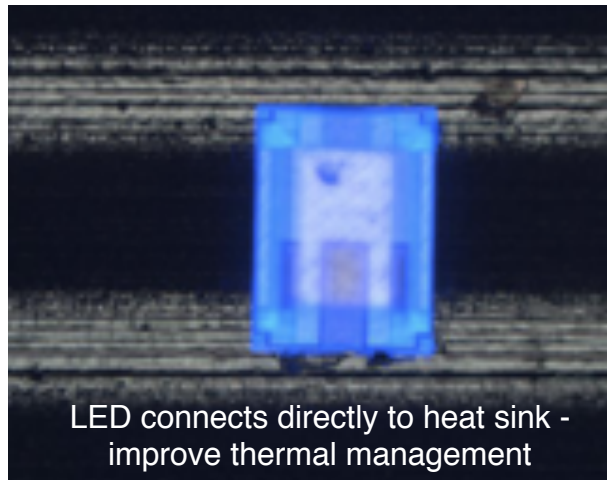
Surface mounted on glass

SMD Connection

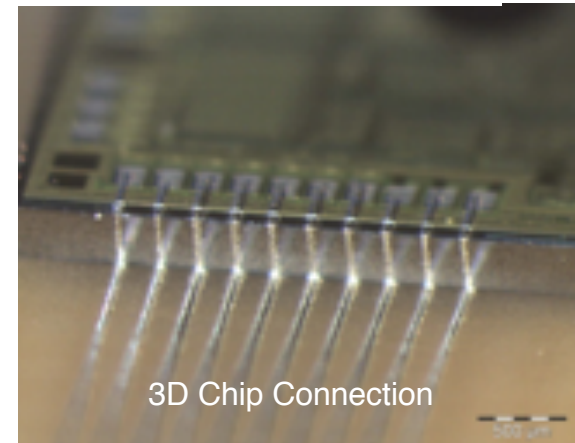
1. Print Conductive Adhesive – Flip Chip



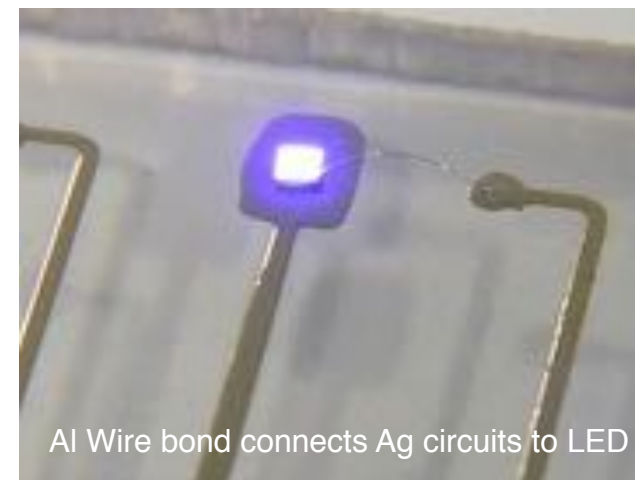
2. Use Circuit material to fix SMD



3. Directly Write Interconnects



4. Wire Bond onto printed circuit



Technology Goal

To provide complete 3D Digital Manufacturing Process Chains spanning all production levels

Prototyping -> Medium Volume

High Volume

3D Print Mechanical Structures

Traditionally Manufactured Part
(e.g. Injection Moulded)

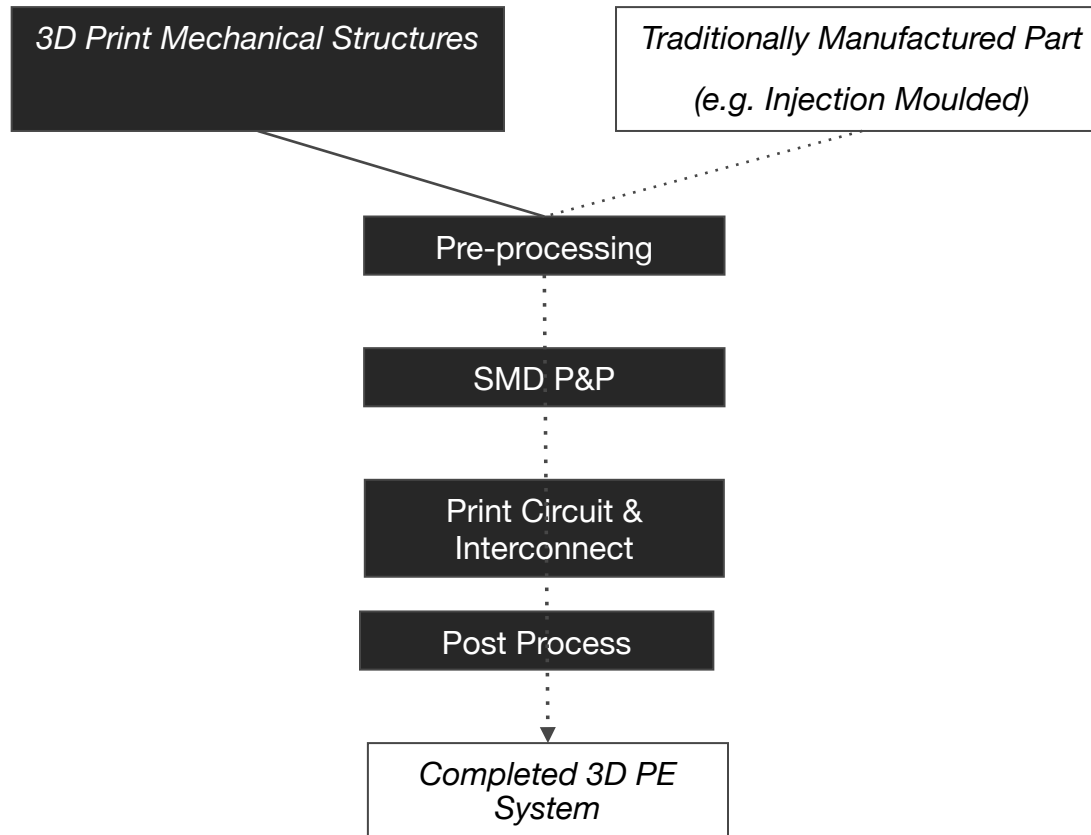
Pre-processing

SMD P&P

Print Circuit &
Interconnect

Post Process

Completed 3D PE
System



EU PENTA Project: Hyb-Man

Hybrid 3D Manufacturing of Smart Systems

1. Develop hybrid 3D manufacturing methods to enable flexible first time right production of smart systems
2. Exploit 3D Printing of polymers in combination with 3D Printed Electronics as core production technologies
3. In-line testing and quality monitoring processes will be integrated as part of the complete process chain
4. Outcome: improved Additive Manufacturing processes, a hybrid manufacturing production cell and prototypes of integrated electrical products (LED luminaires, automotive adaptive sensors)

Processes, Materials & Equipment

Industrialization

Products



TNO

Technolution

TU/e
HTSC

reden
research development nederland



Signify



Fraunhofer

Henkel

XENON

Neotech AMT
Advanced Manufacturing Technologies for 3D Printed Electronics

BOSCH

EU PENTA Project: Hyb-Man

First Product Demonstrator: LED Box

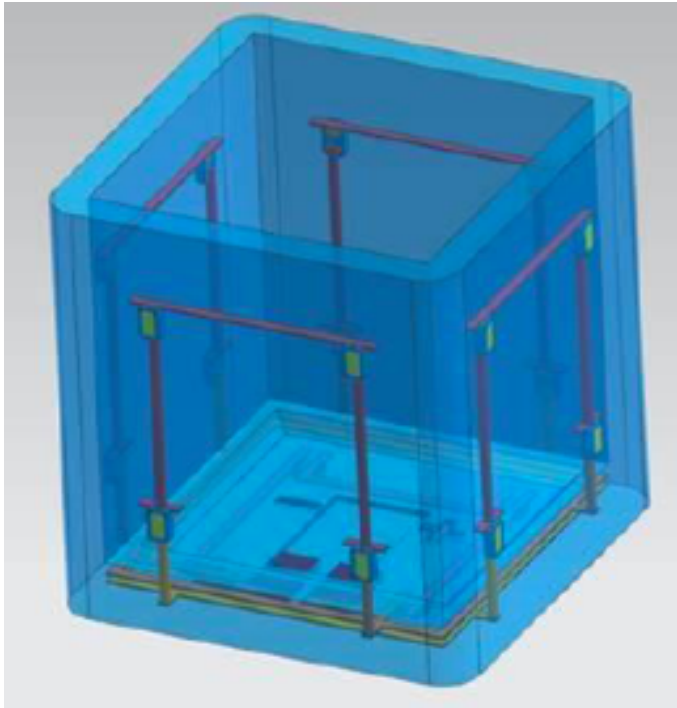
Main box body printed in PLA, next transfer to PC/ABS then PA

20 LEDs added (5 sets of 4):

4 in base added and then circuit printed to directly contact.

16 LEDs in walls mounted with conductive adhesive.

Side wall circuits use 5 axis motion



EU Manunet Project: AMPECS



1. Will develop fully Additive Manufacturing process for 3D Printing Electronics with Ceramic Substrates
2. The German-Spanish consortium will develop 3D printable ceramic materials for creating the structural body and integrate printed electronics into and onto this component.
3. End use applications will cover areas where harsh environments exists such as automotive and aerospace as well as in mobile communications.

Project Timeframe:1.6.17-31.5.20



Francesco Alberto S.A.U



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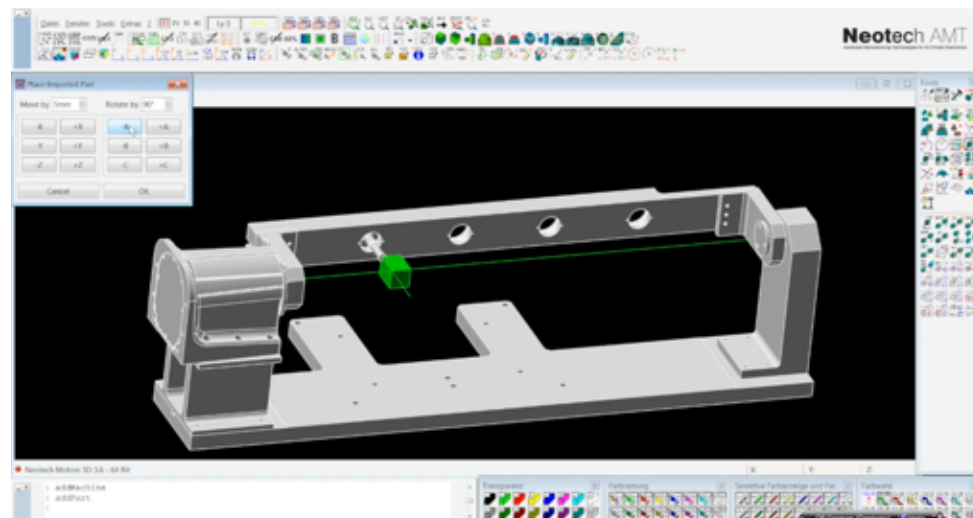


System Offerings

Neotech Products

Consist of 5 axis machine tools containing a variety of 3D capable print, pre- and post-processing tools with integrated software, training & service:

Print Platforms	Print/Functionalising Tools	Pre/Post-Processing
45X – multi head systems for volume manufacture	Piezo Jetting	CNC Machining
15X – “single” head system for R&D/Product Development	Aerosol Based	Plasma Cleaning
or custom size	Ink Jetting (Single & Multi-Nozzle)	Sintering (Light/Laser)
+ 3D CAD/CAM Software	Dispensing	UV Curing
	FDM	Adaptive Tool Path Vision System
	SMD Pick & Place	





Summary

1. Designing 3D Printed Electronics process
2. Current Application Examples
3. Development to more complex device manufacture
4. “Fully Additive” 3D Printed Electronics

Neotech AMT

Advanced Manufacturing Technologies for 3D Printed Electronics

Thank you for your attention!

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