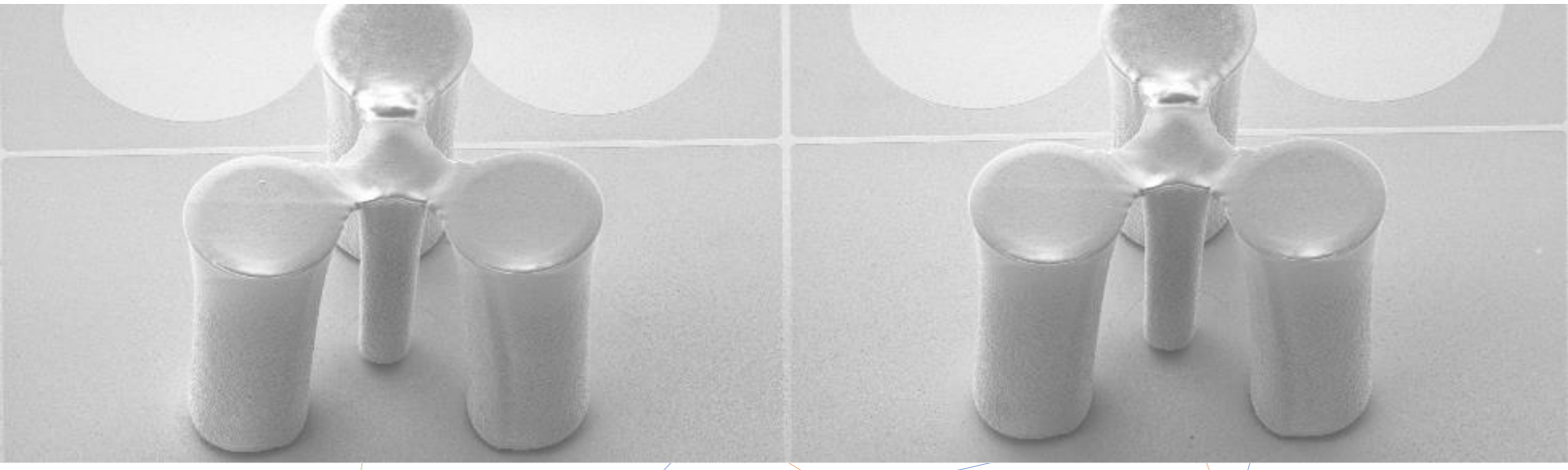
Whitepaper n°1 – April 2021

ICON Photonics follows TELCORDIA standard requirements



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Content

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A tangible and industrial problematic

Reaching new data rate standards is a constant challenge in the optical communications industry. For both Telecom (long distance) and Datacom (short distance) applications, the need of high performance is constantly growing.

Data rates have boomed up from 10Gbps, 25Gbps to 40Gbps. 112Gbps per channel are coming up in the next few years. To reach these high data rates, all the value-chain is looking to performance improvements directly at the chip level. Semiconductor chipmakers are reducing the optical aperture size of their photodiodes and sources to meet up the bandwidth needs and to lower the power consumption per gigabit. Such small active areas raise up new challenges on the fiber to device optical coupling. Assembly integration is requiring new micro-optics solutions to reduce the packaging time and cost.

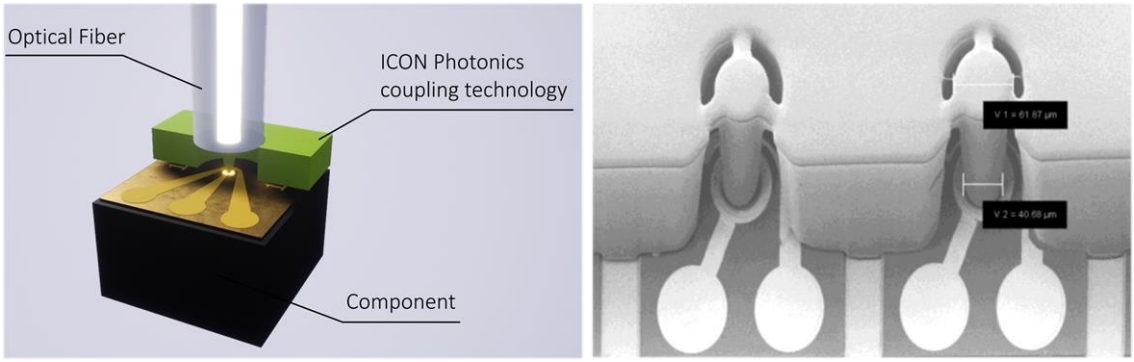
High-speed photonics market is still expecting a wafer-level mass-manufacturing micro-optics solution to pursue its growth.

All data exchanges can be split in two main steps: their transport and their storage. Imagine how many users are simultaneously exchanging data all around the world (using long-haul telecommunications) and how many bytes are processed and stored continuously (using short-reach datacenters)… according to Statista Digital Economy Compass, the world generated 33 zettabytes of data in 2018, with a growth estimation to 40 zettabytes in 2019.

All that thanks to emitters injecting light inside optical fibers, transporting the info to a receiver!

ICON Photonics: why & what ?

ICON Photonics is a technology company with a vision to bring to the market a simplifying layer for the optical coupling to the fiber, enabling the next generation of ultrafast optical components. Based on on-chip 3D polymer micro-optics, it provides a wafer-level collective approach compatible with mass-manufacturing lines and processes.



Seamlessly integrated on wafer, it brings new optical functionalities directly at the chip aperture level improving the light collection, increasing the effective optical active diameter or beam-shaping the emitted light. The figure above shows a 3D illustration (left-hand side) and a SEM picture (right-hand side) of the polymer micro-optic structure acting as a vertical taper waveguide surrounded by three suspended arms. The anchoring structure is providing the mechanical stability and robustness against the vibrations and thermal stress. It can be custom-designed to fit the most versatile assembly requirements (dicing, wire bonding, die-attach, fiber attach, flip-chip, etc.).

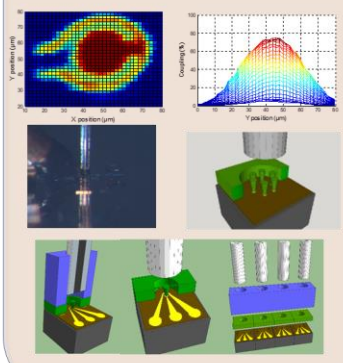
A whole new set of possibilities is opened in terms of advanced interconnect solutions and wafer-level testing. All those solutions bring performance and simplification into existing process lines and standard packaging supply chain.

ICON Photonics is commercializing its solutions across three main axes:

Study

Characterization, design & Simulations

- On Wafer/chip characterization: 2D SNOM, DC, RF, RIN, SFDR, EVM
- Modelling & optical design



Prototyping

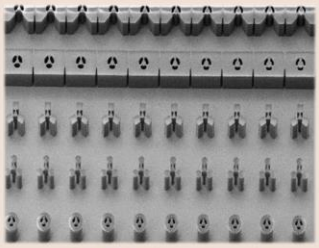
Cleanroom processes & custom development

- Prototyping on wafer/chip
- Advanced wafer-level packaging
- Reliability (T-cycling, moisture, …)

Production

Industrial requirements validation

- Performance validation & reliability testing
- Small/medium series production
- High volume manufacturing transfer possibilities



On-Wafer polymer microoptics

The study phase is a preliminary step to the development and integration of ICON Photonics custom solutions into the customer systems. It can also be seen as a simple R&D externalization.

The prototyping phase is proposed to validate the process and get first prototypes, in order to move on to the production phase. In that phase, ICON Photonics can propose a 4'' industrial production, but also a technology transfer in case of need.

TELCORDIA standards

Talking about industrial production brings many questions. One of the most important ones is the reliability aspect of the technology at an industrial level.

To help companies going in the same direction, standards have been defined such as the ones of TELCORDIA, which are accepted by the largest number of industry players throughout the whole value-chain in the field of optical communications.

They imply quite stringent environmental tests such as rapid thermal cycling along large ranges of temperature to meet conditions such as -40°C and +85°C, as well as high humidity and high temperature storage conditions, among others.

Each component, sub-component, system or sub-system has its own series of requirements to fulfill!

As a passive element directly integrated to another component during its fabrication process, ICON Photonics structures have to pass the TELCORDIA requirements of the component on which they are incorporated.

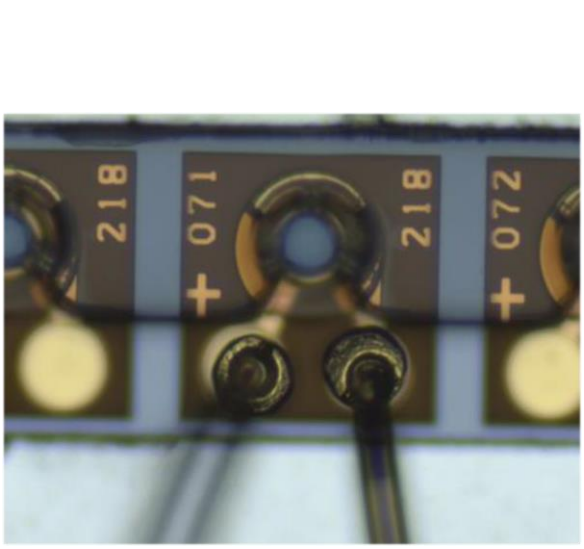
ICON Photonics structures integrated on a wafer

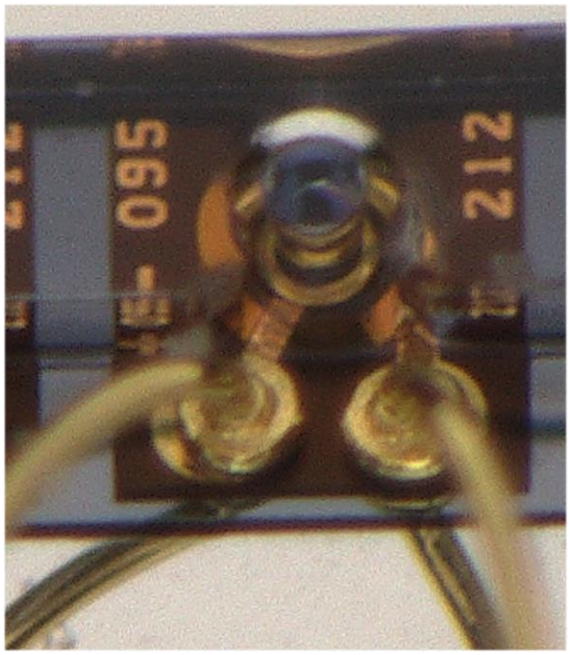
High reliability performance

ICON Photonics validated all the important tests with outstanding performance. We keep demonstrating highest robustness day after day.

We passed the tests with no degradation of the optical performance **even after 1.000 hours under a BDH (biased damp heat) at 85°C and 85%rH (relative humidity).**

The tests have been implemented on pre-coupled photodiodes, meaning photodiodes on which ICON Photonics manufactured its coupling technology. The pictures below are showing the photodiodes tested with the BDH with a zoom focus provided on the right hand-side of the figure.





The integrated structure supported over **50 cycling tests between -40°C/+85°C without any degradation on the optical performance.**

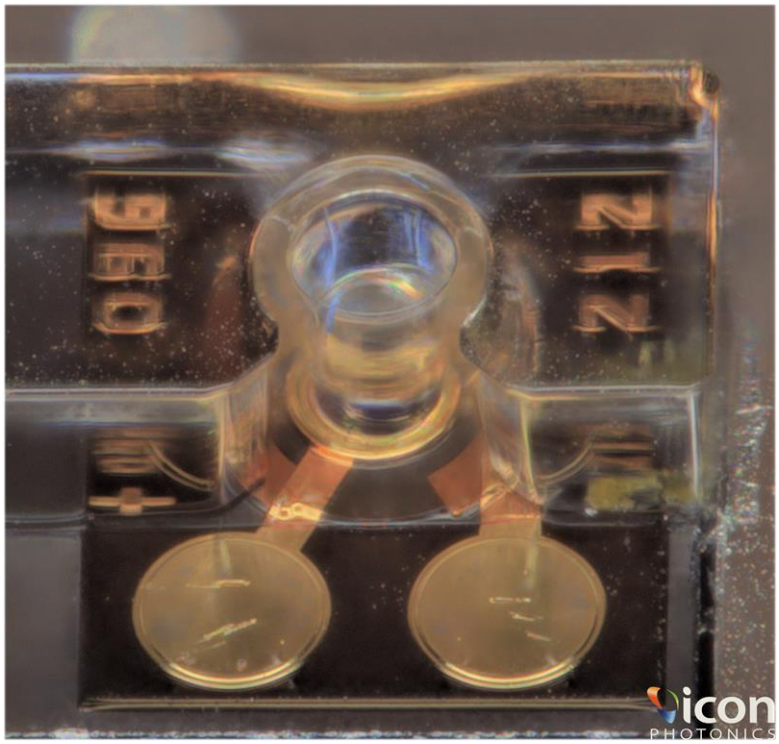
The shear stress and adhesion forces of the polymer onto the active chips was also an important parameter of control. Imagine what? It did not move a single nail and kept well bonded on top of the device.

In terms of extreme temperatures, at the lowest side the polymer is also **withstanding cryogenic temperature**, while at the highest side a maximum temperature of 270°C for more than 30 minutes has been withstood without any degradation.

As mentioned previously, each situation, project or application has its own reliability levels to pass. We presented here the essential TELCORDIA tests asked in the Datacom / Telecom applications, but we would be glad to provide you information on your specific request of reliability.

Reliability… but what for?

These strong results reinforce ICON Photonics strategy in the datacom & telecom markets, but also reinforce the general technology robustness. It is now clear that ICON Photonics technology is designed for the industrial applications and productions.



An example of application in the datacom industry is the development of a 20µm or 10µm active area diameter photodiode. Today, such a photodiode would be very difficult to align to the optical fibers and so useless to produce despite its high-speed performance. Once equipped with ICON Photonics technology, this specific photodiode will be aligned in the same way as a 30µm photodiode, but with its core performance significantly enhanced. The ICON Photonics optical taper is enlarging the equivalent optical aperture from 10µm to up to 60µm.

A new good friend!

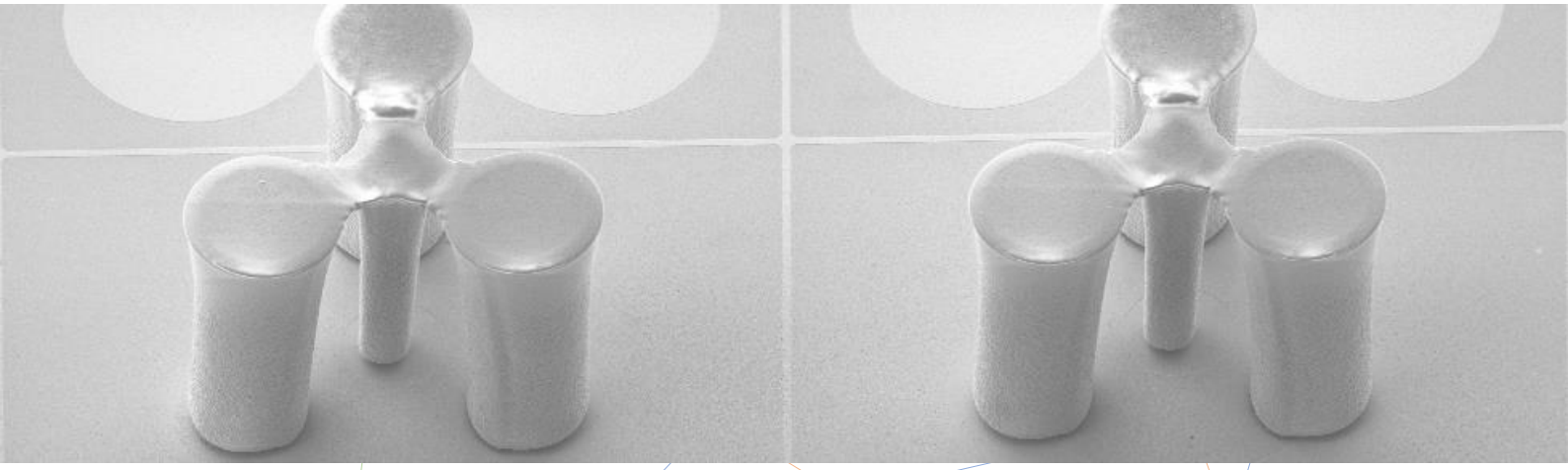
ICON Photonics is glad to present its new testing equipment.

This humidity chamber gives the possibility to control both relative humidity and temperature and is now used to validate the different prototypes for both internal and customer developments.

Feel free to contact us to discuss about your reliability & qualification needs!

Feedback wanted: contact@icon-photonics.com

https://icon-photonics.com – Follow us on LinkedIn!



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