Hybrid 3D manufacturing of smart products

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THE CHALLENGE: EVOLVING ELECTRONICS MARKET

Electronics manufacturing is still heavily relying on **mass production**:

- **Standard** products and components, rigid supply chains
- **High investment** cost (tooling, R&D)
- Long initial **lead times** (tooling, shipment)

Industries like Signify and Bosch are facing:

- Demand for **customized and personalized products** leading to increased diversity
- Request for **new product designs** offering **improved functionality and form factors**
- Need for **cost effective manufacturing of small series**.
- Need **faster response** to changes in the market.

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**Need for more flexible manufacturing methods**

- No product specific tooling → low investment → short lead time
- Design freedom
  Integration of functionalities
- Local/distributed manufacturing
- Digital process
  Digital design
- Stock free
  More flexible supply chain
The Hyb-Man project will develop **hybrid 3D manufacturing methods** to enable **flexible first time right production** of **smart systems**

**Product Cases**
- Automotive
- Adaptive Sensors
- LED Luminaires

**Technology Development**
- Hybrid 3D manufacturing methods, combining:
  - additive manufacturing/3D printing
  - 3D electronic structure processing
  - 3D assembly & interconnect

**Design Rules**
- Inline testing
- Quality Monitoring

**flexible first time right production**
HYB-MAN APPROACH

**Design guideline activities to link relations materials-processes-products**

- **Product architectures**
  - Product designs

- **Metrology**
  - T, geometry, conductivity

- **Processes and technologies**
  - **AM**
    - FDM, SLA, dispense
  - **3DPE**
    - jet, dispense, FDM
  - **P&P**

- **Control platform**
  - Sense
  - Act

**Materials**
- structural, electrical

Complex set of activities
- need to run in parallel
- many mutual interactions
- broad set of competences

→ drive for cooperation in Hyb-Man

**Control platform to integrate processes and metrology**
HYB-MAN ACTIVITIES AND PARTNERS

Product architectures
Invented for life

TU/e
Technische Universiteit Eindhoven
University of Technology

reden
Research Development Network

Materials
Structural, electrical

Henkel

T , geometry, conductivity

Design guidelines

Senses
Act

Processes and technologies
AM
FDM, SLA, dispense
3DPE
jet, dispense, P&P

• Reden
• Signify
• Technolution
• TNO
• TU Eindhoven
• VSL

• Fraunhofer IFAM
• Henkel
• Neotech AMT
• Robert Bosch
• Xenon
HYB-MAN RESULTS – 5-AXIS PLATFORM & LED DEMONSTRATOR

3D product design: LED cube containing integrated tracks, LEDs and connection

hybrid manufactured functional product

Processing route for 5-axis FFF/FDM

1. Import Step file into Motion 3D CAD/CAM SW.
4. Base printed via FFF in PLA.
5. 4 LEDs in base added and then Ag circuit printed to directly contact.
6. Main body printed with FFF.
7. Side wall circuits use 5 axis motion.
8. 16 LEDs in walls mounted with conductive adhesive.
Process and equipment development:
• Baseline stereolithography 3D printing (SLA)
• Modular
• Pick & place of components
• Interconnection by dispensing metal paste
• Metrology & control
Modular AM process simulation:
• Prediction of internal stresses and warpage
• Prediction of temperature field
• Suitable for multiple AM techniques and materials

3D printing simulation to predict temperature distribution (location and time)

after release from build platform
Additive manufacturing materials (polymers) with increased functionality
→ Filled materials with thermal/electrical conductivity

Balancing properties

1. Tuning polymer properties
   - PA Hotmelts: highly amorphous low polarity

2. Optimization polymer/filler composites
   - doubling of thermal conductivity
   - maintain good viscosity

Material optimization

Optimized product properties
PA hotmelt + multiple fillers
HYB-MAN RESULTS AND OUTPUT

Product designs

Know how

Models

Materials

(Integrated) processes

Equipment and tools

Development platforms

Manufacturing methods

Methods and tools

Product architectures

Product designs

Control platform

Sense

Act

Processes and technologies

AM
FDM, SLA, dispense
3DPE
jet, disperse, FDM

Metrology

T, geometry, conductivity

Control platform

SW platform

SW platform

Methods and tools

Product designs

Know how

Models

Materials

(Integrated) processes

Equipment and tools

Development platforms

Manufacturing methods

Methods and tools
HYB-MAN EXPLOITATION OF PROJECT RESULTS

- Material sales
- Product sales
- Equipment sales

- Manufacturing services
- Simulation consultancy
- Metrology consultancy
- SW platform services

- New partnerships
- New funded projects

- Intellectual property

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Changing environment and customer demands drive the need for **more flexible manufacturing methods**
smaller series, customized products – design freedom – faster response to changes

**Huge opportunities**
- product design
- manufacturing (local, on demand)
- supply chain and business model
- service offerings

**Many challenges**
- technologies and materials
- industrial processes
- first time right
- new product designs

**Multi-disciplinary approach and partnerships** needed to move forward
Hyb-Man is a project labelled by the EUREKA Cluster PENTA, supporting innovation in micro- and nanoelectronics based components & systems.