EPIC European Photonics Industry Consortium

ficonTEC photonics assembly & testing 20 YEARS

EPIC Technology Meeting on Electronics & Photonics – Two Sides of One Coin

Photonics Assembly & Test – A Roadmap to High Volume Manufacturing

PHOTONICS AUTOMATED ASSEMBLY AND TESTING

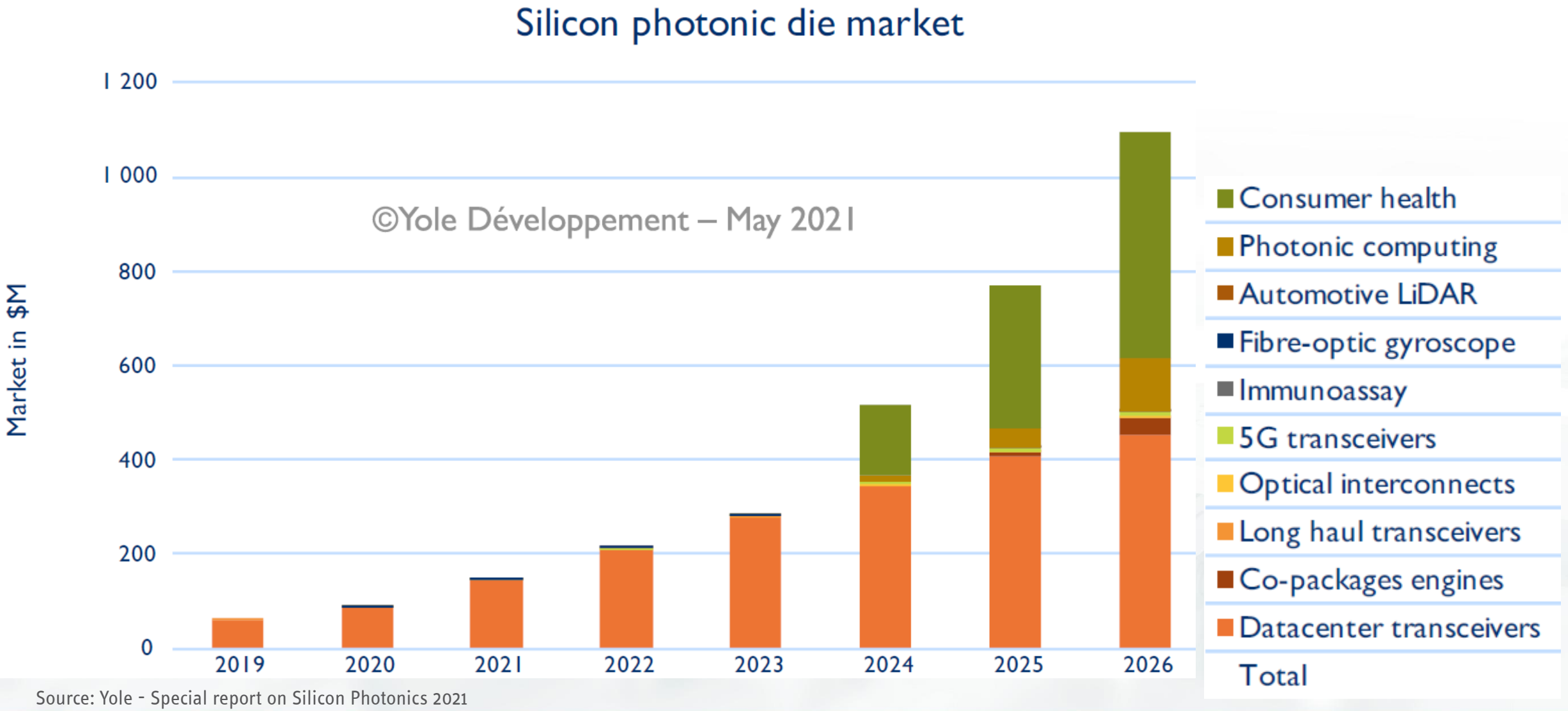
FROM LAB TO FAB

ficonTEC

MANUFACTURING MADE LIGHT

Solutions for integrated photonics. Built to scale.

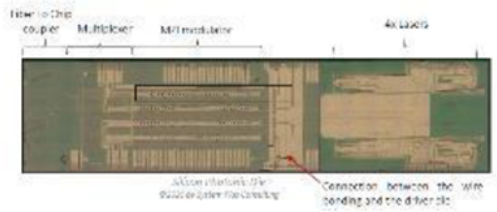
Silicon Photonics Market Forecast in Units



Source: Yole - Special report on Silicon Photonics 2021

Die vs. Packaging, Assembly and Test Cost

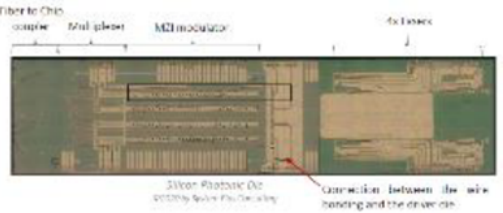
Optical transceiver



The Si photonic die (Intel, including laser)

Die cost: $10

Die price



The Si photonic die (Intel, including laser)

Die price: $17

In communication, packaging, assembly and testing are a major % of the final syste ASP: **more than 80%.** It is because of the need for high performance, fiber alignment …

System price

Intel CWDM4 transceiver (end-system)

Transceiver retail price $150

Consumer health

ASP used in forecasts

The Si photonic die (including laser)

Die price: $18

In consumer, assembly and testing are less stringent compared to communication (contact measurement). The ASP delta between die and system is from higher margins.

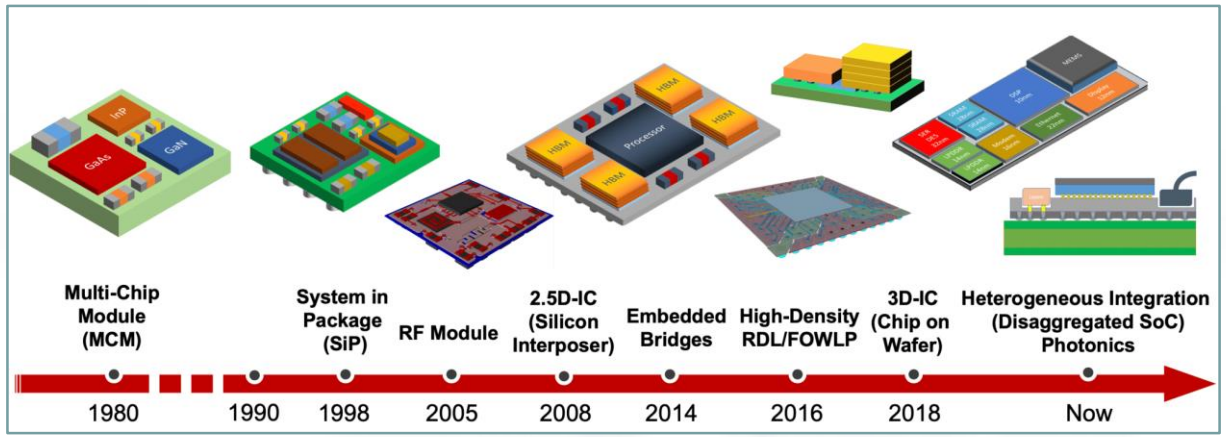
Smartwatch retail price $699+

Source: Yole - Special report on Silicon Photonics 2021

Integrated photonics for the 21st C

Micro-electronics has seen continued evolution since the 1960's/1970's

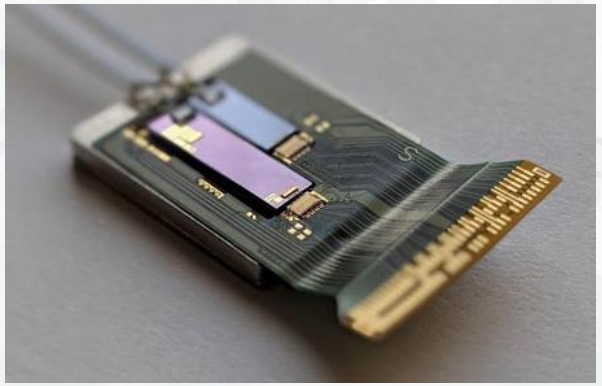
Today, ever more complex and powerful devices are all manufactured cost-effectively at wafer level. Some also now incorporating photonic elements …

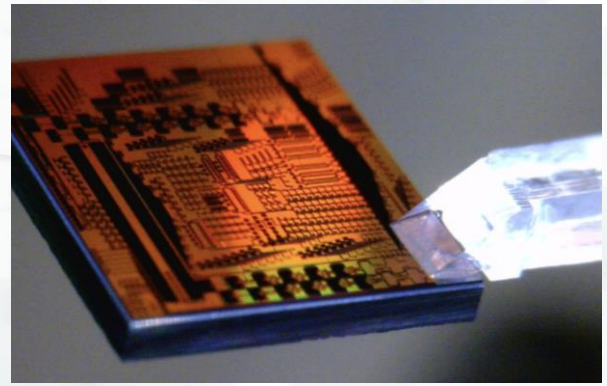


Source: Cadence

Fully integrated photonic devices are the equivalent to ASICs for micro-electronics.

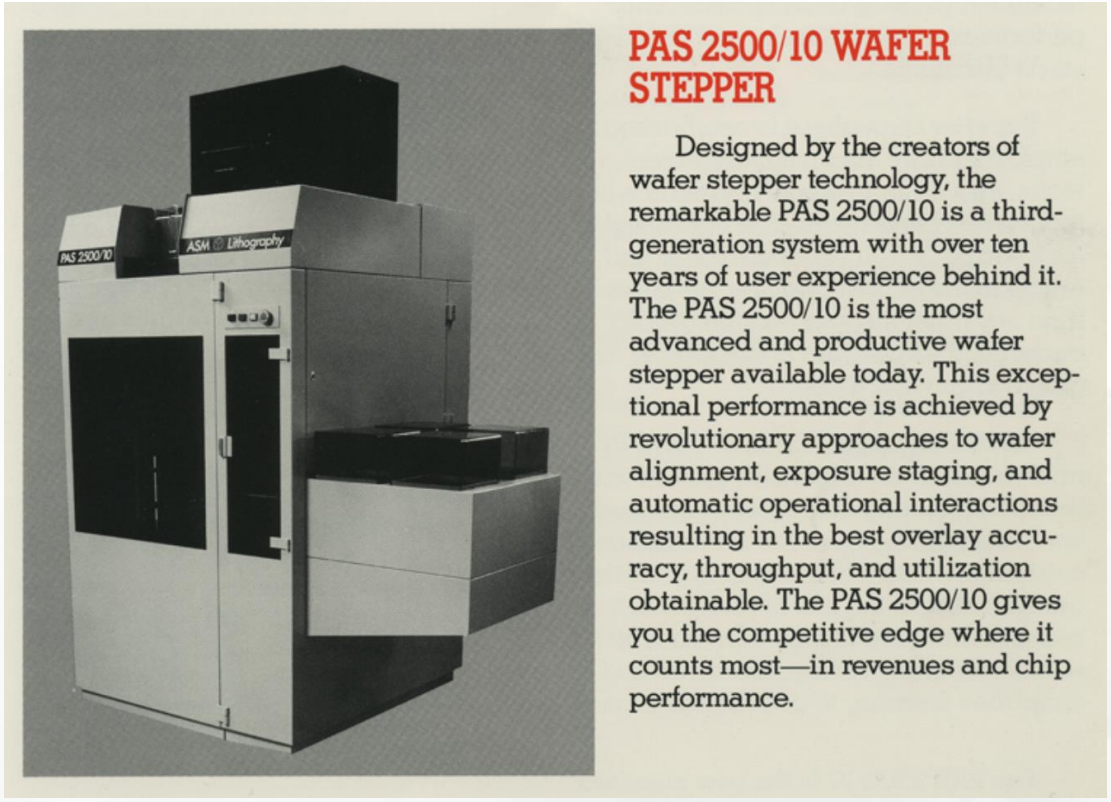
Photonics is today riding the same generational transition to 'micro, hybridized, integrated & monolithic'. But 35-40 years later …





Semi equipment history vs. Photonic present

ASML 1986



Source: https://www.chiphistory.org/178-asml-pas-2500-series-wafer-steppers

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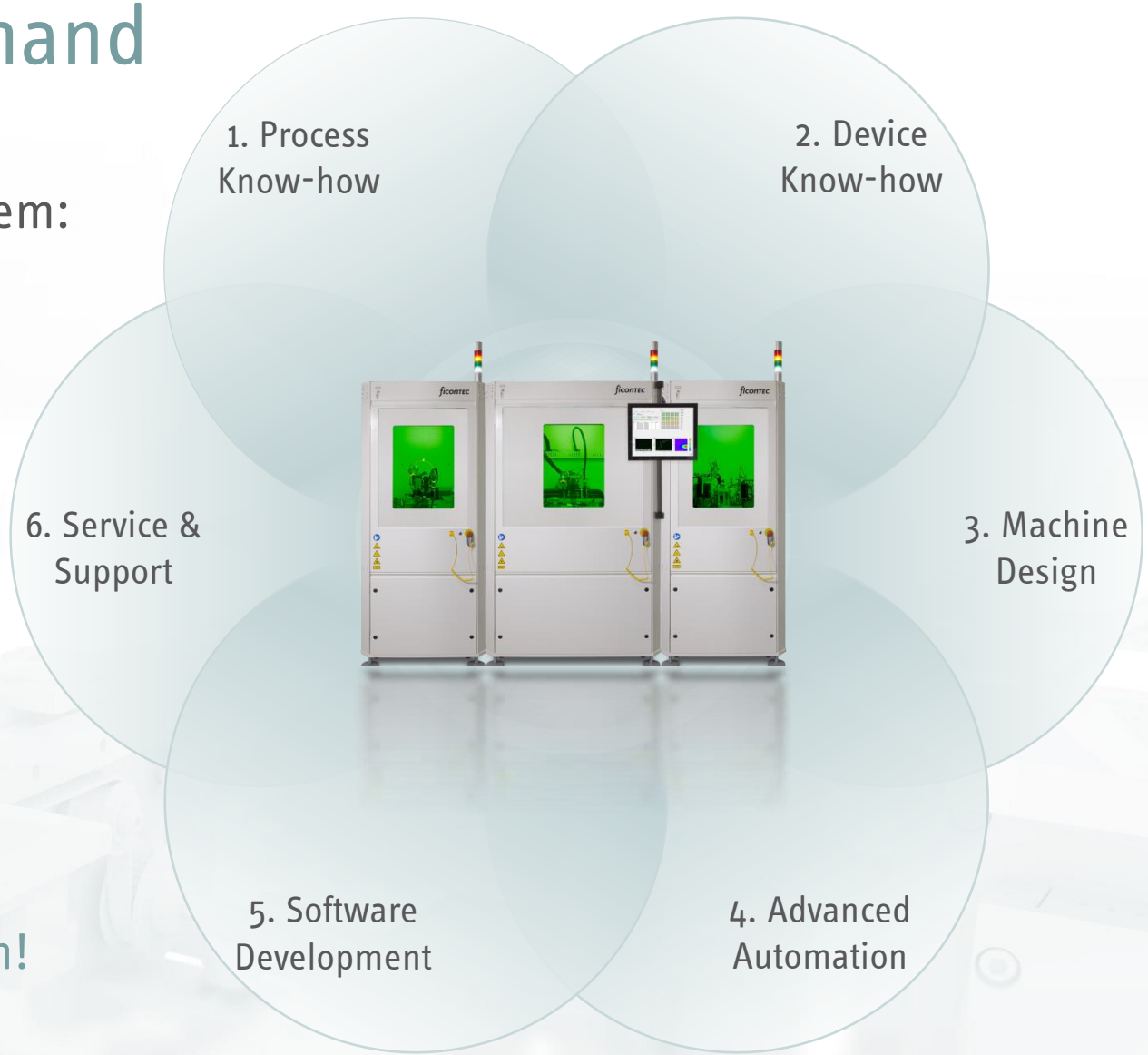
Required Toolbox to meet demand

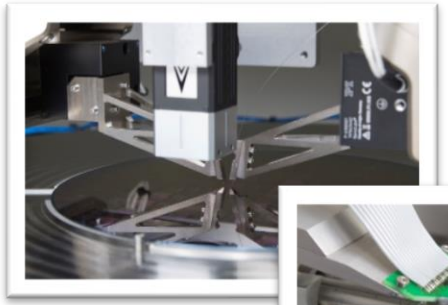
We are uniquely positioned within the eco-system:

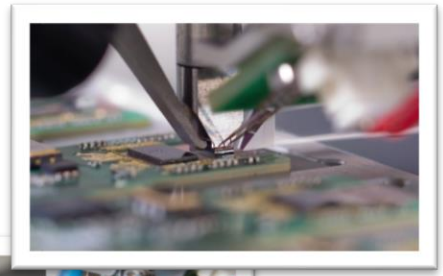
1. 21 years & 1000 installations
2. collaborate internationally on R&D
3. modular machine design
4. advanced & well-received software UI
5. software UI / 1500 instruments / APIs
6. applying Industry 4.0 & AI/ML

… this helps dial-in device throughput, yield, performance & ultimately the value proposition!



Value chain of QFSP module as an example





Wafer level

Chip level

Chip Test

Separation

Passive bonding

Active bonding

Chip Bonding

Wire Bonding

Active assembly

Module Assembly

Packaging

Lens Assembly

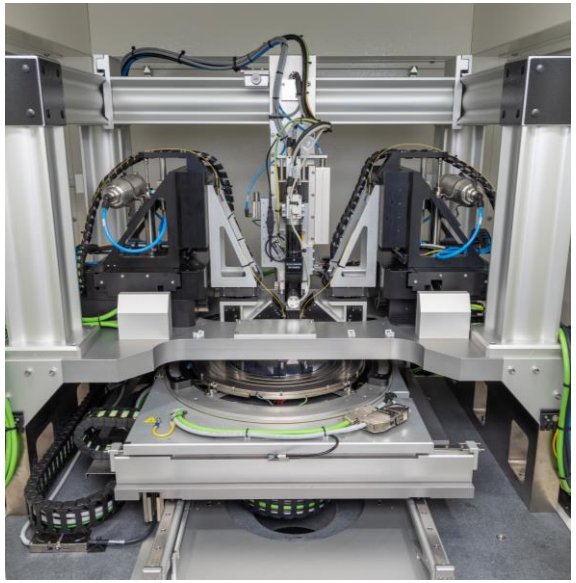
Fiber Assembly

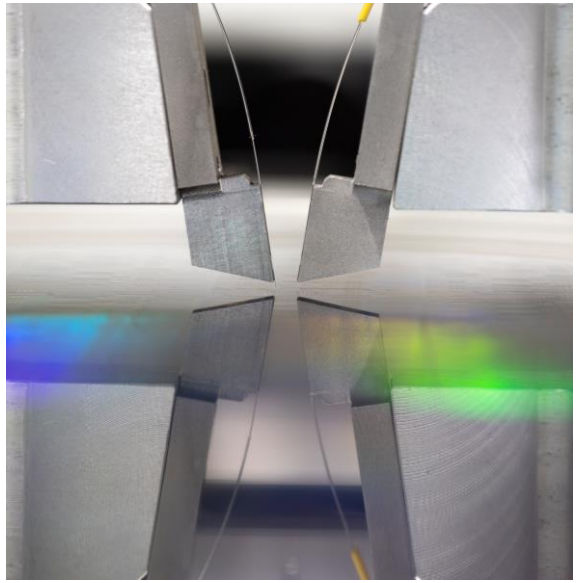
EoL Test

Standard Electronic Process

Photonics Process

Optical wafer level testing – T1200





Optical wafer level testing – T1200

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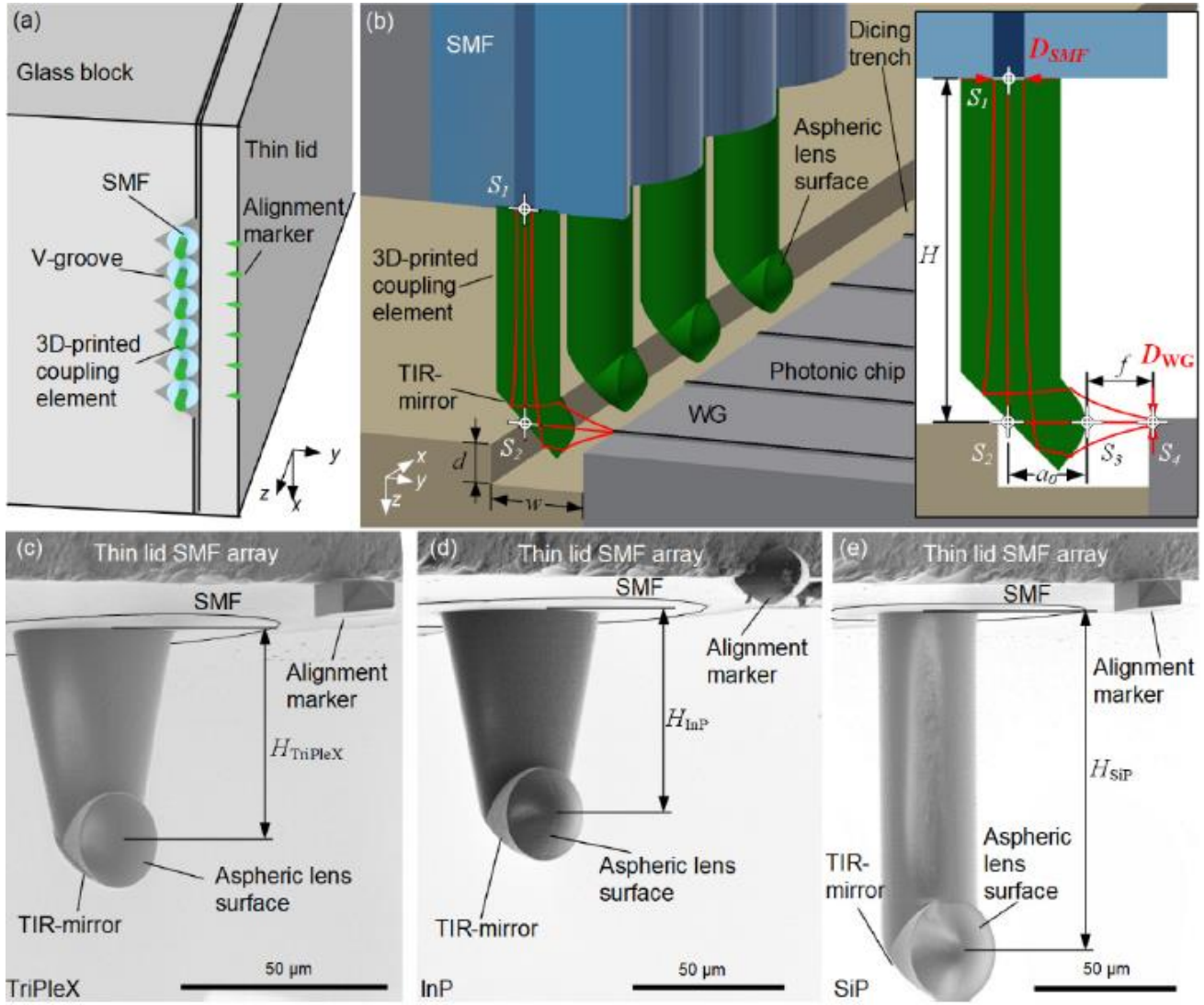


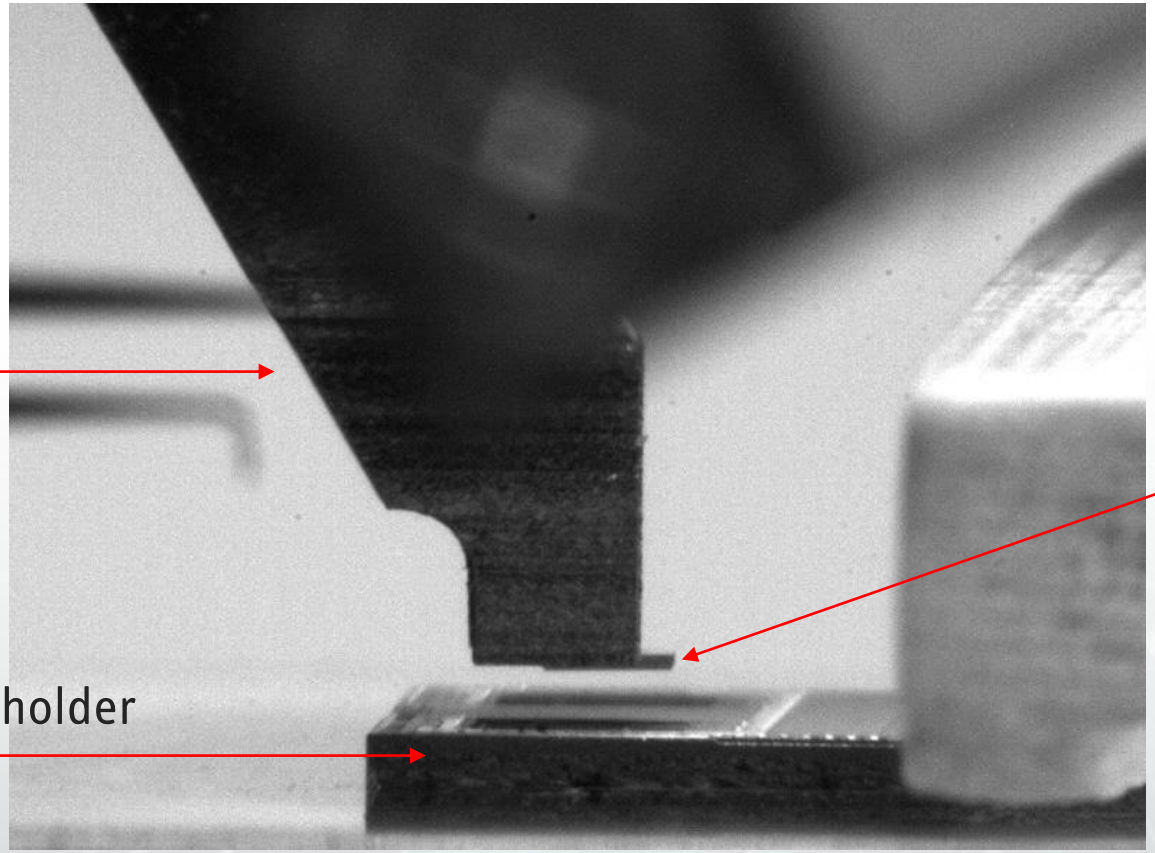
Source: Vanguard Automation

Edge coupling on the Wafer scale!

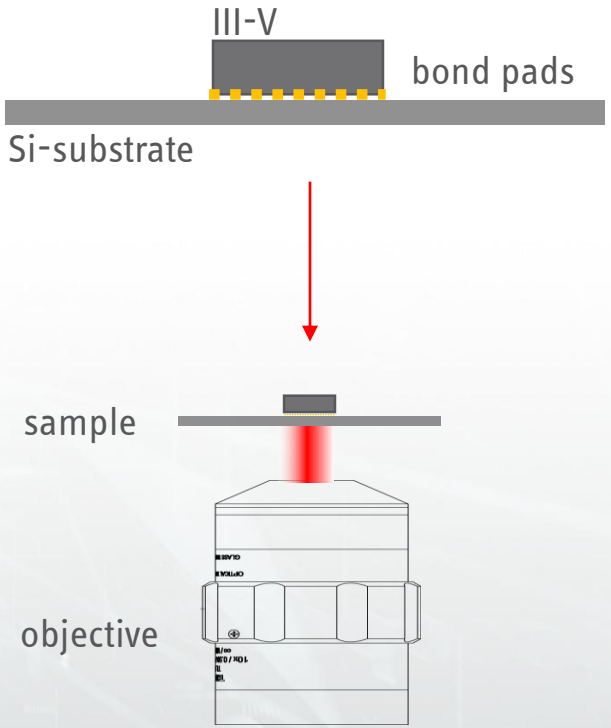
- 4-64 Channels
- Alignment in etched trenches
- No grating couplers necessary
- Basically wavelength independent
- Mode size can be adjusted to PIC

Wafer level passive laser soldering for III-V to PIC

Pickup tool on high accuracy 6-axis aligner



SiP fixed on the holder

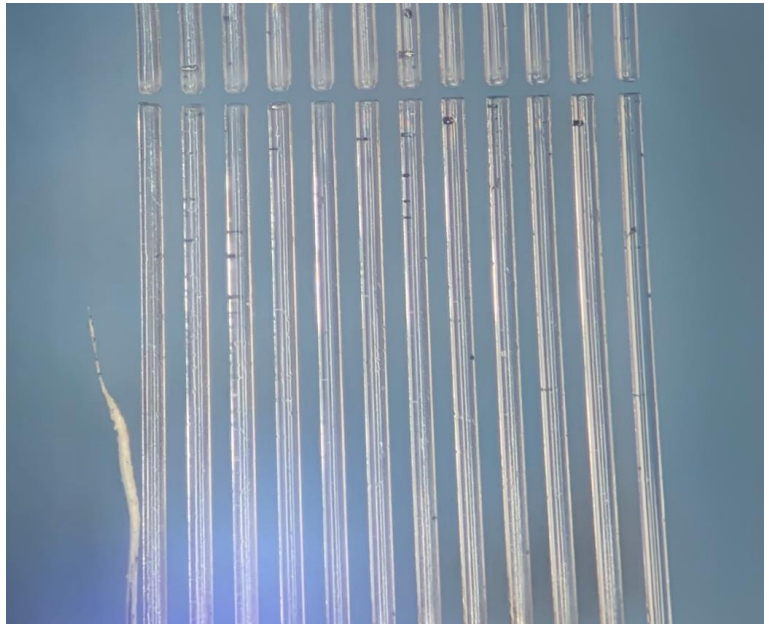


Fiber strip, cleave, insert or place

Develop system for Laser-based automated fiber cleaving and stripping

- Stripping & cleaving of single „standard“ (250/125/9) fibers
- Integration into fiber assemlby systems

Coating removal



Cutting of fibers

Fiber strip, cleave, insert or place

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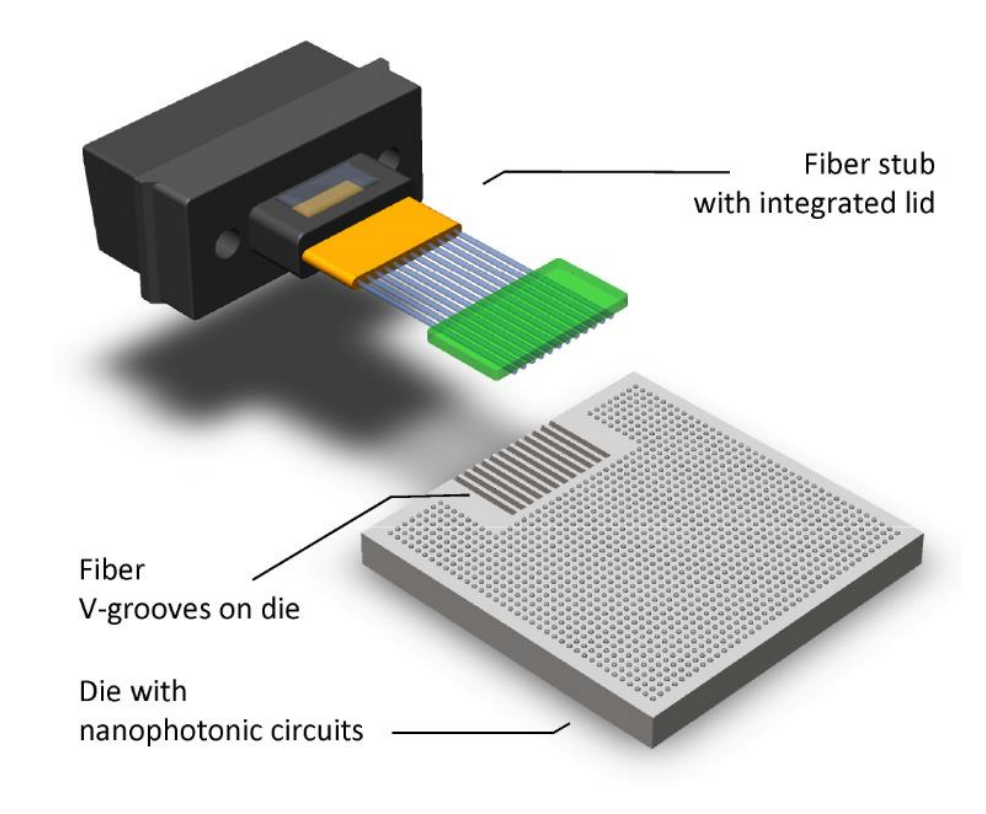
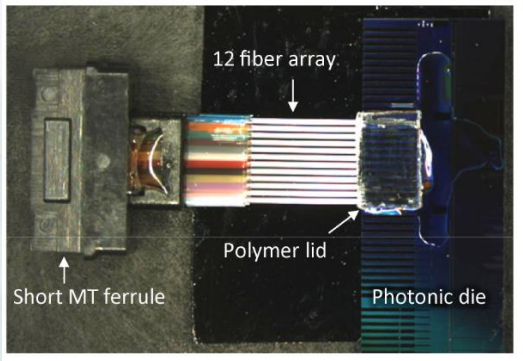
Passive v-groove placements



Source: IBM

- Etched v-grooves in PIC
- V-grooves match to waveguides
- Insertion of fiber arrays
- Passive process



Current Industry State of the art Lens and Fiber Attach

Video from 2019

VIDEO:

- 45-55 UPH cassette-to-cassette systems TxLens, TxFiber and RxFiber
- Full data-tracking though the line
- 150 systems of the same kind in production
- Process revision control
- Designed per Customers assembly process requirement(s)

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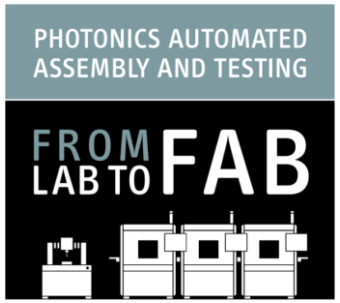
From Prototype Machines to Mass Production



Fully automated Production Line consisting of several Feeders, Passive and Active Attachment, EoL test and Laser marking

Automated Production System consisting of 1 Input Feeder; 1 System; 1 Output Feeder

Production System with Development capability

Lab System with Production capability

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Closing Words …

ficonTEC has the breadth and depth of experiences and technologies to lead HVM strategy.

ficonTEC is a market-driven company and a driver – it's in our DNA. Nevertheless, given the fragmented composition the market and lack of its standardization, our systems technology reflects that …

Unlike the 90's telecom/datacom boom-&-bust (i.e., 'demand-push' market), ficonTEC believes that we are in the 'demand-pull' market where we have the fundamental market demand for optical-communication products at all levels. Therefore, we believe that the industry will reach a threshold/tipping-point toward such 'systematic standardization' that forces HVM, which will in turn force manufacturers to design devices that are conducive to high-volume automation, and in turn, collaborate and enable automation system suppliers to address the demand of the industry.

ficonTEC conducts its business and operates with this view. Therefore, our customer base – whether large or small – tends to be strategic and complementary. ficonTEC has the roadmap in place to reach this strategic goal with or without any one company.

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