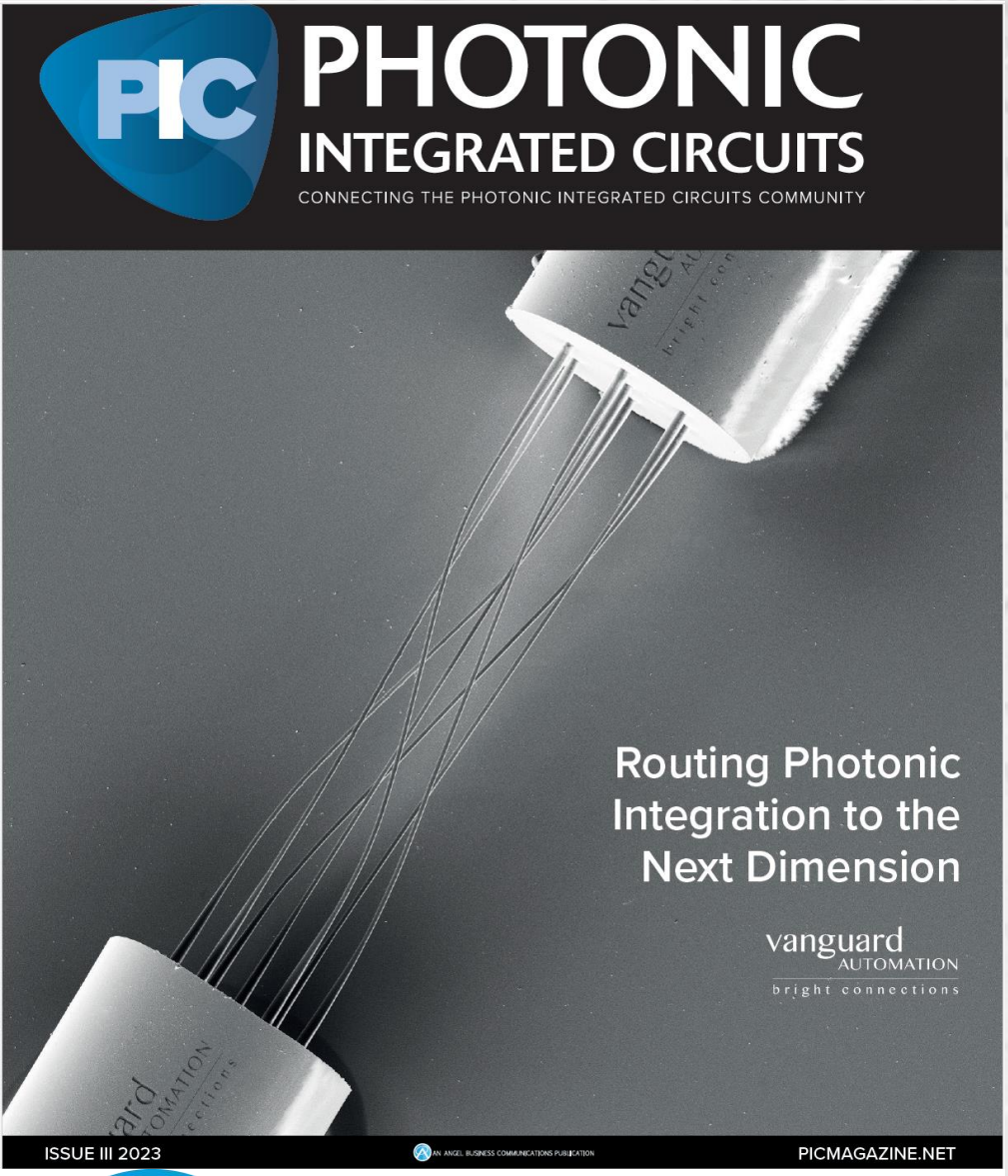


PIC INTERNATIONAL CONFERENCE

ANGELTECH

vanguard AUTOMATION

bright connections

Scaling photonic integration & packaging of hybrid multi-chip assemblies using 3D lithography

Photonics Integrated Circuits are Growing Rapidly

25.9% CAGR (source: MarketResearchFuture.com)

Tele and Data Communications

3D Sensing

AI/Optical Computing

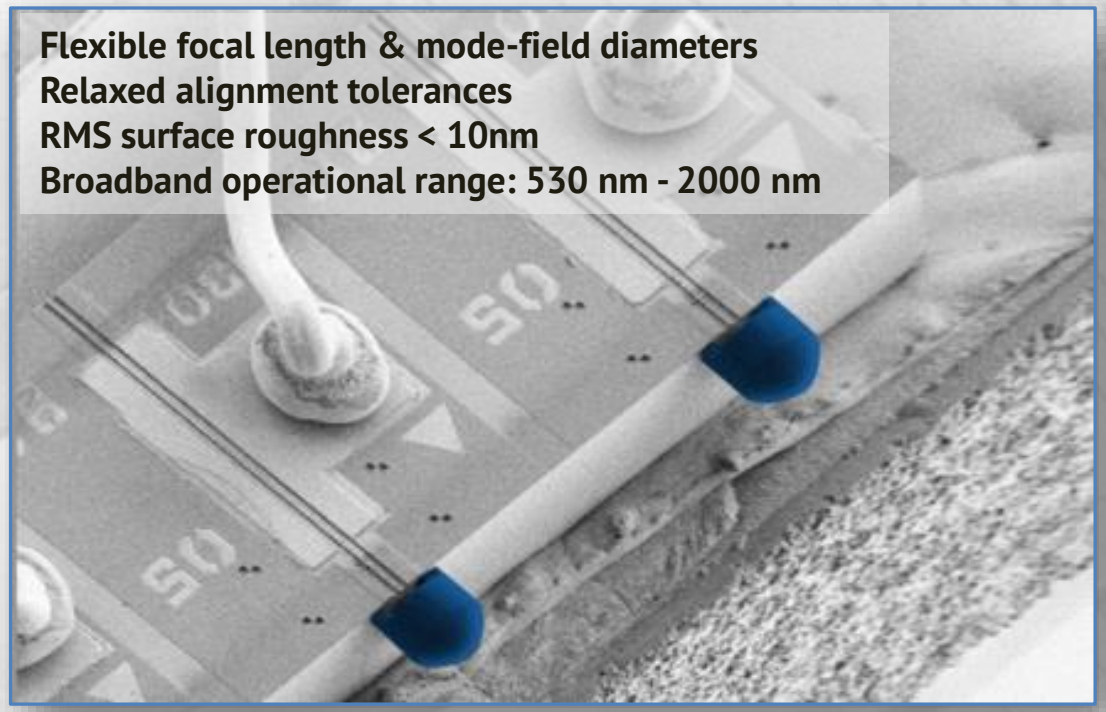
Quantum Applications

Mission

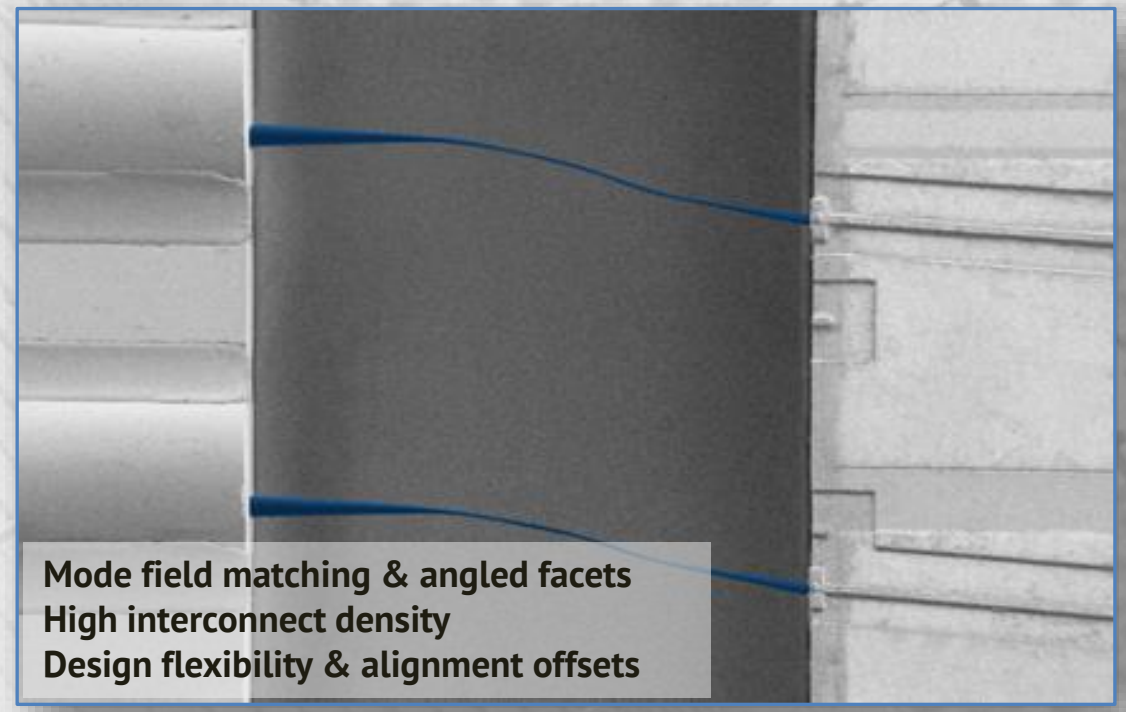
Advance Photonic Packaging and Assembly by providing scalable 3D lithography solutions for prototyping and manufacturing

Industry Proven Photonic Integration and Packaging Solutions with 3D Laser Lithography

Samples by PIXAPP (Photonic Packaging Pilot Line)



Laser by Freedom Photonics LLC

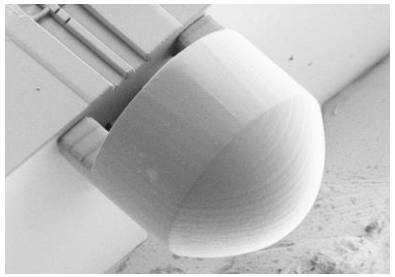


Facet-Attached Micro-Optical Lenses (FAML) and Photonic Wire Bonding (PWB)

Path to Implement Photonic Integration with 3D Lithography

Step 1- 3D printed elements

3D printed elements



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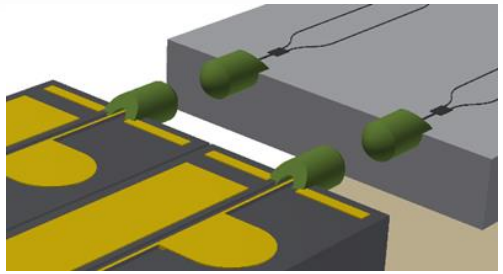
Active alignment

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

Step 2- passive alignment

FaML



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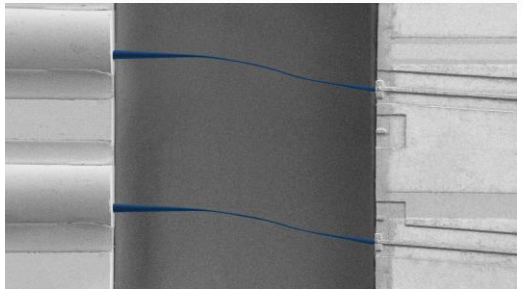
Passive alignment (±15µm)

- 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

3D Printed Optics: Solutions with Micro-Optical Elements

Step 1- 3D printed elements → **Step 2- passive alignment** → **Step 3- PWBs with relaxed alignment tolerances**

SUMITOMO ELECTRIC
Connect with Innovation

Low Insertion Loss 128-Gbaud HB-CDM with 3D Printed Spot Size Converter Integrated InP-based Modulator
(Y. Mizuno et al., 2023 OFC, San Diego, CA, USA, 2023, pp. 1-3, doi: 10.1364/OFC.2023.Th2A.8)

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**

Increased alignment tolerances to 1.6μm with 1dB penalty

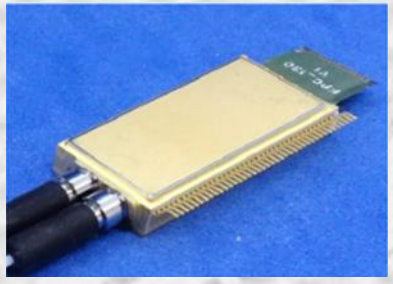
Industry proven reliability and mechanical shock testing (**Telcordia GR468 standard**)

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

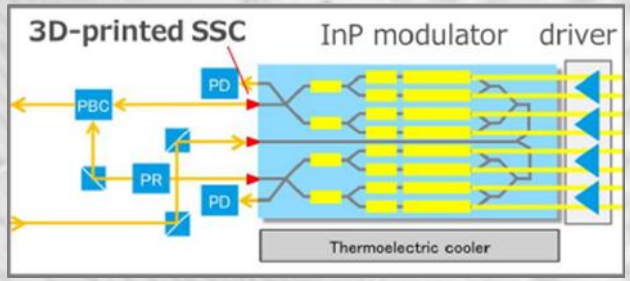
Shock testing
- Acceleration of up to 1500 G
- Vibration 20-2000 Hz

High power operation
- 200 mW optical output up to 3000 h

Cryogenic operation
- > 10 cycles 4K to room temperature



HB-CDM module



Block diagram

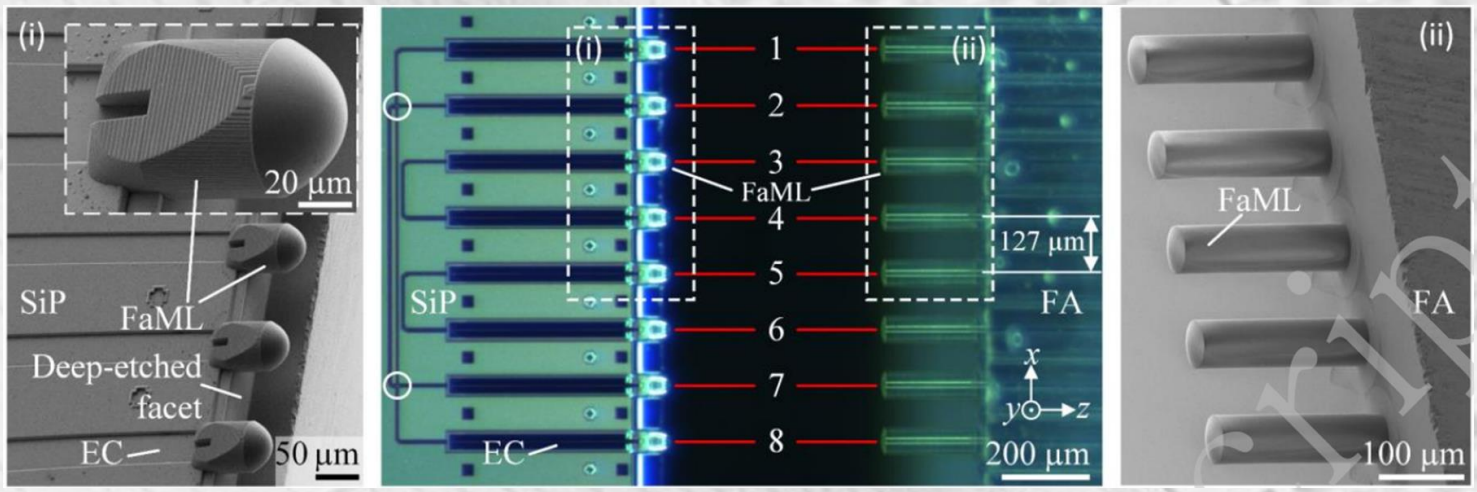
Passive Alignment: Solutions with Micro-Optical Elements

Step 1- 3D printed elements → **Step 2- passive alignment** → **Step 3- PWBs with relaxed alignment tolerances**

KIT Karlsruhe Institute of Technology · Tyndall National Institute Instituid Náisiúnta · vanguard AUTOMATION bright connections · eblana · imec · COHERENT · ficontec photonics assembly & testing

3D-printed facet-attached microlenses for advanced photonic system assembly

(Xu et al., 2023. Light: Advanced Manufacturing, 4 (3). doi:10.37188/lam.2023.003)



Micro optics were printed to the facets of chips and fiber arrays

Relaxed alignment tolerances that make **passive assembly** a viable process with **industry standard machine vision**

- Micro-optics with a **25µm mode field diameter**-increases the alignment tolerance to **± 6 µm** with a 1 dB penalty
- Micro-optics with a **60µm mode field diameter** -increases the alignment tolerance to **± 14.4 µm** with a 1 dB penalty

Passive Alignment: Solutions for Co-packaged Optics & AI

Step 1- 3D printed elements → **Step 2- passive alignment** → **Step 3- PWBs with relaxed alignment tolerances**

POET Technologies

vanguard AUTOMATION
bright connections

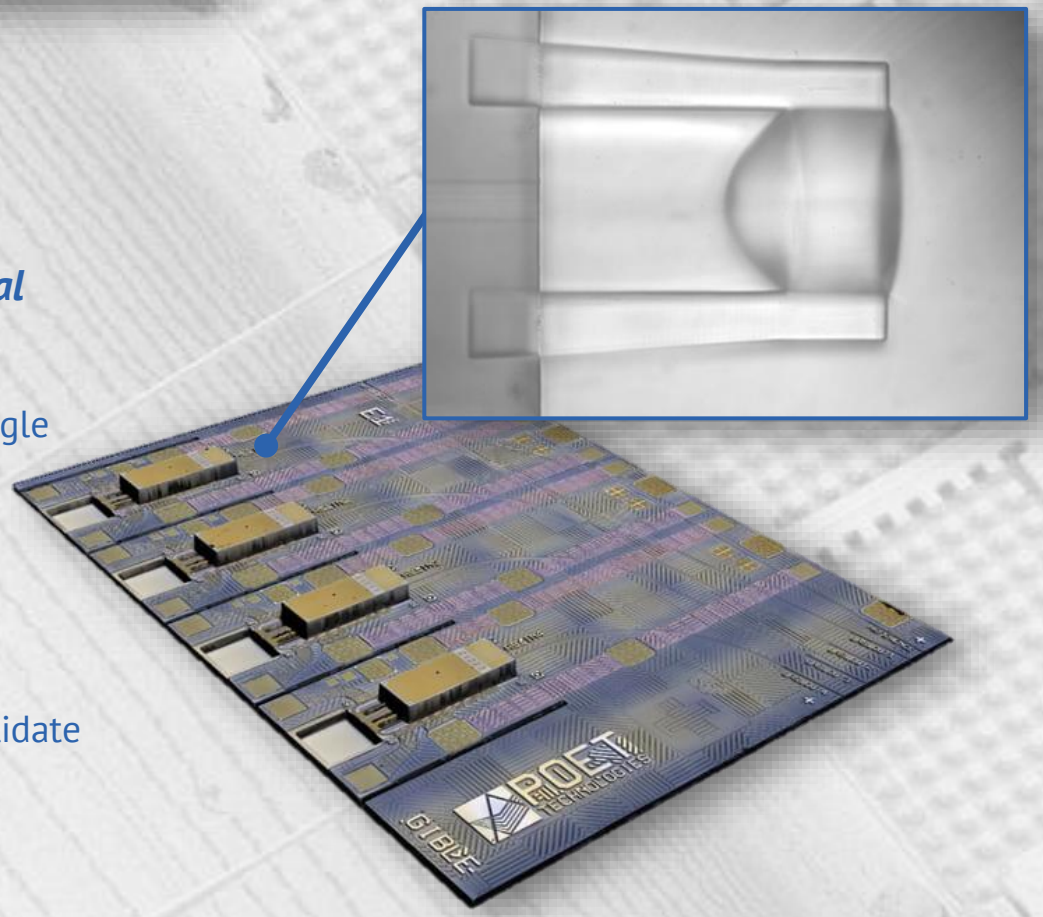
Collaboration to incorporate 3D-lithography technology into POET's Optical Interposer™

POET's Optical Interposer™, integrates electronic and photonic devices into a single multi-chip module

Micro-optics printed to products with passively aligned lasers

- Maximize coupling efficiency
- Improved coupling efficiency shall reduce power consumption

Initially micro-lenses shall be 3D-printed to the POET's LightBar™ product to validate the power efficiency improvements and the viability of chip scale wafer level manufacturing



Photonic Wire Bonds: Relaxing Alignment Tolerances

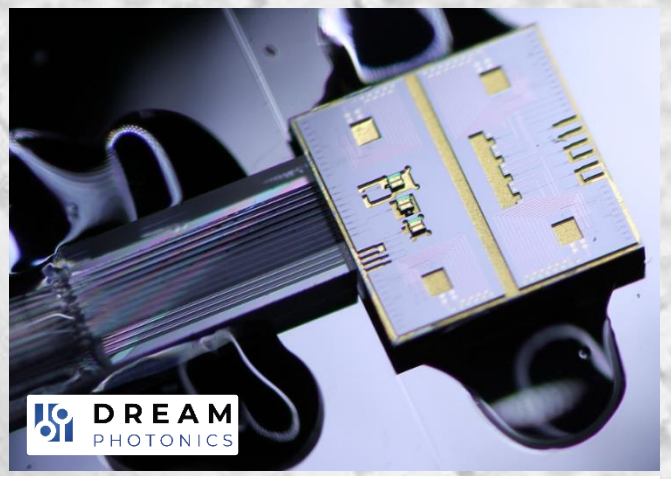
Step 1- 3D printed elements → Step 2- passive alignment → **Step 3- PWBs with relaxed alignment tolerances**

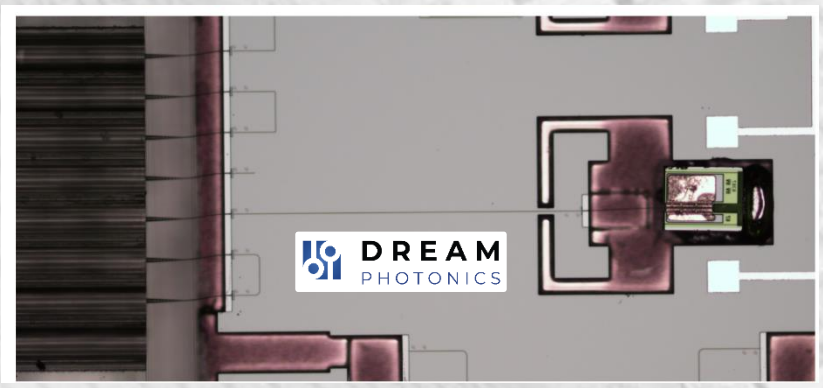
DREAM PHOTONICS

Hybrid multi-chip, laser and fiber integration

Bringing Photonic Wire Bonding to the Industry

an eco system partner rapid prototyping and process development for integrating photonic components via photonic wire bonds





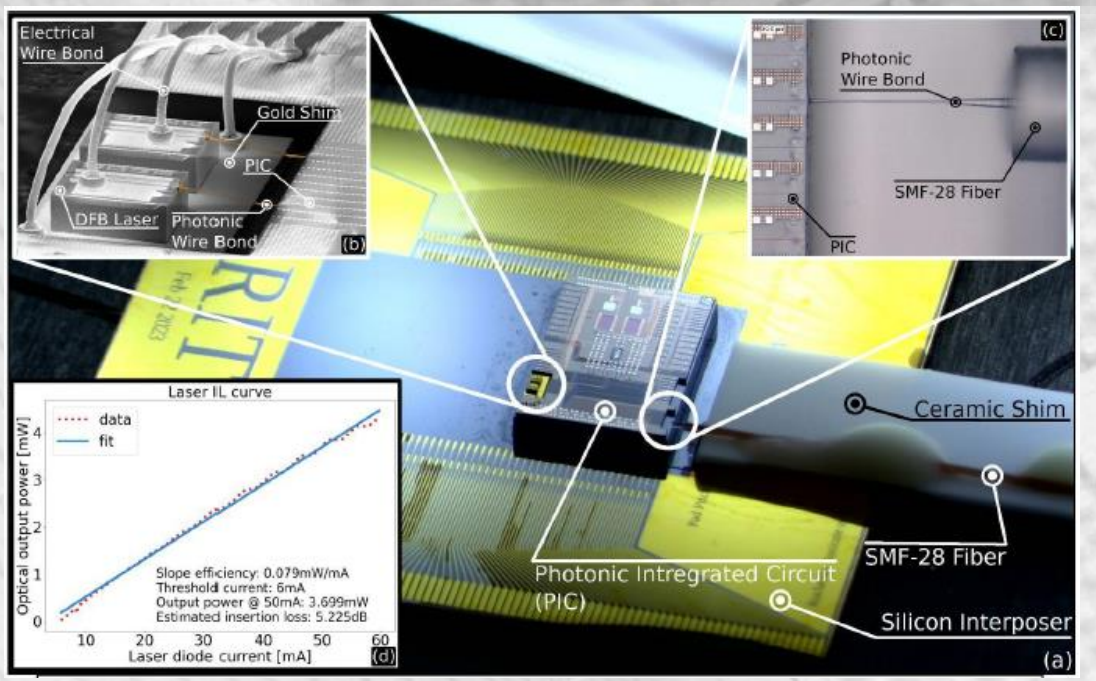
- Prototyping **lead times of ~8 weeks**.
- PWB interfaces/PDK available in **foundries** such as **AMF, ANT, VTT,** and more to come
- Integrating hybrid multi chip assemblies via Photonic Wire Bonding and/or lenses
- High-yield, low-insertion-loss, and high-throughput, disparate mode field shapes and sizes.
- Versatile method of packaging photonic components such as **chip-to-fiber, laser-to-chip** interconnects with relaxed alignment tolerances
- Find more information at **dreamphotonics.com**, or email **pwb@dreamphotonics.com**

Photonic Wire Bonds: Relaxed Alignment Tolerances

Step 1- 3D printed elements → Step 2- passive alignment → **Step 3- PWBs with relaxed alignment tolerances**

RIT Rochester Institute of Technology | UBC | vanguard AUTOMATION bright connections

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



- **Hybrid** multi-chip **integration**
- **Mode field matching**
- **Passive** laser to PIC integration process

Vanguard SYMPHONY 1000

Software-Defined Fabrication of PWBs and Micro-Optical Lenses

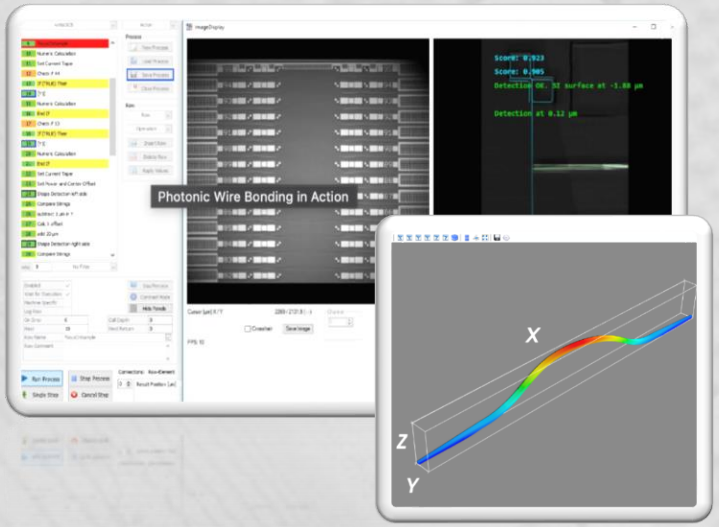
Automated 3D Lithography Based Nano Fabrication

SONATA 1000

Automated Pre- and Postprocessing (Development and Encapsulation)

REPRISE 1000

Software for Machine Control, Process Development and Management



Composer and BrightWire3D

Standard Fabrication Processes | Material | Product Support and Services

"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

Ecosystem Partners, Academic and Industrial Users