MANUFACTURING MADE LIGHT

Solutions for integrated photonics. Built to scale.

ficonTEC photonics assembly & testing

PHOTONICS AUTOMATED ASSEMBLY AND TESTING

FROM LAB TO FAB

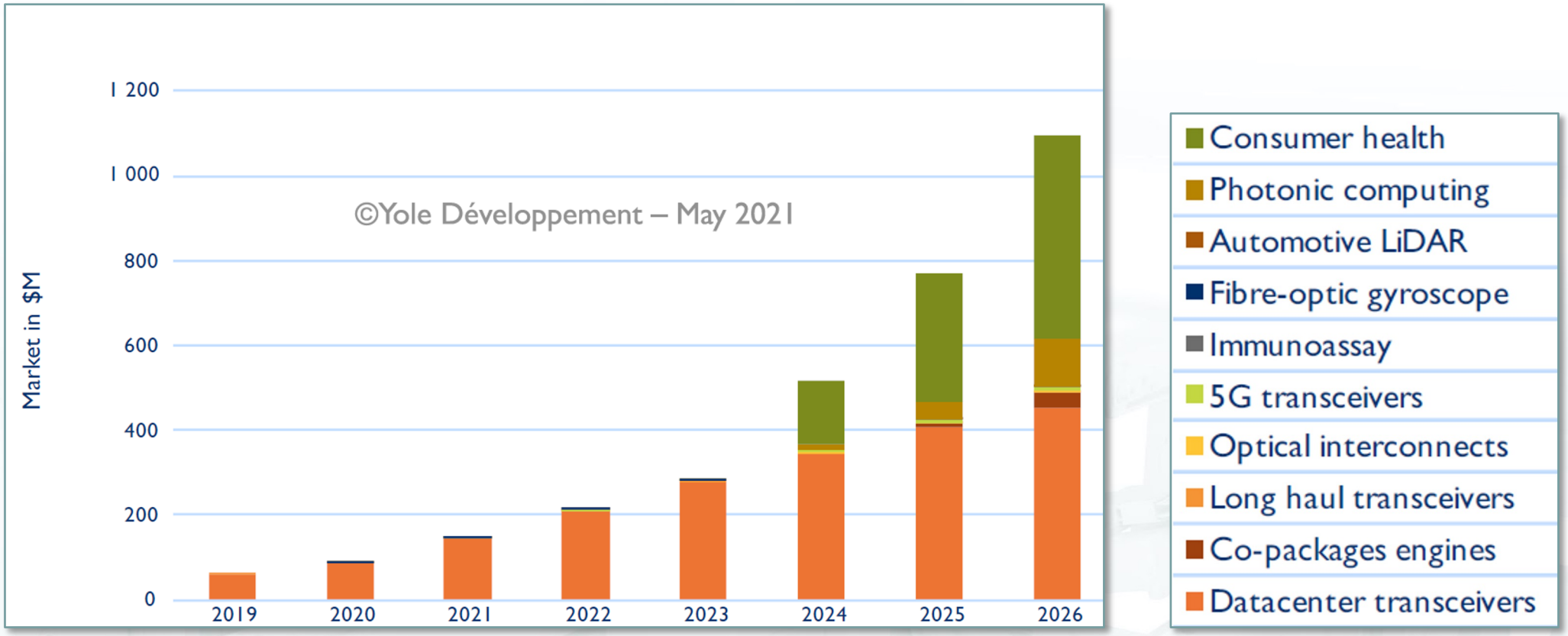
ficonTEC

Challenges and Strategies for High-Volume Manufacturing and Testing of Co-Packaged Optics

Torsten Vahrenkamp, CEO ficonTEC Service GmbH

COBO Webinar, February 22, 2023

Integrated Photonics Device Forecast



Source: Yole - Special report on Silicon Photonics 2021

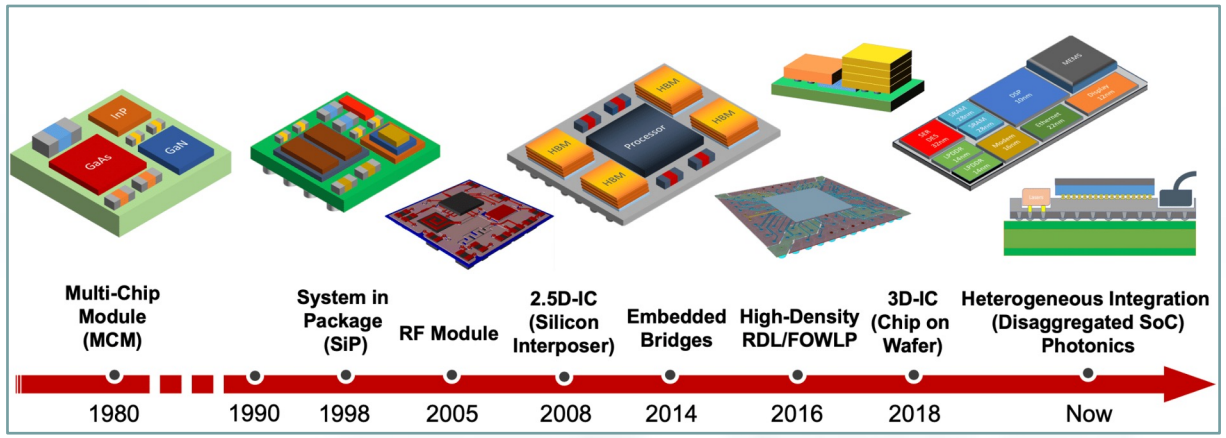
Semiconductor Evolution a Success Story

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

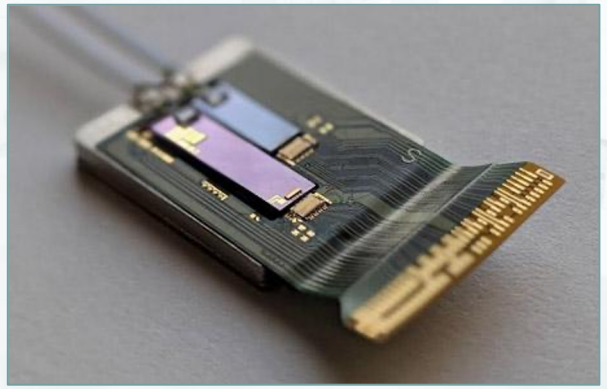
Today, ever more complex and powerful devices are all manufactured cost-effectively at wafer level. Some also now incorporating photonic elements…

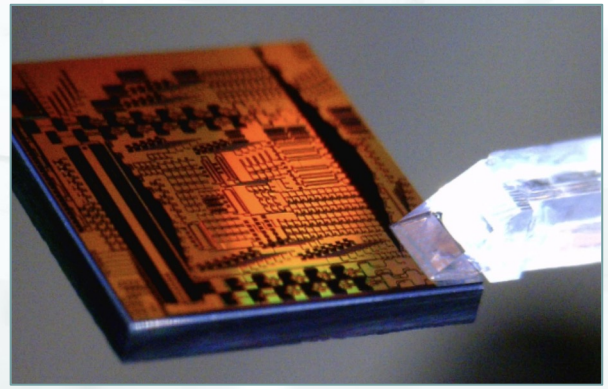
Fully integrated photonic devices are the equivalent to ASICs for micro-electronics.

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



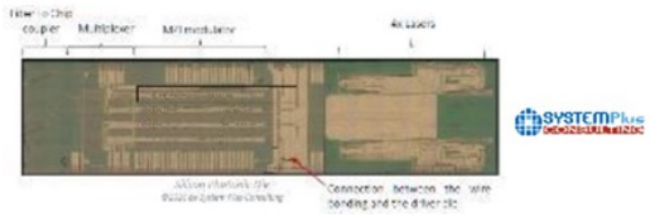
Source: Cadence





Die vs. Packaging, Assembly and Test Cost

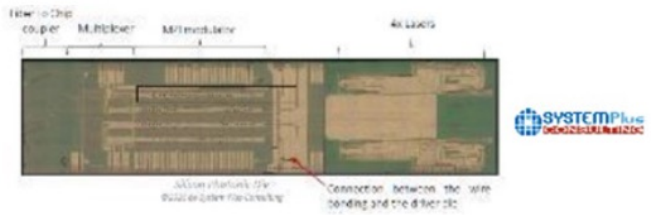
Optical Transceiver



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 systems 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

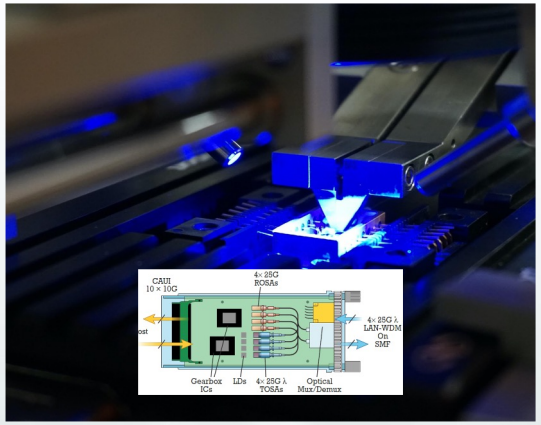
In consumer, assembly and testing are less stringent compared to communication (contact measurement). The ASP delta between die and system is from higher margins.

Smartwatch retail price: $699+

Source: Yole - Special report on Silicon Photonics 2021

Successes – Where have we made a difference?

Telecom/Datacom

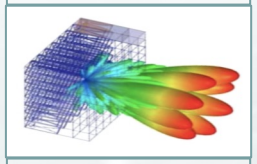


Supplier of volume production systems for fiber align-&-attach & TOSA/ROSA for long-haul, data center & free-space comms

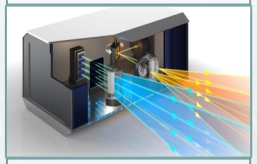
Lidar Development

Pulsed/Scanned Flash [Credit: LeddarTech]

Flash solid-state: VCSELs + SPADs [Credit: Ouster]



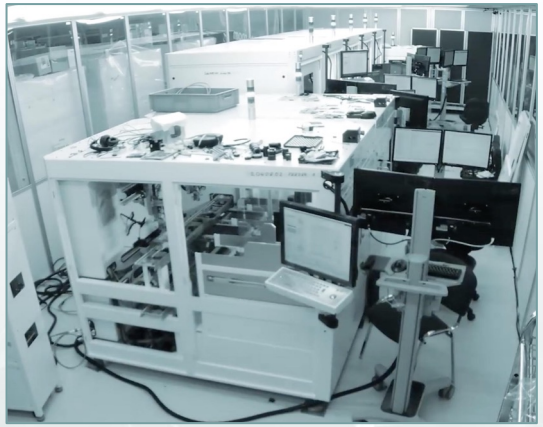
Pure solid-state via OPA



Micro-/macromechanical scan [Credit: OSRAM]

Process development and volume production systems across multiple near & long-term lidar technology schemes

High-volume Manufacturing



High-volume, high-tact-rate & high-yield production lines, e.g. for P2.5 µm air purity optical detection modules

Quantum Technology

With permission: QUANTUM OPTICS JENA

Fully automated systems for photonics-enabled quantum devices, e.g. for miniaturized polarization entangled sources

HVM in Photonics Assembly is not a New Thing

Air purity optical detector sensor for a German Tier 1

Mass production site in Thailand with over 150 machines, incl. automatic module handling (cassette to cassette)

Assembly Strategies in Co-packaged Systems

Active vs Passive Assembly

SiP-Chip with V-Grooves

Passive Fiber Alignment and Attachment

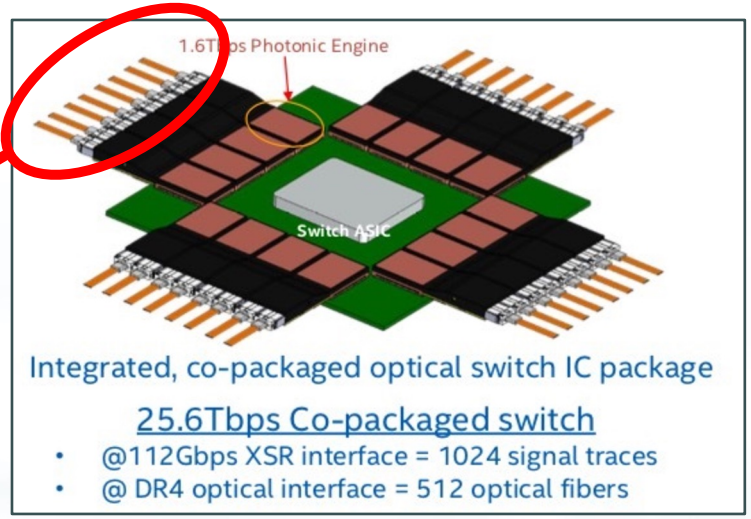
Cleaved and Stripped Fiber Ribbon

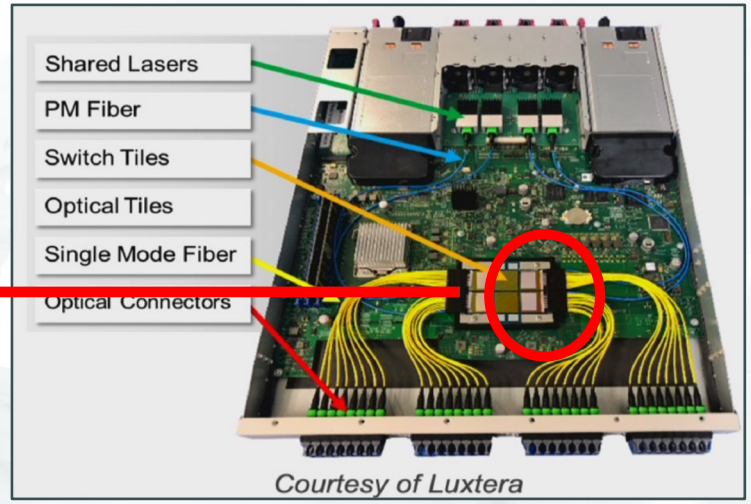
SiP-Chip with Edge Couplers

Active Fiber Alignment and Attachment with and without additional Optics

Lens

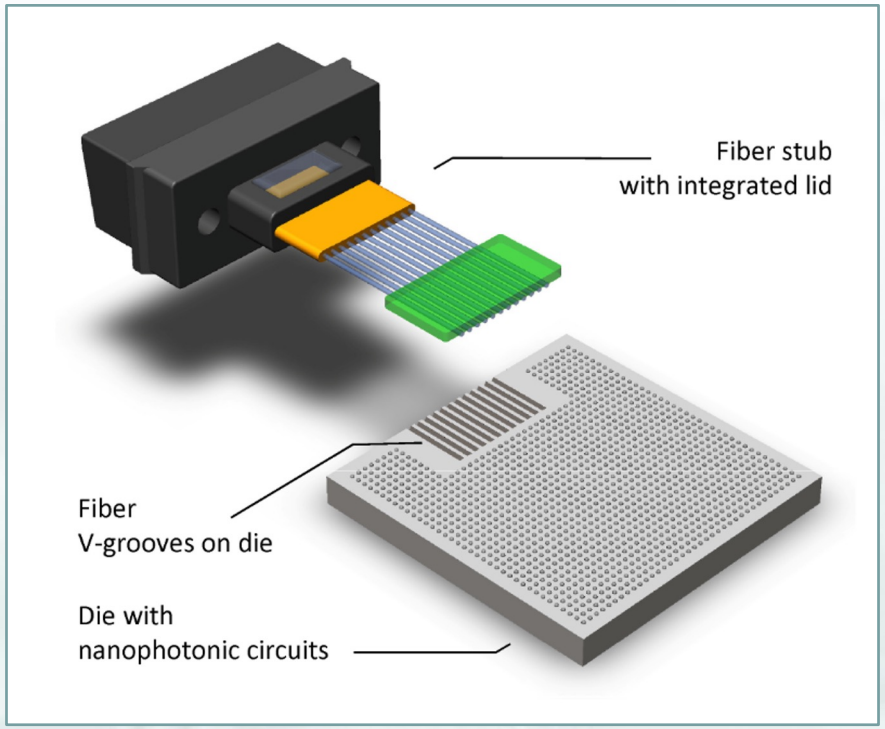
Fiber Ribbon with polished Glass Block



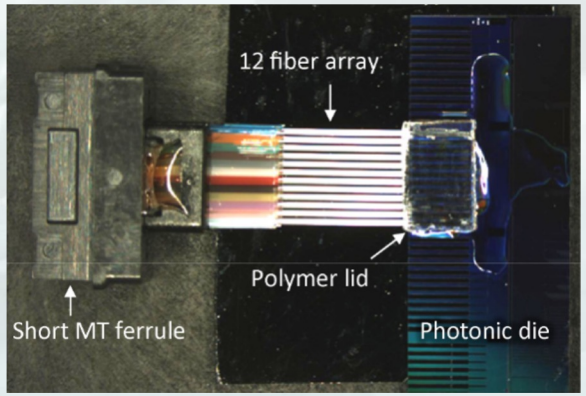


Source: https://community.cadence.com/cadence_blogs_8/b/breakfast-bytes/posts/the-photonics-summit-2019

Passive Ribbon in V-groove Placement as an Example

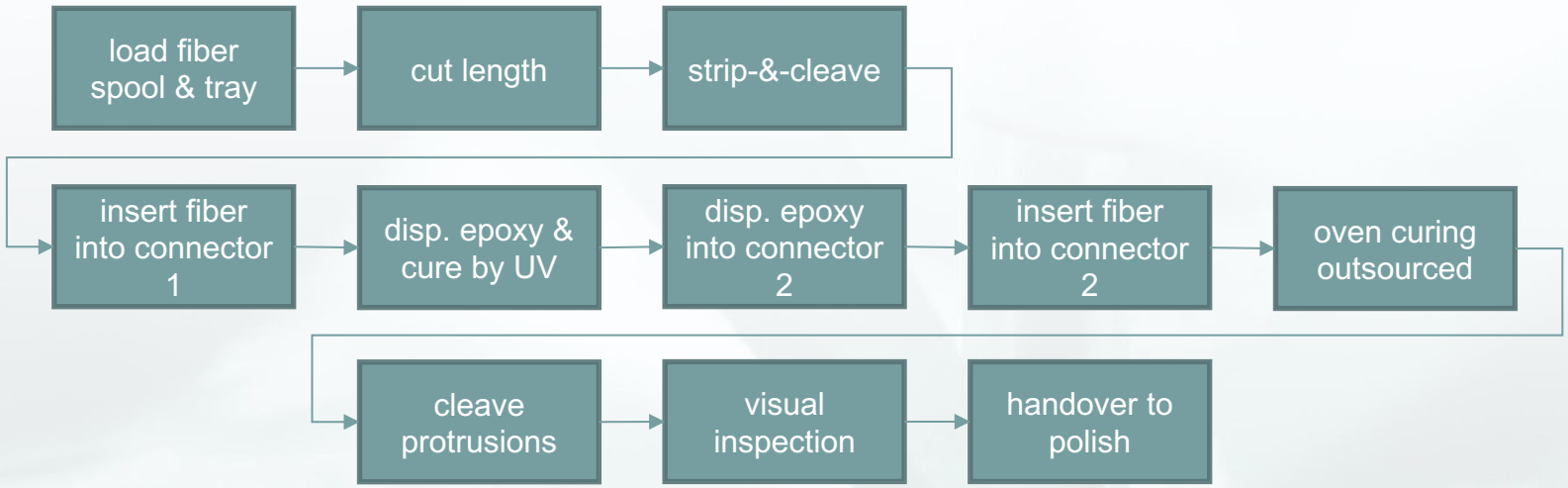


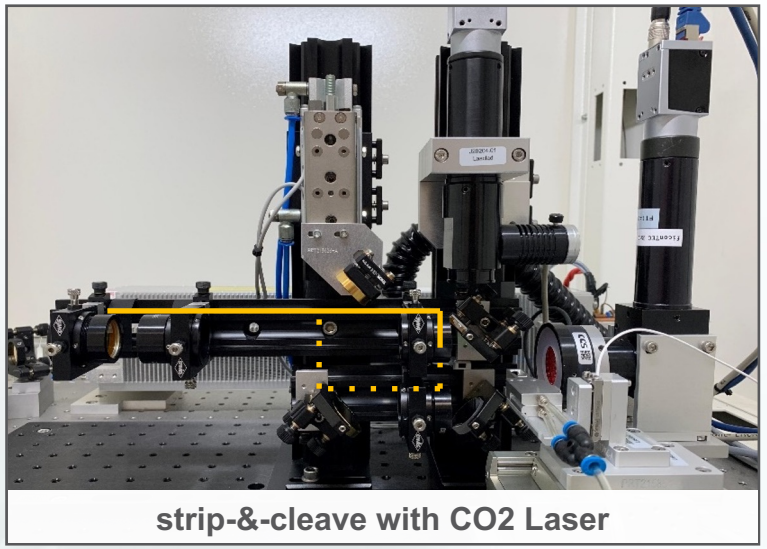
- Etched v-grooves in PIC
- V-grooves match to waveguides
- Insertion of fiber arrays
- Passive process



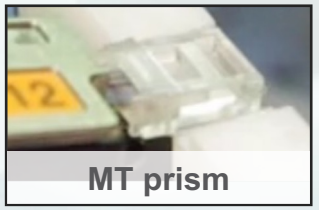
Automated, self-aligned assembly of 12 fibers per nanophotonic chip, T. Barwicz et al., ECTC 2015

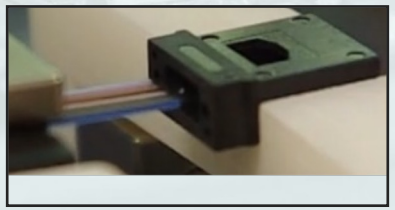
F1600 – Fiber preparation workflow

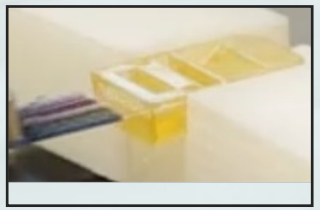



strip-&-cleave with CO2 Laser


Fiber ribbon insertion


MT prism





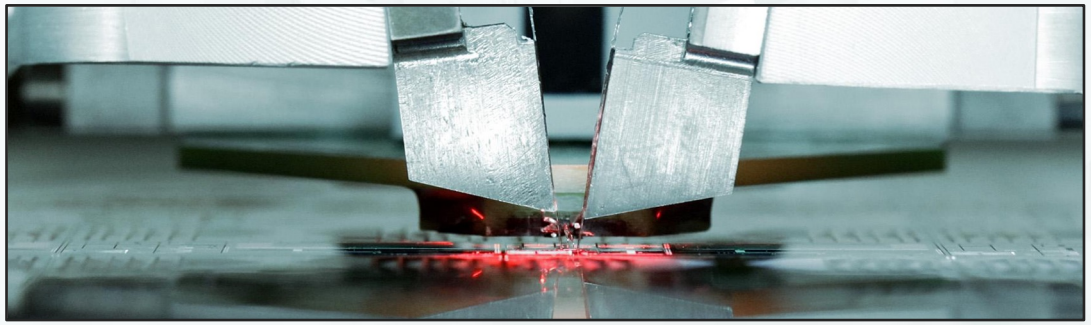
FIBERLINE

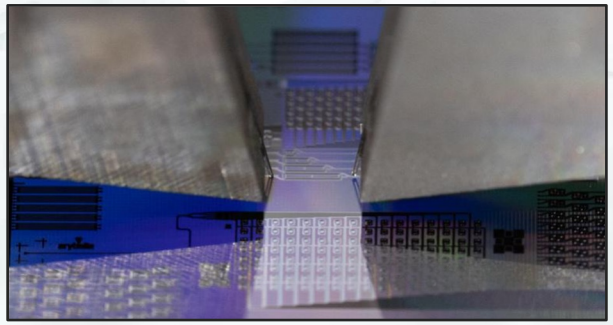
Automated Fiber Ribbon Insertion

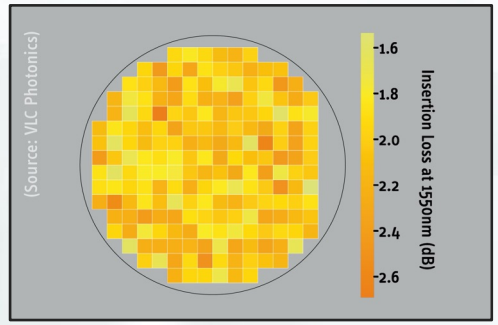
Wafer-level Test – Transition from 2019 to 2022

Overview of Photonics Handling and Test Demonstration

- Overall test solution
  - ficonTEC integrated prober and test system
  - Optical test performed by Coherent Solutions
  - 200 mm photonics demo wafer with optical waveguide and grating coupler
  - Capable of electrical and optical test
- PXI products highlighted
  - Tunable laser source
  - Optical switches
  - Optical power meters
  - Optical signal analyzer (OSA)



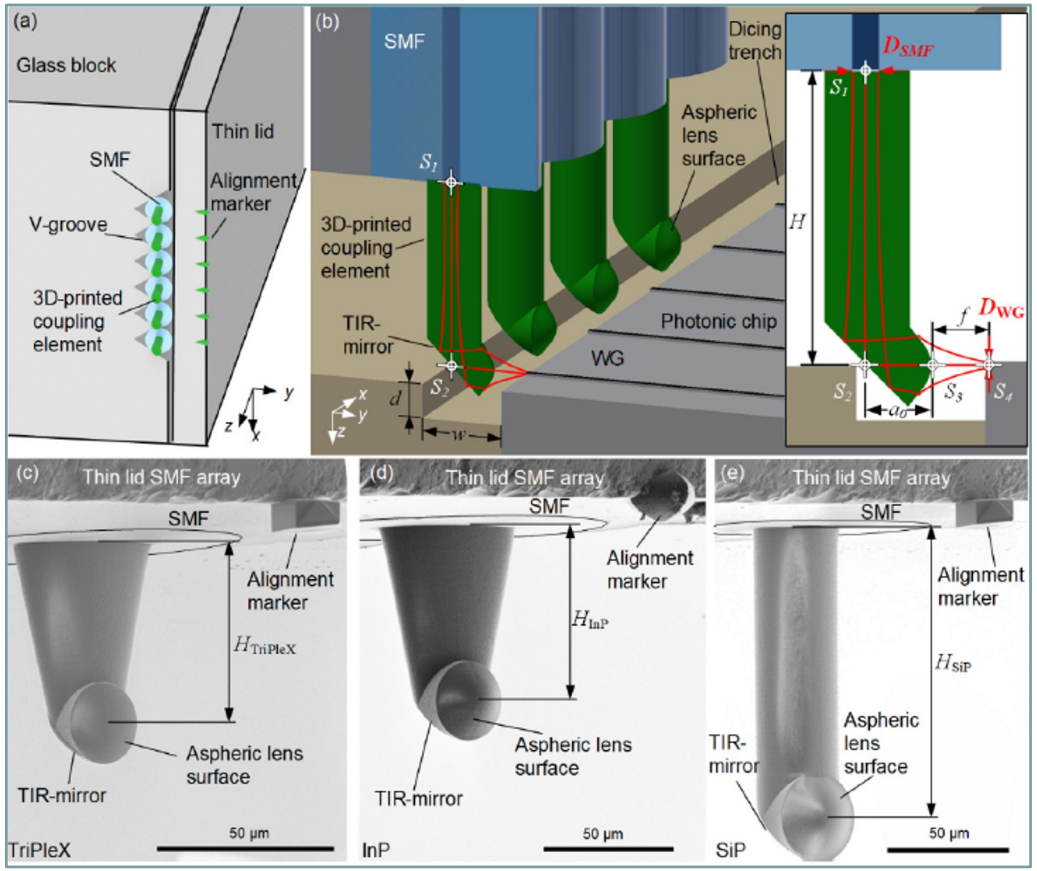




WAFER TESTLINE

Fully Automated Wafer-level PIC Test Systems

Optical Wafer-level Test – WT1200



Source: Vanguard Automation

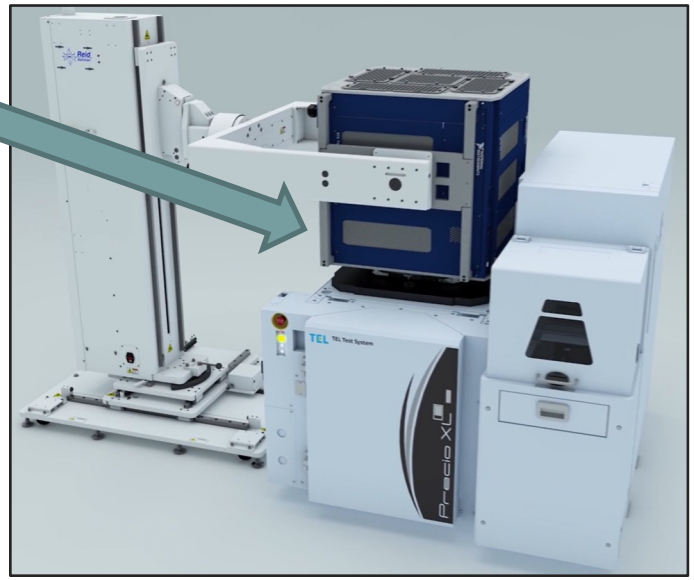
Edge coupling at wafer scale!

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

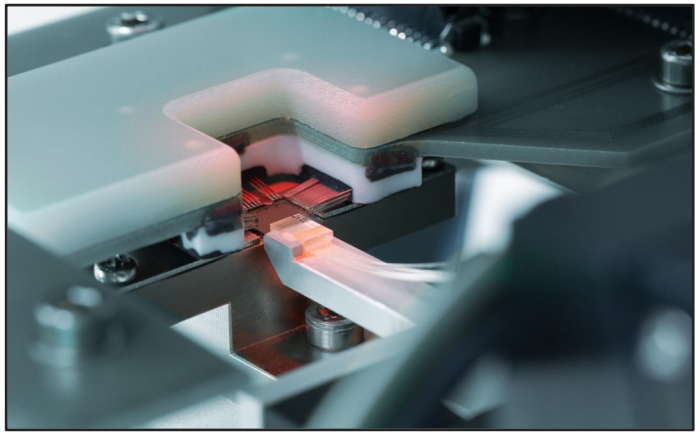
Characterization and High Channel Count Testing

Ficontec Wafer level test system for characterization

QUANTIFI PHOTONICS
TEST. MEASURE. SOLVE.



TEL Tester with National Intrument Test Instrumentation



Singulated Chip Testing with optical and electrical probes

Thank you

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