3D Electronics Integration in Lighting: opportunities and challenges

Rob van Asselt
Philips Lighting Research
January 24, 2017
Electronics mass manufacturing industry

- Optimized for cost and quality
  - Standardized products
  - High upfront investment
  - Long initial lead times
External trends

- Industrial Internet of Things
- Big Data
- Digitization
- 4.0 Industry
- From waste to resources
- Interactive dialogue with customers
The challenge: evolving electronics market

Industries like Philips Lighting are facing needs for:
• customized and personalized products leading to increased diversity
• new product designs offering improved functionality and form factors
• cost effective manufacturing of small series.
• faster response to changes in the market.

Need for more flexible manufacturing methods

- No product specific tooling
- Design freedom
- Local manufacturing
- Digital
- Flexible supply chain (stock, transportation)
Philips LED lighting products

Diverse portfolio:
- modules-luminaires-systems
- small-large size
- indoor-outdoor
- consumer-professional
Product specific tooling

flexible manufacturing: no product specific tooling
LED lighting product functions

wide portfolio → similar functional building blocks

- **Thermal management**
- **LED light source**
- **Optics**
- **Control unit**
  - LED driver, AC/DC
- **Other electrical functions**
- **Mechanics**
  - User interface, control
  - Enclosure/rigidity
  - Connection of parts
  - External connection

Power (mains) input → Light output
Function integration

Combination/integration of functions
Part consolidation

- Part count reduction
  - Easy assembly
  - Simplified supply chain
- Size reduction/miniaturation

Typical product architecture
- Many parts
- Separate parts for separate functions
New designs

discrete electronics “boxes”

distributed electronics/light sources

form freedom, adaptable shapes
The next wave of LED development

1. Replacement conventional → LED
2. Cost down
3. Digitization & feature up
Integration of electronics

LEDs on ceramic heatsink

Injection molded structural electronics

iPhone case with integrated antenna

3D MID, Laser direct structuring
3D printed electronics
Voxel8 3D electronics printing – state-of-the-art

Challenges to move beyond the state-of-the-art:
• Processes and materials for end products
• Industrial processes (reliable, cost effective)
• First time right design and manufacturing
• New product designs fully benefiting from the 3D integration opportunities

Voxel8 Developer’s Kit
+ 3D printed functional products
+ Good quality 3D prints
+ Easy to use SW

- Time consuming process
- Manual insertion of components
- Materials
3D electronics integration approach

Partnerships needed to move beyond the state of the art

- Material requirements
- Process requirements
- Equipment requirements

- Flux, CCT, CRI, lm/W
- Size, weight, mounting

- Product/process performance and long term stability
- Product-process relationships

- New product architectures and designs
- Production and testing
EU project Hyb-Man

Develop hybrid 3D manufacturing methods to enable flexible first time right production of smart systems

<table>
<thead>
<tr>
<th>Ambition</th>
<th>Hyb-Man</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective</strong></td>
<td></td>
</tr>
<tr>
<td>1. Essential technologies</td>
<td>Processes</td>
</tr>
<tr>
<td>2. First time right, industrialization</td>
<td>Process integration</td>
</tr>
<tr>
<td>3. Innovative products</td>
<td>Product designs</td>
</tr>
</tbody>
</table>

Hybrid 3D manufacturing:
- the combination of additive manufacturing/3D printing with processes to apply 3D electronic structures and 3D assembly & interconnect
- including inspection and control methods for processes and products
Hyb-Man consortium

Processes, materials & equipment

Industrialization

Products

Technolution
TU/e
VSL
PHILIPS

Fraunhofer
Henkel
XENON
Neotech AMT
BOSCH
Kühling & Kühling

knowhow
materials processes equipment
integrated systems
new products
Wrap-up

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

Many challenges
- suitable for end products
- industrial processes
- first time right
- new product designs

Multi-disciplinary approach and partnerships needed to move forward materials – processes – equipment – process control – product design – manufacturing – inspection and test