Chip Integration
Technology Center

CITC Integrated Photonics Technology Roadmap

- **'Semiconducturize'** the integrated photonics industry assembly and packaging
- Integration of electronics and photonics in a single package
- Cost-effective volume manufacturing
- Passive assembly of optics
- Pluggable optical interconnect

4 Heterogeneous integration

- Wafer level integration of active optical material to passive optical structures (front end)

3 Hybrid integration

- Panel level assembly (optical fan out panel level packaging)
- Multi-chip modules both electronics and photonics
- Multi PIC platform in single package
- Passive/active optical assembly of PIC
- Pluggable optical interconnect

2 Volume manufacturing

- Strip level assembly
- Reduced cost > lower BOM, ease of automation
- Active optical assembly
- Fiber pigtailed packages

1 State of art

- Complex optical systems (active alignment)
- High assembly cost
- Low volume (one piece flow)
- No standardization
- Fiber pigtailed packages

Assembly and packaging of integrated photonics today

Need

- Start-up companies or established companies seek support in assembly and packaging of their (first) integrated photonic dies

Activities

- CITC supports these companies by sharing knowledge in electrical (RF) and optical packaging processes
- Design for processing criteria of the package
- Material and process selection for optical, electrical and thermal interconnect
- Develop process recipe and demonstration of process feasibility on limited amount of samples

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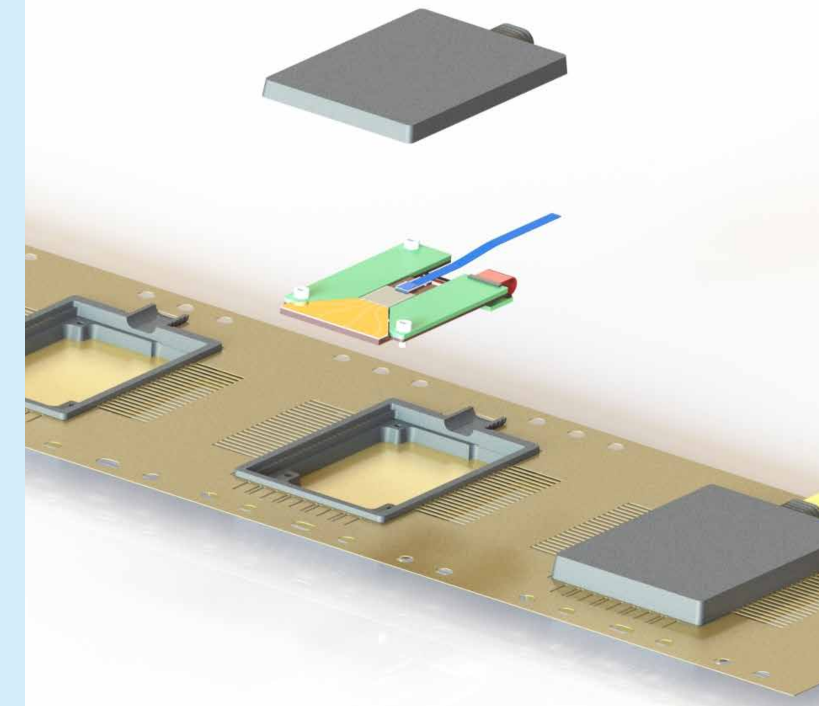
Scalable manufacturing for integrated photonics packaging

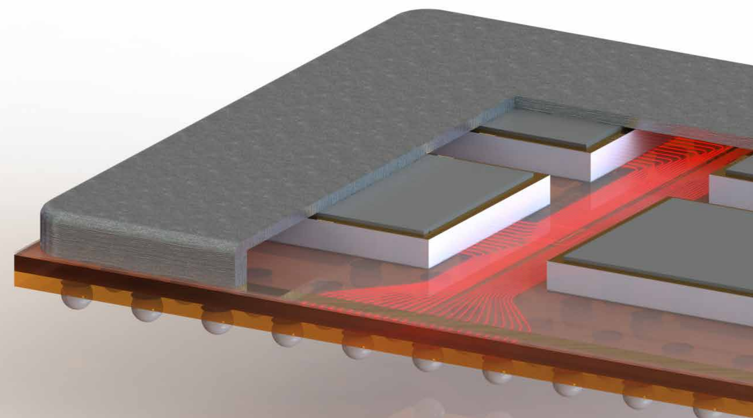
Need

- Assembly and packaging cost for integrated photonics is relatively high compared to semiconductor packaging
- Commonly used metal box package (butterfly package) is expensive and limits scaling of the assembly in volume

Result

- Together with RJR technologies a lead frame with injection molded air-cavity packages has been developed as replacement for butterfly packages
- Using LCP material and solid metal base, the robust design provides near-hermetic performance (10^{-8})
- Strip format eases automation of assembly (automatic indexing and handling)
- Metal base features thermal expansion matched to minimize differential thermal stresses
- Cost efficient, roughly 50% cost reduction BOM





'Semiconducturize' packaging of integrated photonics components

Need

- Scalable assembly and packaging for hybrid integration of semiconductor dies and integrated photonic dies
- Higher electrical and optical IO density
- Improved RF interconnect to increase bandwidth
- Improved thermal management
- Pluggable optics

Result

- CITC has defined a 'moon shot' package concept and processes for assembly and packaging of integrated photonic dies addressing the needs of upcoming photonic packaging
- The concept is a set of packaging technology building blocks for hybrid integration of semiconductor dies and integrated photonic dies in a single package
- The concept features chip to chip communication inside the package and outside world in both the optical and electrical domain
- In Dutch Growth Fund framework, CITC together with PITC develops and demonstrates the function of the technology building blocks

Where our developments in semiconductors meet the challenges in integrated photonics

Technologies in semiconductors	Challenges in integrated photonics
Materials and technologies for 100 GHz and beyond	Increased bandwidth
Die attach materials thermal conductivity >150 W/mK	Better thermal performance
Additive manufacturing technologies based on printing	WLFOP increased electrical and optical IO density
Strip/wafer and panel level concepts	Solutions for scalable volume manufacturing

Shared building blocks