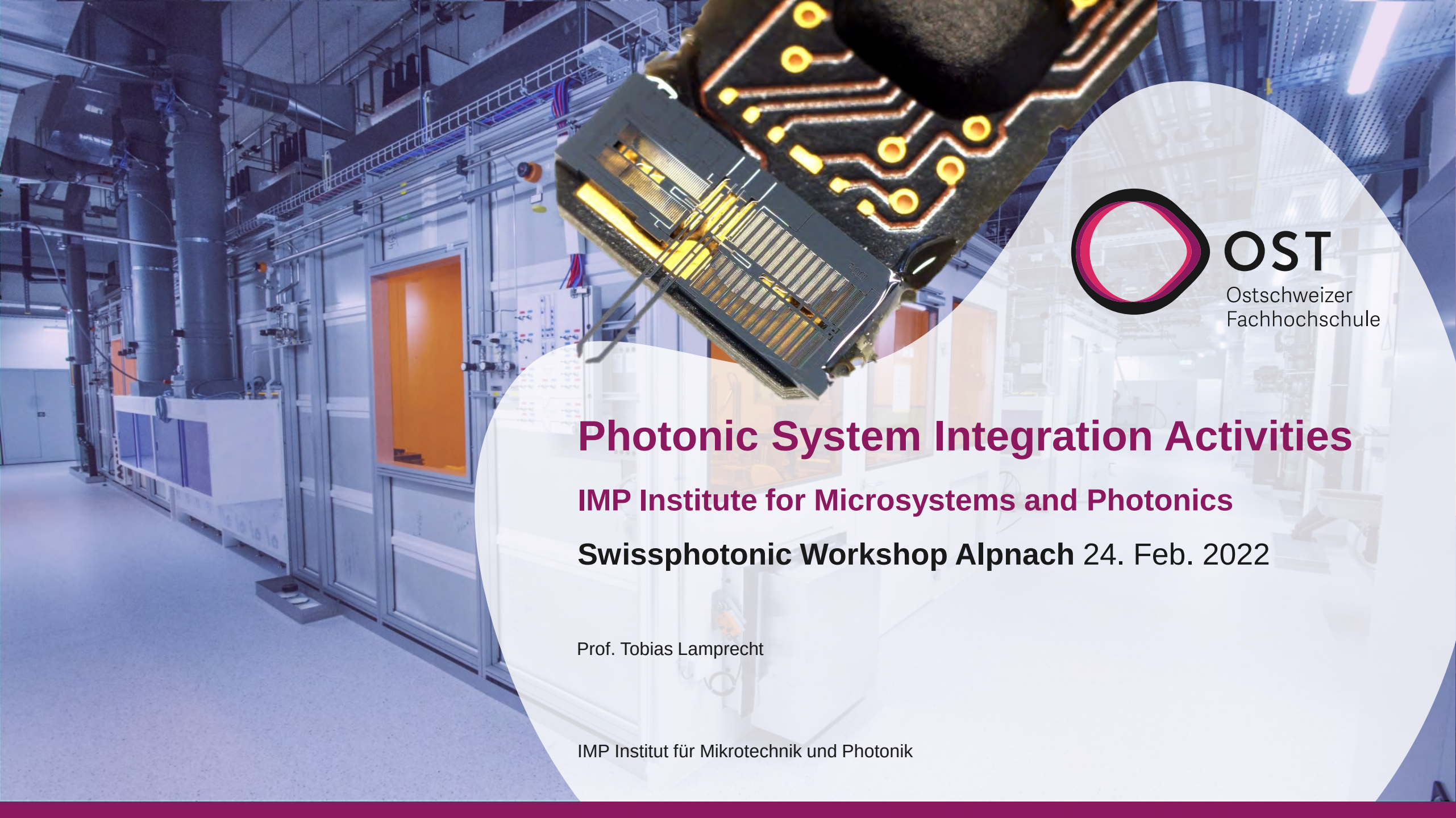


OST
Ostschweizer
Fachhochschule

Photonic System Integration Activities

IMP Institute for Microsystems and Photonics

Swissphotonic Workshop Alpnach 24. Feb. 2022

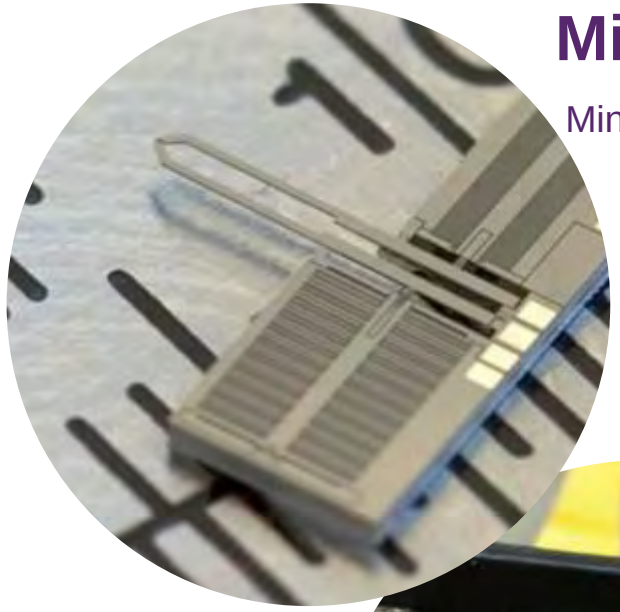
Prof. Tobias Lamprecht

IMP Institut für Mikrotechnik und Photonik

Agenda

- **Micro Systems Engineering**
- System Aspect
- Process and Product examples

Institut für Mikrotechnik und Photonik (IMP)



Microtechnology (MEMS)

Miniaturized systems,.. …

Fab

Wafer based processing

R&D

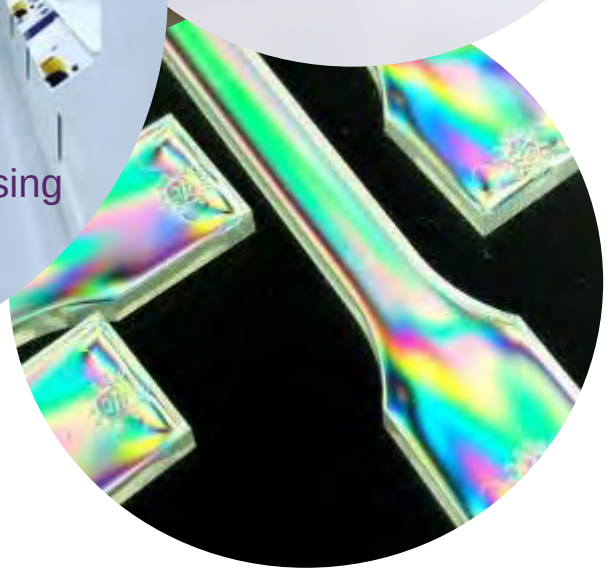
Pilot line

Production Metrology

Dimensions in highest accuracy

Photonic & Optics

…from development to production



Materials

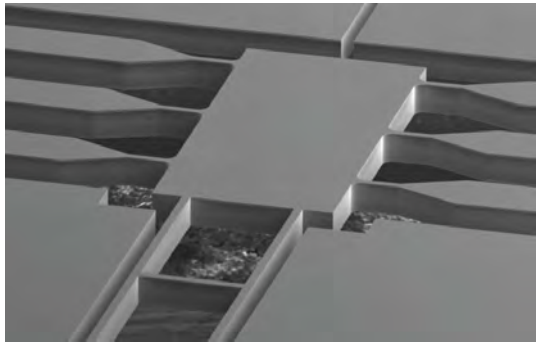
Characterization and formulation of materials

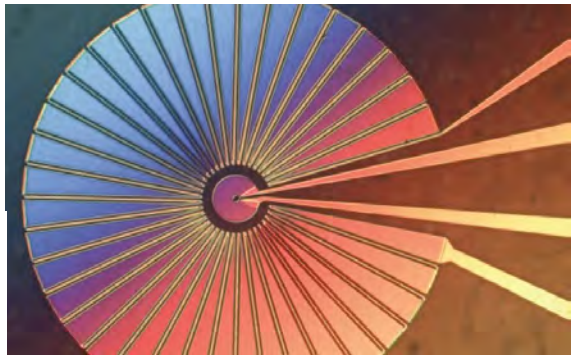
Micro Systems Engineering

Mission: Miniaturization of technical Systems

- Design, fabrication and testing of sensor and actuator systems

- Hybrid integration
(mechanics, electronics, optics, fluidic,…)





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Agenda

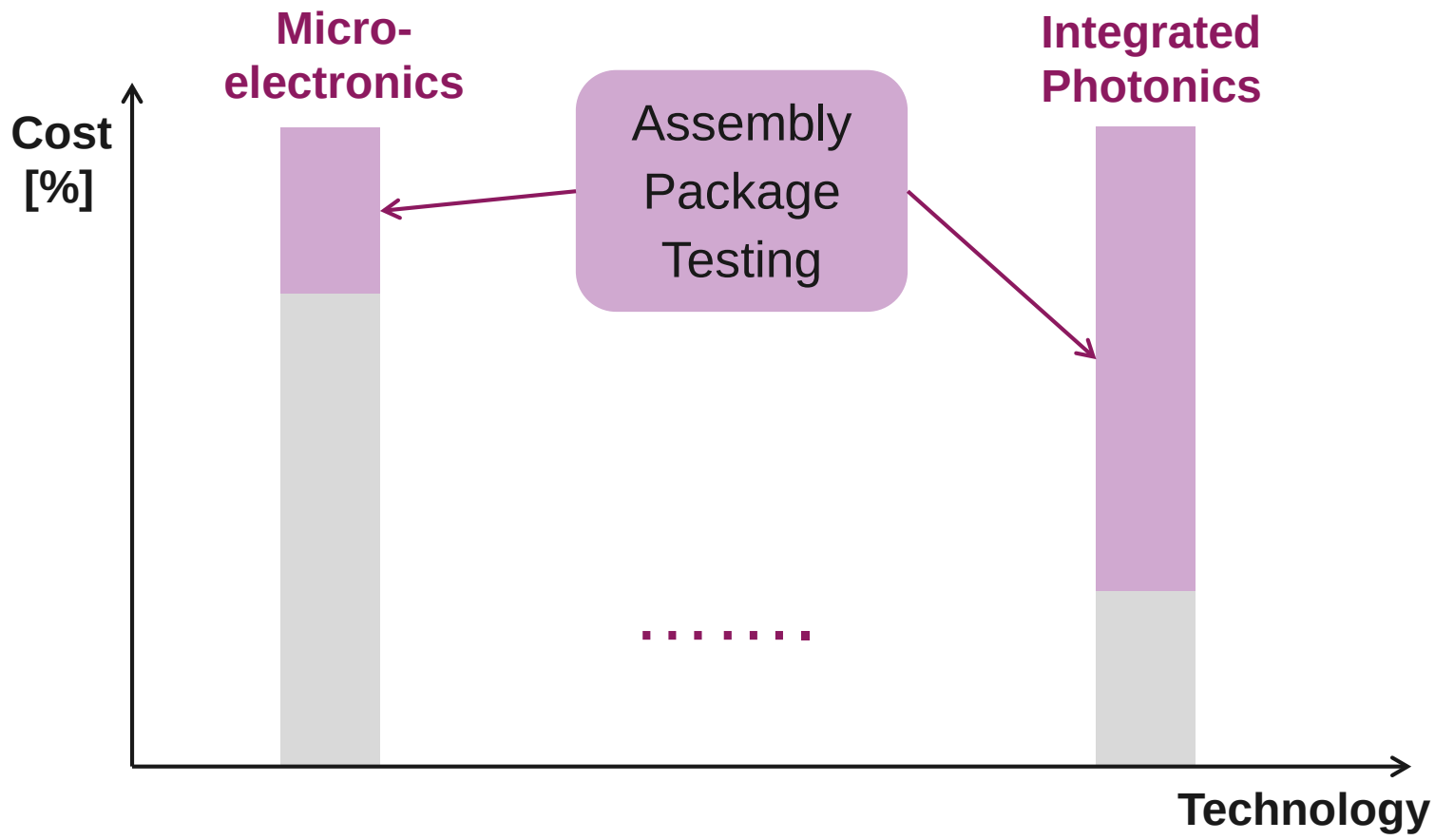
- Micro Systems Engineering: Miniaturization of Photonic Systems

➔ **System Aspect**

- Process and Product examples

Cost Driver in Photonic Systems

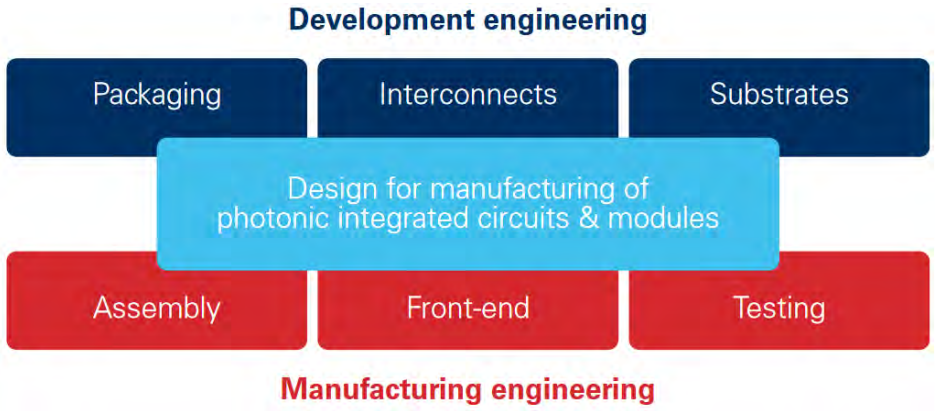
- High cost for back-end
  - Risk!
  - Opportunity?



data source: https://semiengineering.com/attaching-fibers-to-photonic-chips/

System Aspect

- Photonic system design includes assembly, packaging and testing



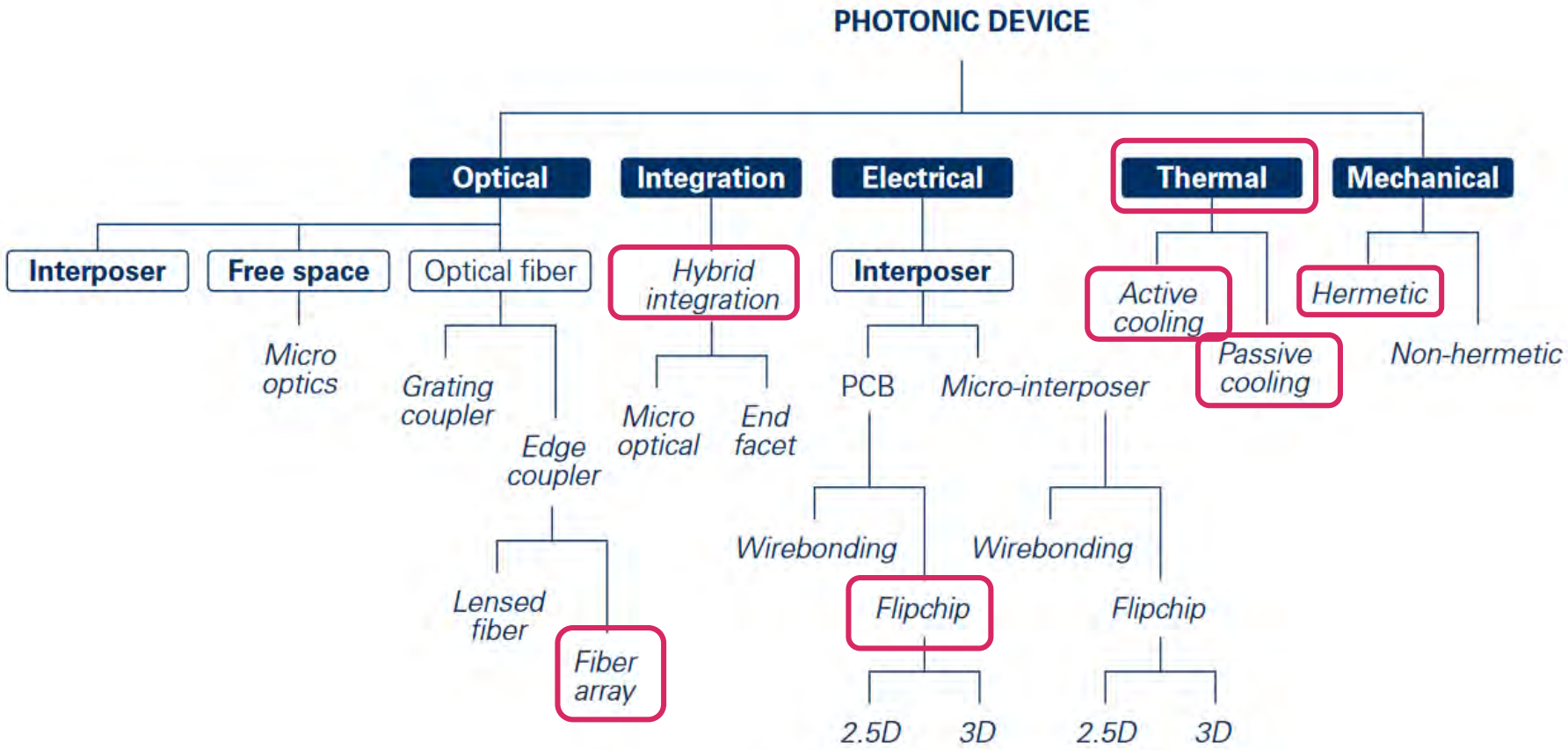
Source: https://photonicsmanufacturing.org/roadmap-structure-overview

- High performance & high integration density → **holistic system design** approach

Systems Engineering

- Photonic devices: multi-domain systems

Examples



Source: https://photonicsmanufacturing.org/roadmap-structure-overview

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Agenda

- Micro Systems Engineering: Miniaturization of Photonic Systems
- System Aspect

→ **Process and Product examples**

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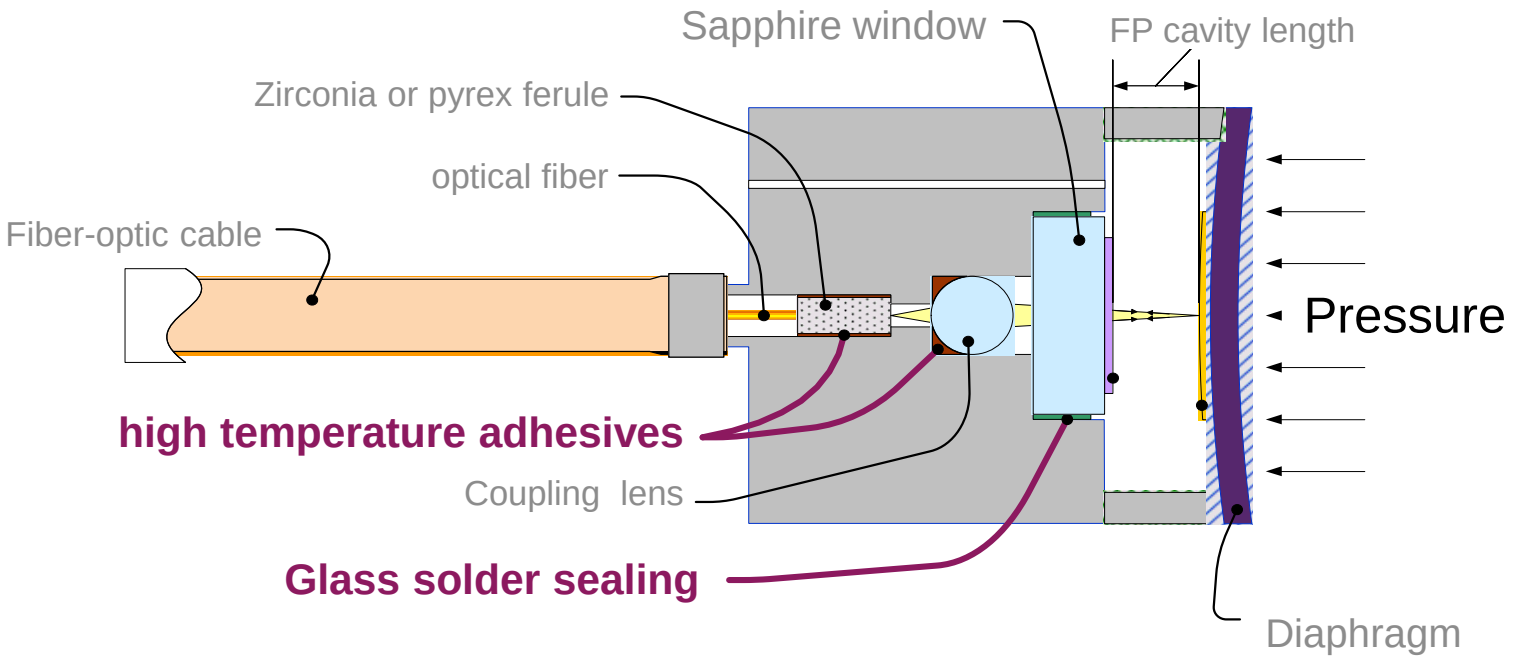
Optical Pressure Sensor – High Temperature Application

- Accurate measurement of pressure using photonic system
- Glass soldering for hermetic sealing

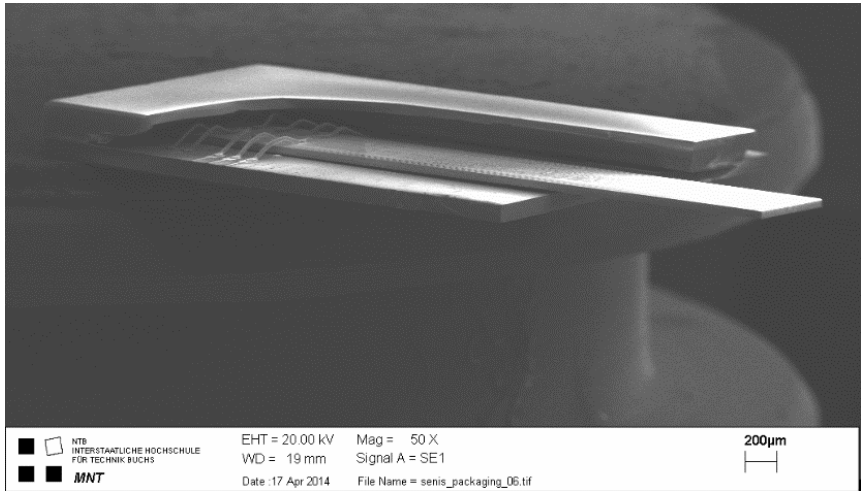


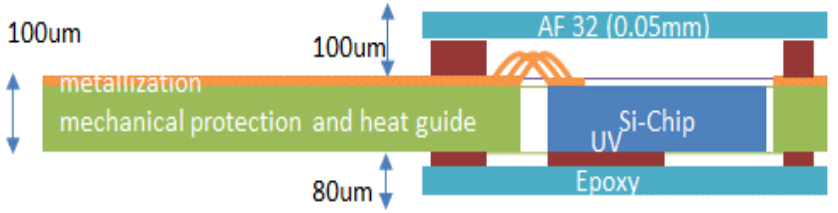
CDG gauge

Packaging Example

Thermal-Management

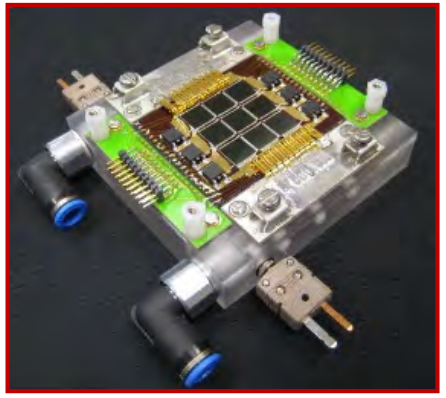
- Ultra thin Hall-sensor
- Applicable for high temperatures
- Optimized package design
- Soldering (metal, glass)



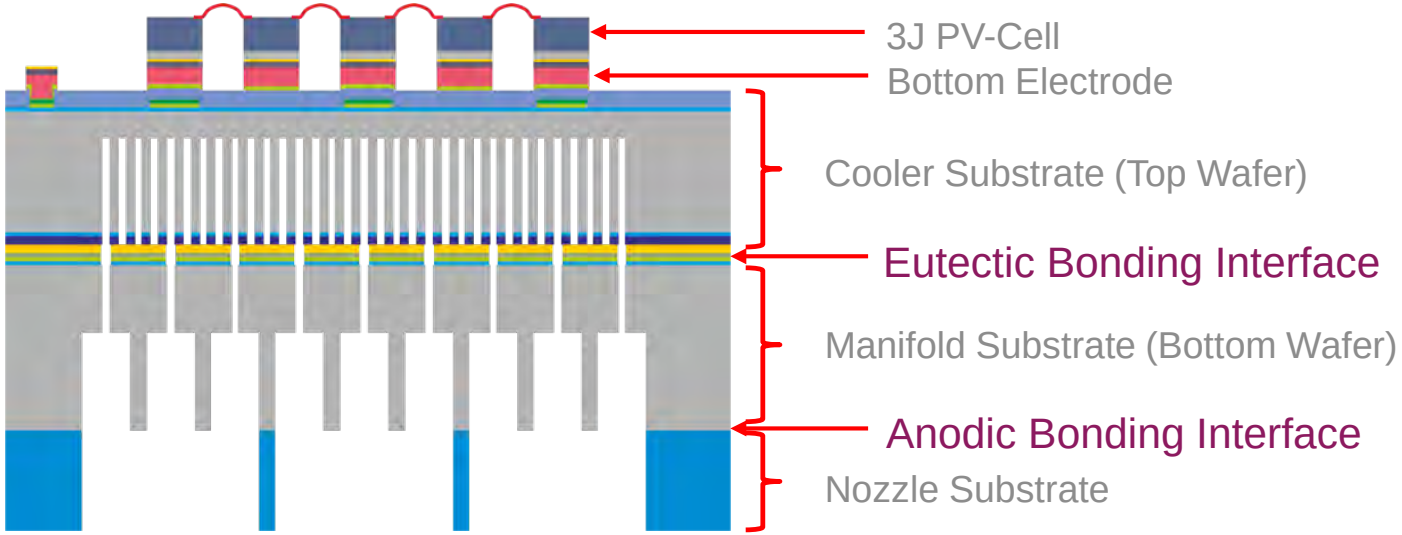


Packaging of High-Power Photovoltaic Module

- Thermal cooling of photovoltaic → thermal energy harvesting
- Reliable joining technologies on large areas



Assembled module



cross-section of multi-chip stack

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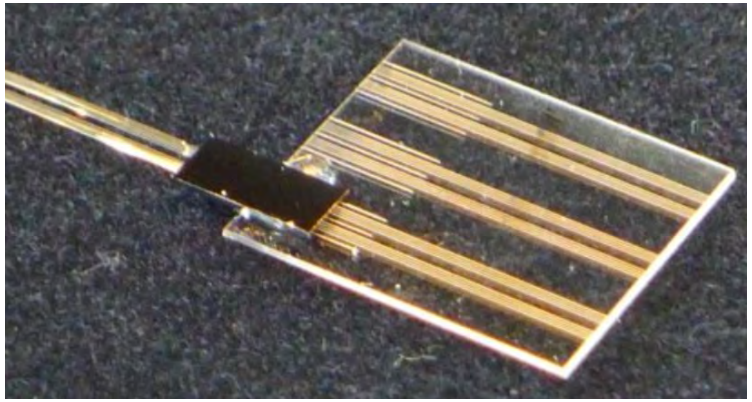
MEMS Passive Alignment

- Custom fiber array < ±1µm positioning accuracy (IL)
- Silicon based micro-mechanical bench

Fiber array to waveguide board

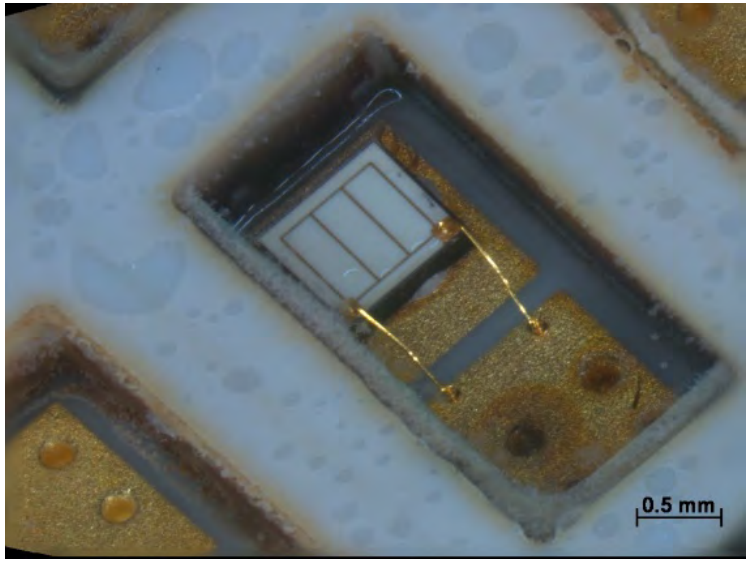


Fiber array in custom v-groove device

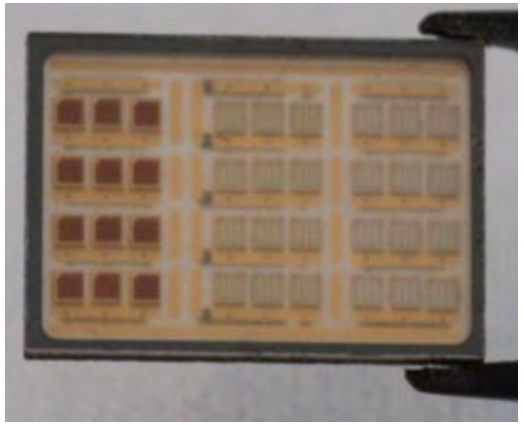
Source: OST (NTB), J. Kremmel, urn:nbn:de:gbv:ilm1-2019000511

Hermetic LED Package

- Combination of various materials (ceramic, glass,…)
- Autoclavable 2000+ cycles
- Soldering



LED in ceramic frame

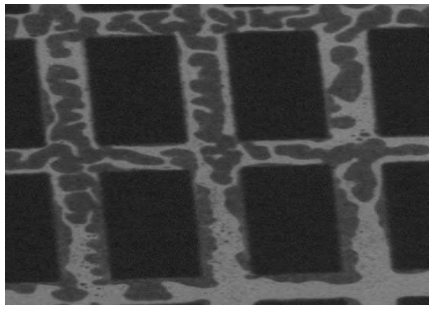


fabrication substrate

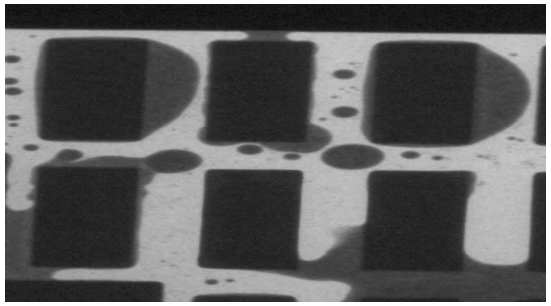
Hermetic LED Package – Optimization of Soldering

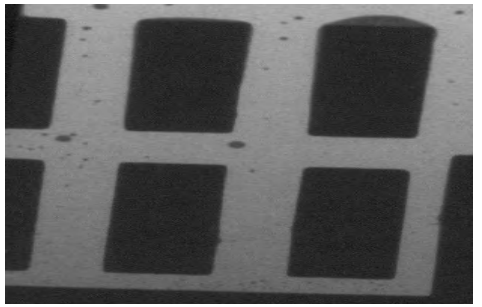
- Glass soldering for hermetic sealing
- Autoclavable: optimal glass soldering process

Progress of process optimization



hermetic





Hermetic & autoclavable

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LUCEA AG
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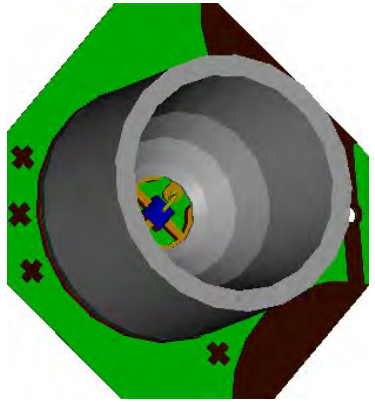
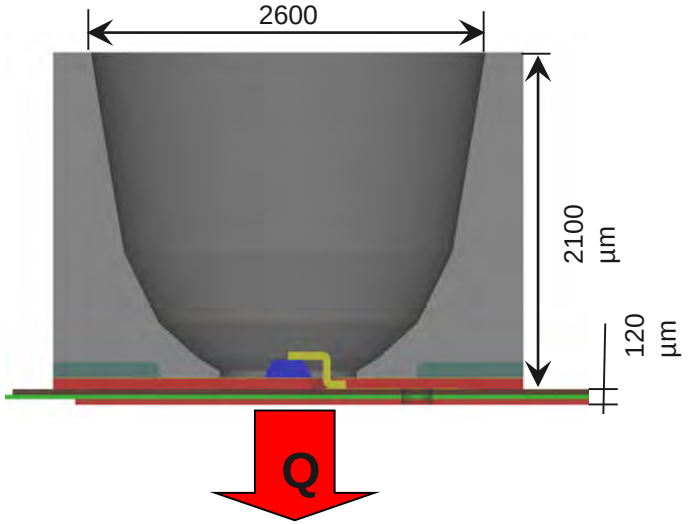
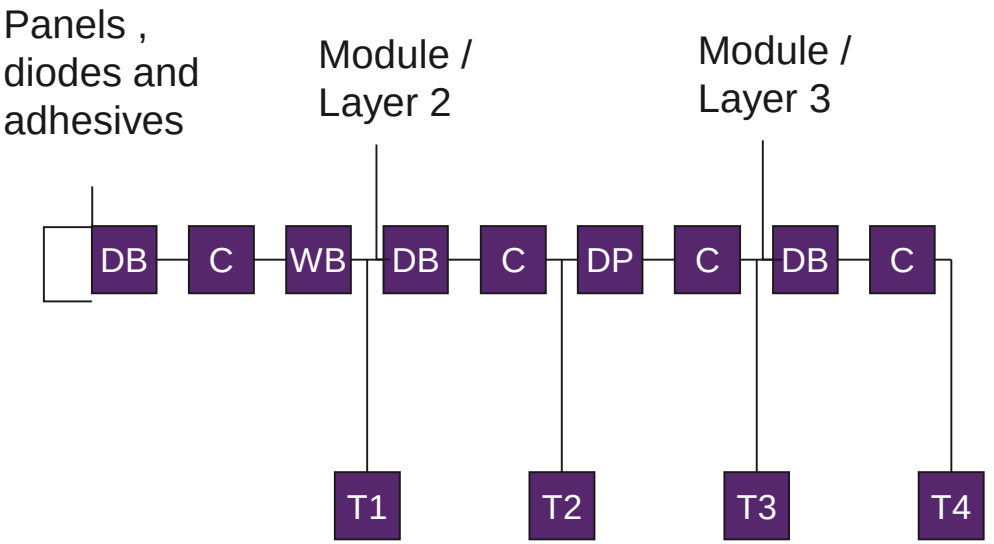
Project: LED Panel I

- High-power performance







DB **Die Bonding**
WB **Wire Bonding**
C **Curing/Soldering & Cleaning**
DP **Dispensing**
T1-4 **Testing**

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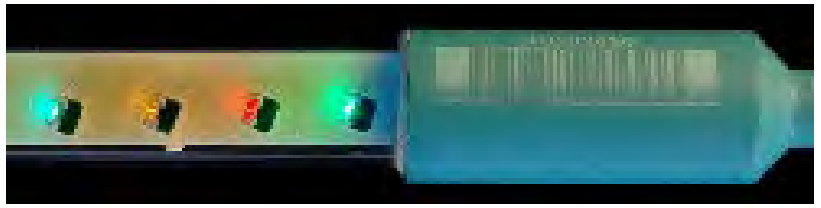
Packaging of Photonic Systems

Photonic component assembly

- Alignment: active / vision-based / passive
- Componentes: chips, optics, fibers

LED module



optical spectral absorption sensor:
LEDs and waveguides

Electronic component assembly

- Flip-chip Bonding: soldering, adhesives
- Wire-bonding
- Cleaning and housing

wire bond

flip chip

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Agenda

- Micro Systems Engineering: Miniaturization of Photonic Systems
- System Aspect

→ **Process examples**

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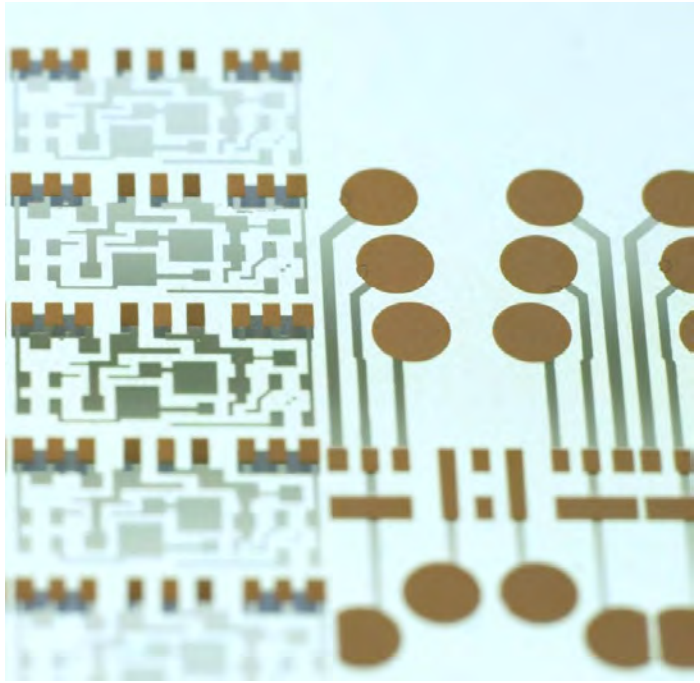
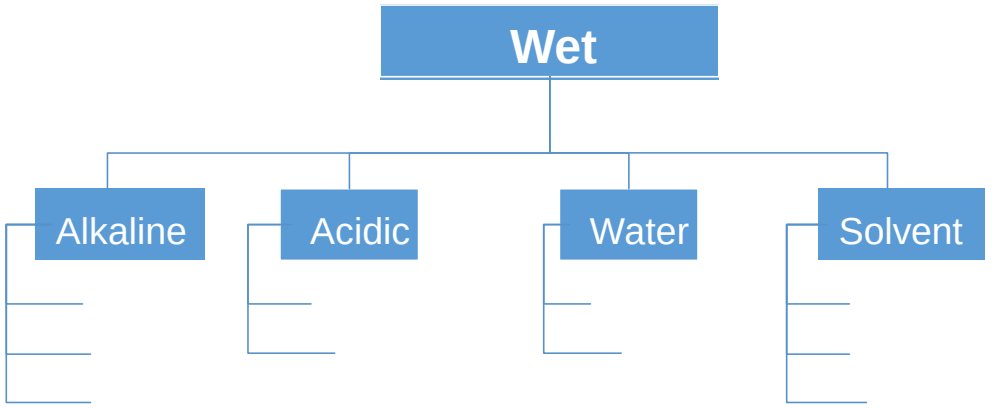
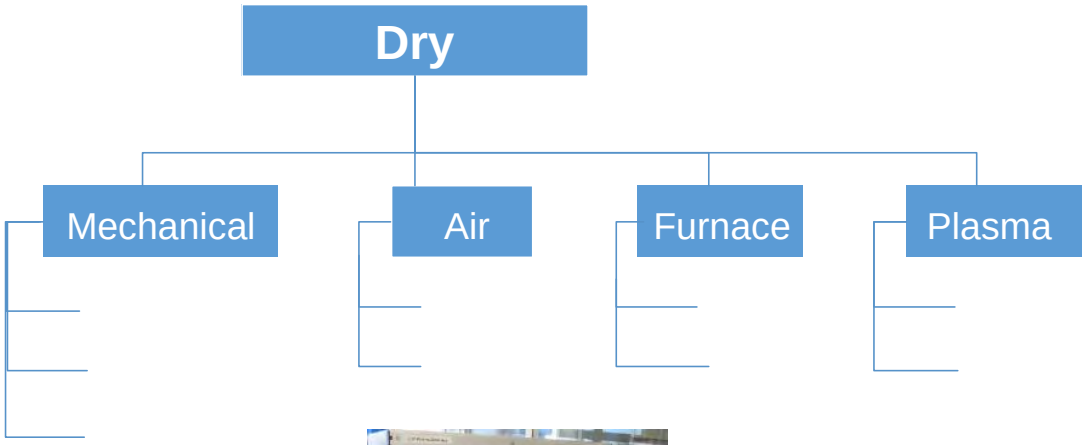
Coating and Structuring

- Advanced Packaging Substrates
- Coatings
  - Conductors
  - Dielectric
- Various substrate materials
  - Electrical, mechanical and thermal performance



Cleaning – Key to Packaging





…and handling, inspection of delicate components

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Dispensing

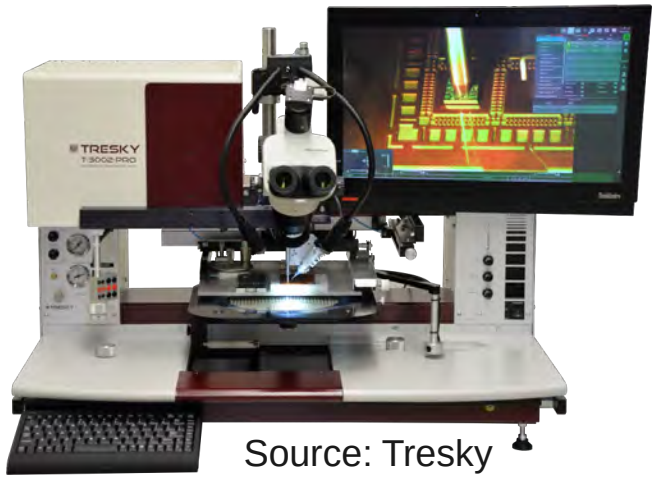
- Auger valve (high viscosity pastes)
- Piezo jet valve and inkjet systems
- Semiautomated equipment
- Characterization and modification of fluids

© Essemtec

© EFD Nordson

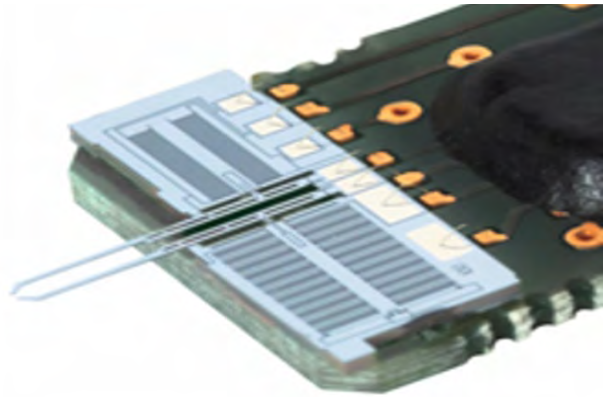
Die Assembly

- Assembly of electronics and photonics (Tresky die-bonder at IMP/OST)
  - Accuracy of ±5µm (visual alignment) down to ±1µm (active alignment)
- Bonindg
  - Adhesive bonds
  - Soldering
  - Ultra sonic soldering



Source: Tresky

MEMS-gripper for micro objects

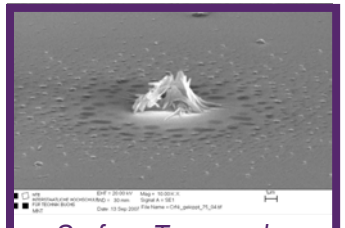


Source: OST

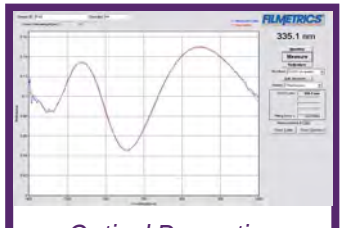
Process Example

Analytic - Overview

X-ray Measurements

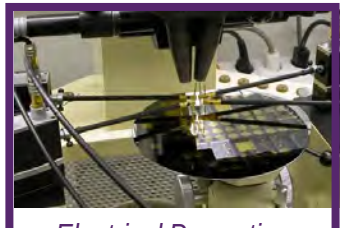


Surface Topography

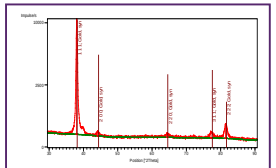


Optical Properties

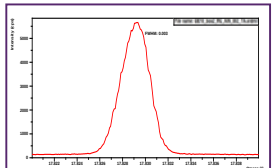
Mechanical Properties



Electrical Properties

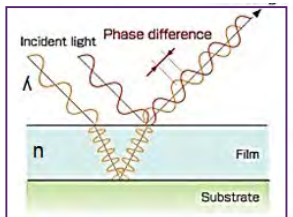


Phase Analysis

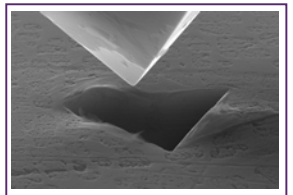


Rocking Curve

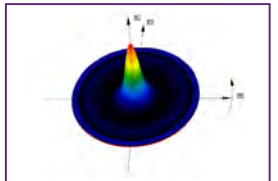
SEM / EDX



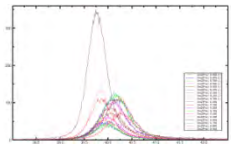
Reflectometry



Nanoindenter

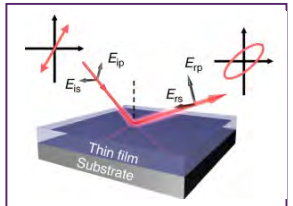


Texture



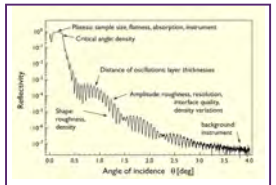
Stress

AFM / Profilometer



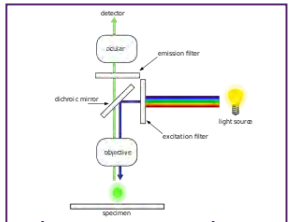
Ellipsometry

Shear-test



Reflectivity

WLI



Flourescence micros.

OST

Conclusion

- Potential of **micro-system** engineering for **miniaturization** of photonic systems

Q&A

Your attention is kindly appreciated

Prof. **Tobias Lamprecht**
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