Hybrid Integration with **Photonic Wire Bonding (PWB)** and **Facet-Attached Micro-Lenses**

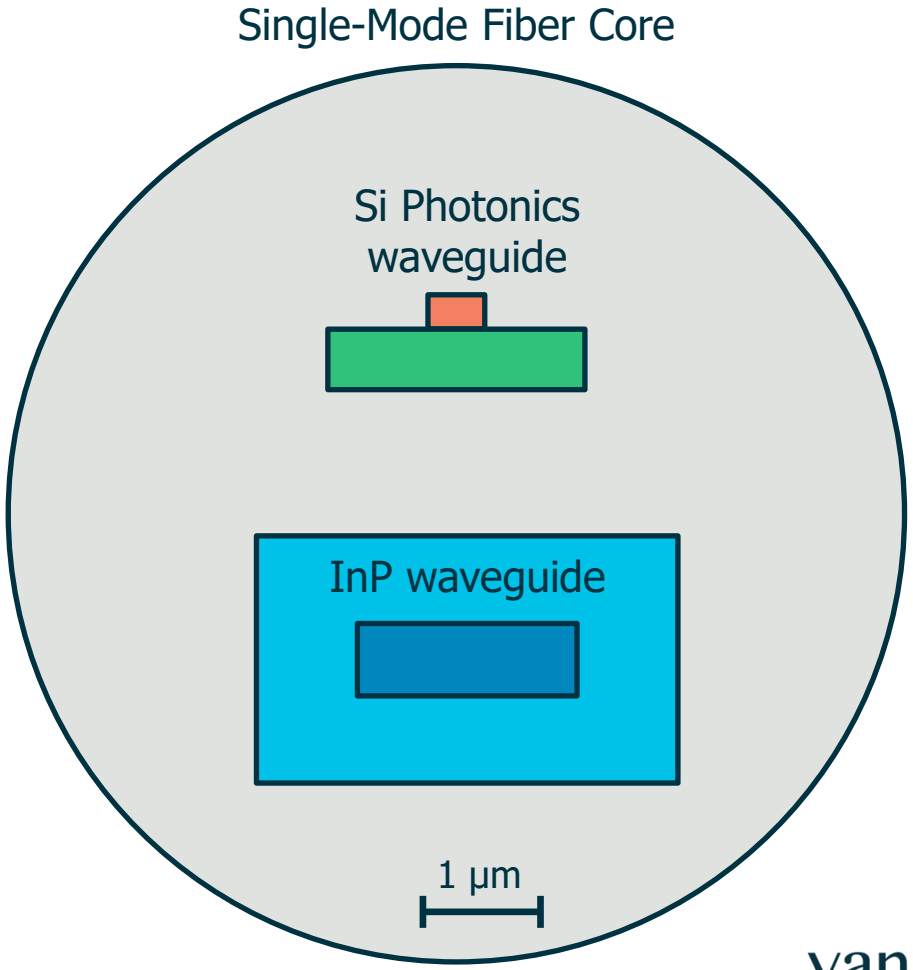
Dr. Laura Horan | Vanguard Automation GmbH (a Mycronic Company) | Photonics Hybrid Integrated Circuits

Today's Packaging and Assembly **Challenges**

Different Mode Field Sizes and Heterogenous Material Platforms

- Mode field matching
- High-precision assembly alignment
- Fast and reproducible packaging
- Reliable under various conditions

Over 70% of the cost of photonic integrated systems are generated by the packaging process



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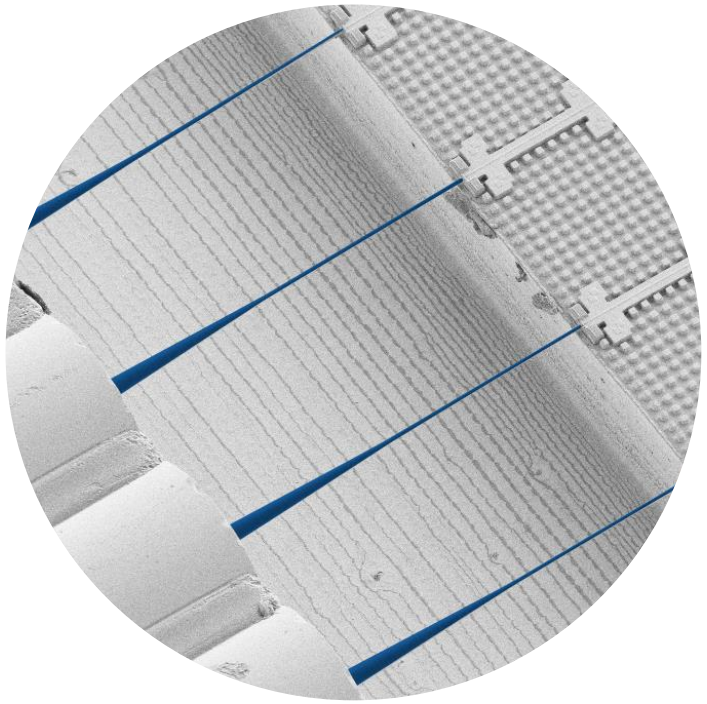
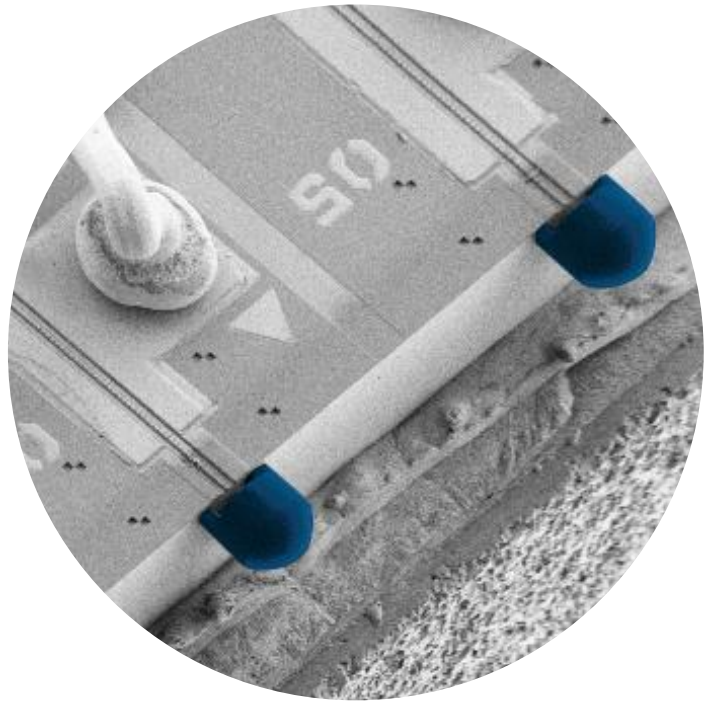
Enabling Next Generation **Photonic Integration and Packaging** Solutions with **3D Laser Lithography Solutions**





Photonic Wire Bonding (PWB) and **Facet-Attached Micro-Lenses (FAML)**

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Recent PWB applications from ecosystem partners

RIT Rochester Institute of Technology

UBC

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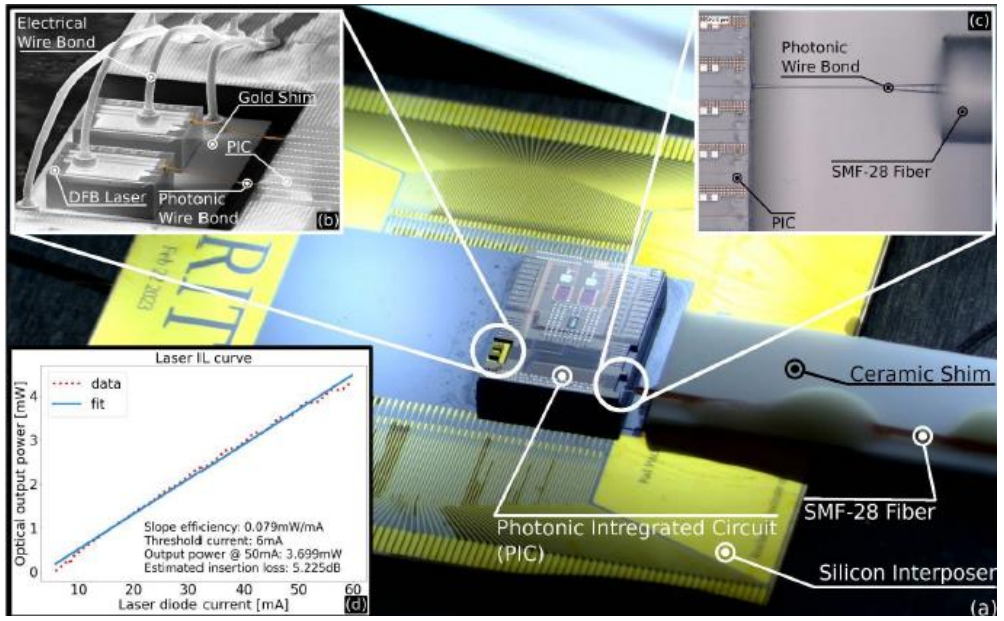
"Packaged Tunable Single-Mode III-V Laser Integrated on a Silicon Photonic Integrated Chip Using Photonic Wire Bonding",(2024)
Deenadayalan et al., IEEE 74th (ECTC), Denver, Colorado, USA)

Multi-Chip Hybrid Integration

Fiber to Chip to III-V Laser in one fabrication process.

Photonic Wire Bonding **doesn't require an alignment process** and PWB has **mode-field-matching** designed in.

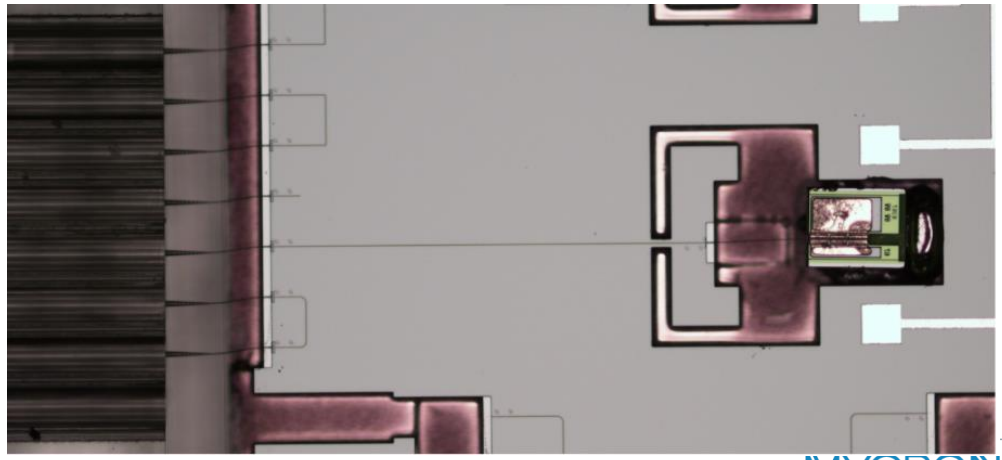
PWB compensates pick and place tolerances of ± 30 µm easily.



DREAM PHOTONICS

Hybrid multi-chip, laser and fiber integration

"SiEPICfab: the Canadian silicon photonics rapid-prototyping foundry for integrated optics and quantum computing",(2021)
Darcie et al. , Proc. SPIE 11691, Silicon Photonics XVI



3D-printed lenses to maximise coupling effciency

Collaboration to incorporate 3D-lithography technology into POET's Optical Interposer™ platform.

Increased Efficiency

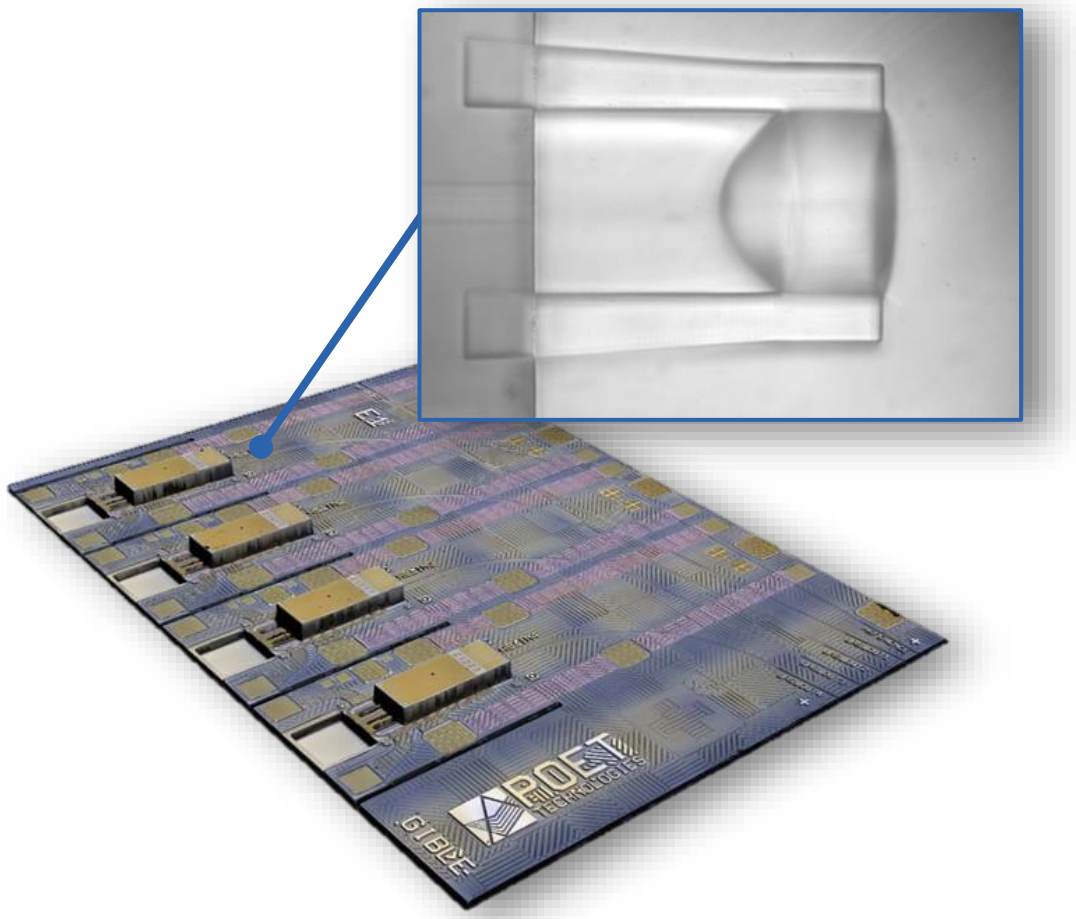
Reduction of coupling efficiency and reduced power consumption.

Cost Reduction

Reduction of cost per optical interconnect through increased throughput and reduced material cost.

Wafer level scaling

Micro-lenses shall be fabricated onto POET's LightBar™ product to validate the power efficiency improvements and the viability of chip scale wafer level manufacturing.



Industry proven **reliability** and mechanical shock testing

SUMITOMO ELECTRIC
Connect with Innovation

HB-CDM module

"Low Insertion Loss 128-Gbaud HB-CDM with 3D Printed Spot Size Converter Integrated InP-based Modulator",(2023)
Y. Mizuno et al., 2023 OFC, San Diego, CA, USA, 2023, pp. 1-3

First demonstration of commercial optical modules benefitting from 3D printed optical components integrated InP devices

Improved coupling efficiency with spot size converter lens- reducing mode conversion losses by **1.5dB per lens**

Relaxed alignment tolerances to 1.6µm with 1dB penalty

InP-Chip becomes **25% smaller** as coupling structures for mode field matching become redundant.

Telcordia GR468 qualified

Reliability testing
- 500 cycles -40°C to 85°C
- Reflow soldering, 3 cycles, 270°C
- Die bonding, 320°C

Shock testing
- Acceleration of up to 1500 G
- Vibration 20-2000 Hz

High power operation
- 200 mW optical output

up to 3000 h

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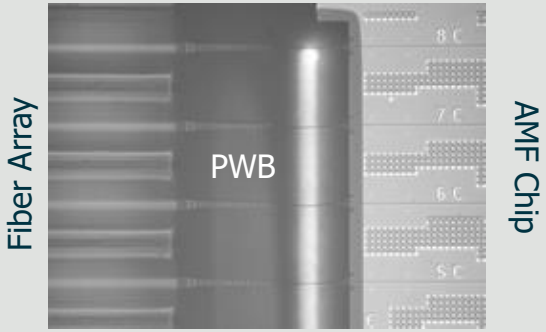
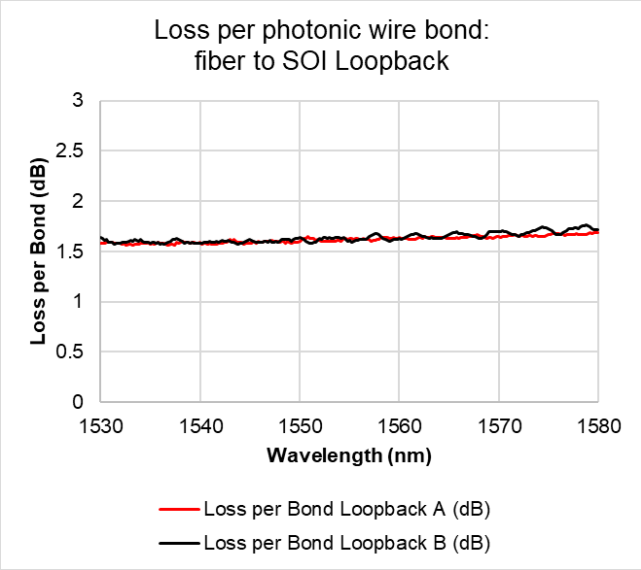
Compatibility with material platforms/foundries

Silicon (**AMF**, Singapore)

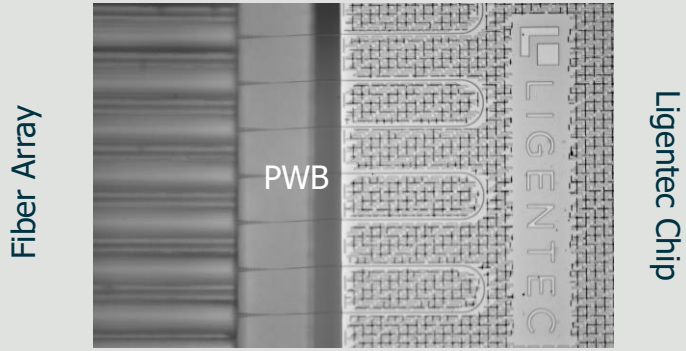
- **~1.5dB loss**

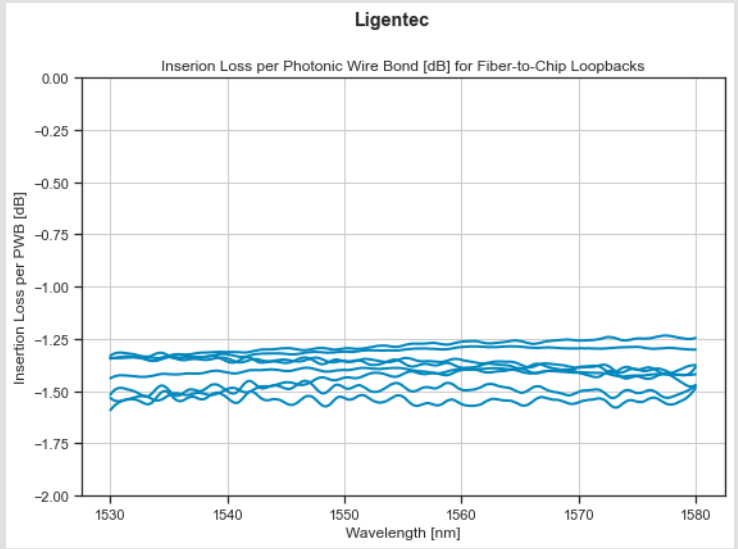




Silicon Nitride (**Ligentec**, Switzerland)

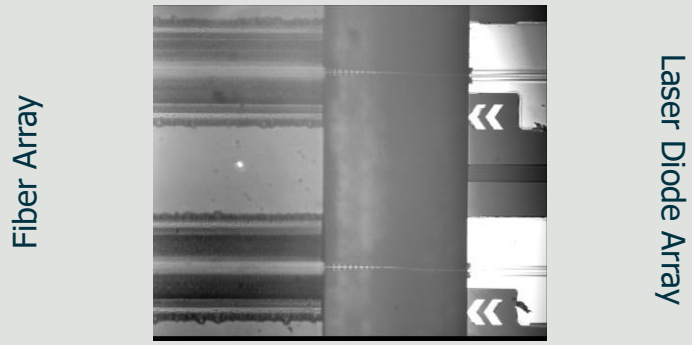
- **~1.5dB loss**

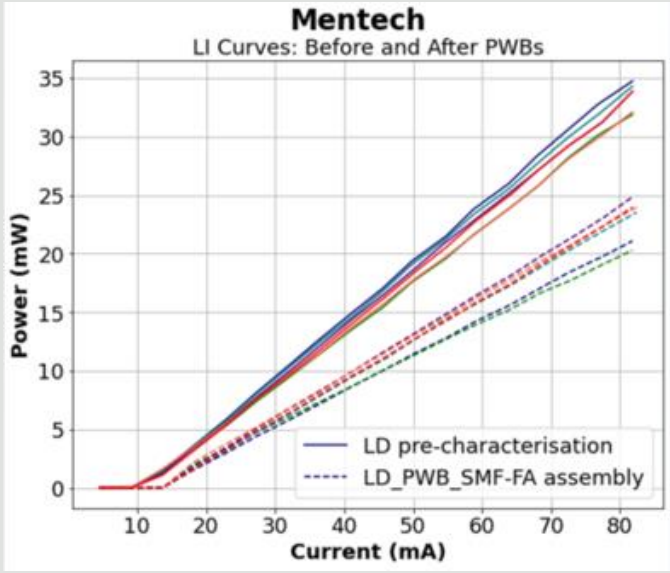




Indium Phosphite (**Mentech**, China)

- **~1.5dB loss**

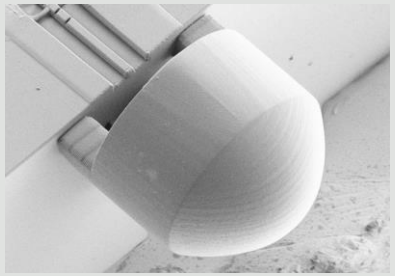




Path to Implement Photonic Integration with 3D Lithography

Step 1- 3D printed elements

3D printed elements



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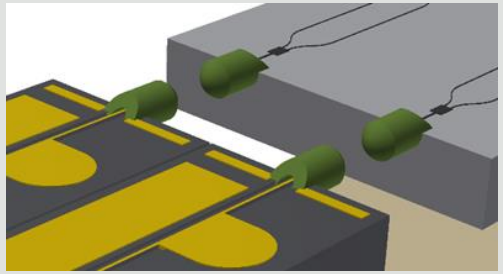
Active alignment

- improve coupling and yield
- No major changes to production process steps

Step 2- passive alignment

FaML



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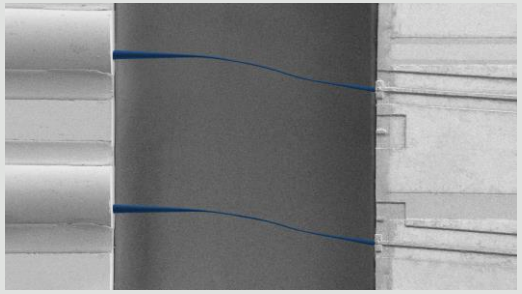
Passive alignment (±15µm)

- passive assembly is a viable process

Step 3- PWBs with relaxed alignment tolerances

PWBs



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Relaxed Pick & Place (±30µm)

- ensuring compact coupling
- high yields
- high package density

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Vanguard **SYMPHONY 1000**

Machines

SONATA 1000

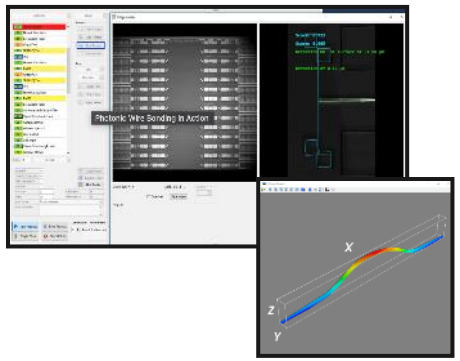
Automated 3D Lithography-based Nano Printing

REPRISE 1000

Automated Pre- and Post-Processing: Development and Encapsulation

Software

Composer and BrightWire3D



Software for Machine Control, Process Development and Management

Additional Products and Services

VanCore, VanClad, …

Materials for the production of PWBs and Micro Optical Lenses

Professional Services

- Training
- Process Development
- Feasibility Studies
- Development Support
- Maintenance Services

The Full Suite: SYMPHONY 1000

"Photonic integration and packaging with Photonic Wire Bonding and facet-attached micro-optical elements", PIC Magazine, September 2023

"As PIC Production Ramps Up, Fabricator Eye Alignment Options", Photonics Spectra, June 2022

"Photonic Wire Bonding: Using Lasers to Integrate Lasers", Photonics Spectra, August 2022

"Integrated photonics for quantum applications", Laser Focus World, September 2022

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Meet us at the **50th ECOC exhibition** in Frankfurt

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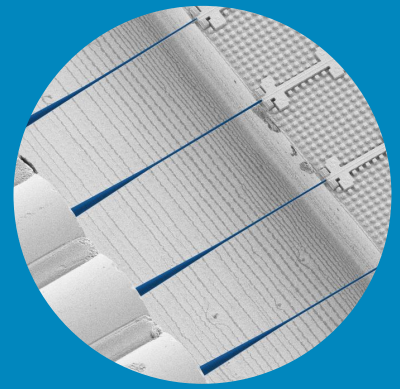

Visit the team at Booth **C104**!

ECOC 2024 FRANKFURT 50th Anniversary

ECOC Exhibit - **Market Focus**
Tuesday 24th September **10:20**

"Next Generation Photonic Integration and Packaging Solutions with ***Photonic Wire Bonding (PWB)*** *and* ***Facet-Attached Micro-Optical Elements"***

Dr. Sebastian Skacel

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