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Packaging solution for photonic biosensors

The photonics packaging pilot line

PIXAPP is the world's first open-access Photonic Integrated Circuit (PIC) Assembly and Packaging Pilot line, helping users to exploit the breakthrough advantages of PIC technologies. A highly interdisciplinary team of Europe's leading industrial and research organisations provides users with single-point access to cost-efficient assembly and packaging solutions for PICs.

PIXAPP provides SMEs with an easy access route to take R&D results from lab to market.

Within PIXAPP, a biosensor-demonstrator is developed to showcase the capabilities of the pilot line, through the assembly and packaging of bio-sensing cartridges which can be manually placed in a reader to perform bioassays.

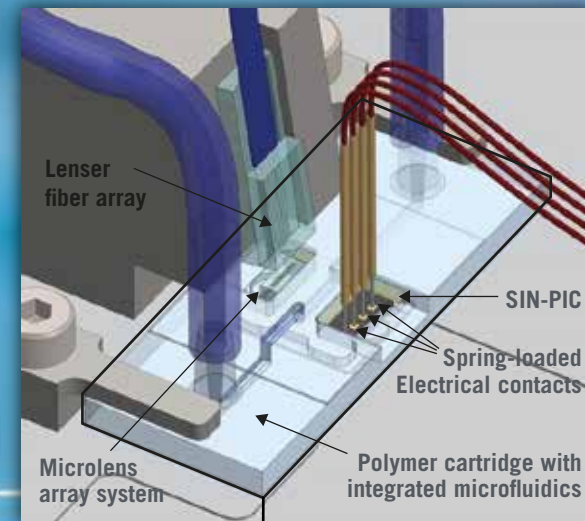
Advanced PIC assembly and packaging solutions for photonic biosensors

The objective of the photonic biosensor is to showcase qualitative interfacing with optics and electronics in combination with manual loading of the bio-samples.

The demonstrator consists of a microfluidic cartridge containing a photonic chip, which is inserted in a reader system.

On the photonic chip multiple bio-functionalized IC sensing areas are implemented, accessible through optical coupling structures and electric contact pads.

A reader containing a lensed fiber array, electrical contacts and simple positioning system is used to read-out the signals provided by the chip.

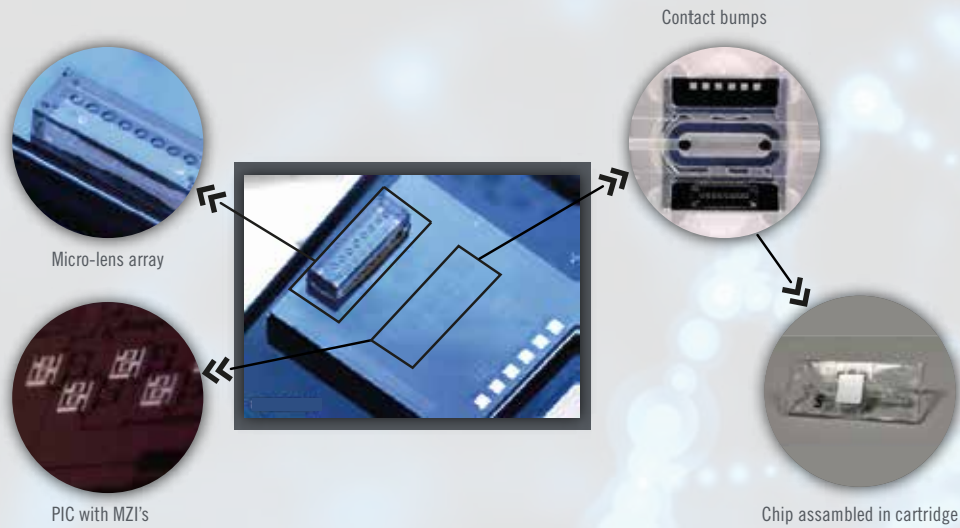


Key Challenges

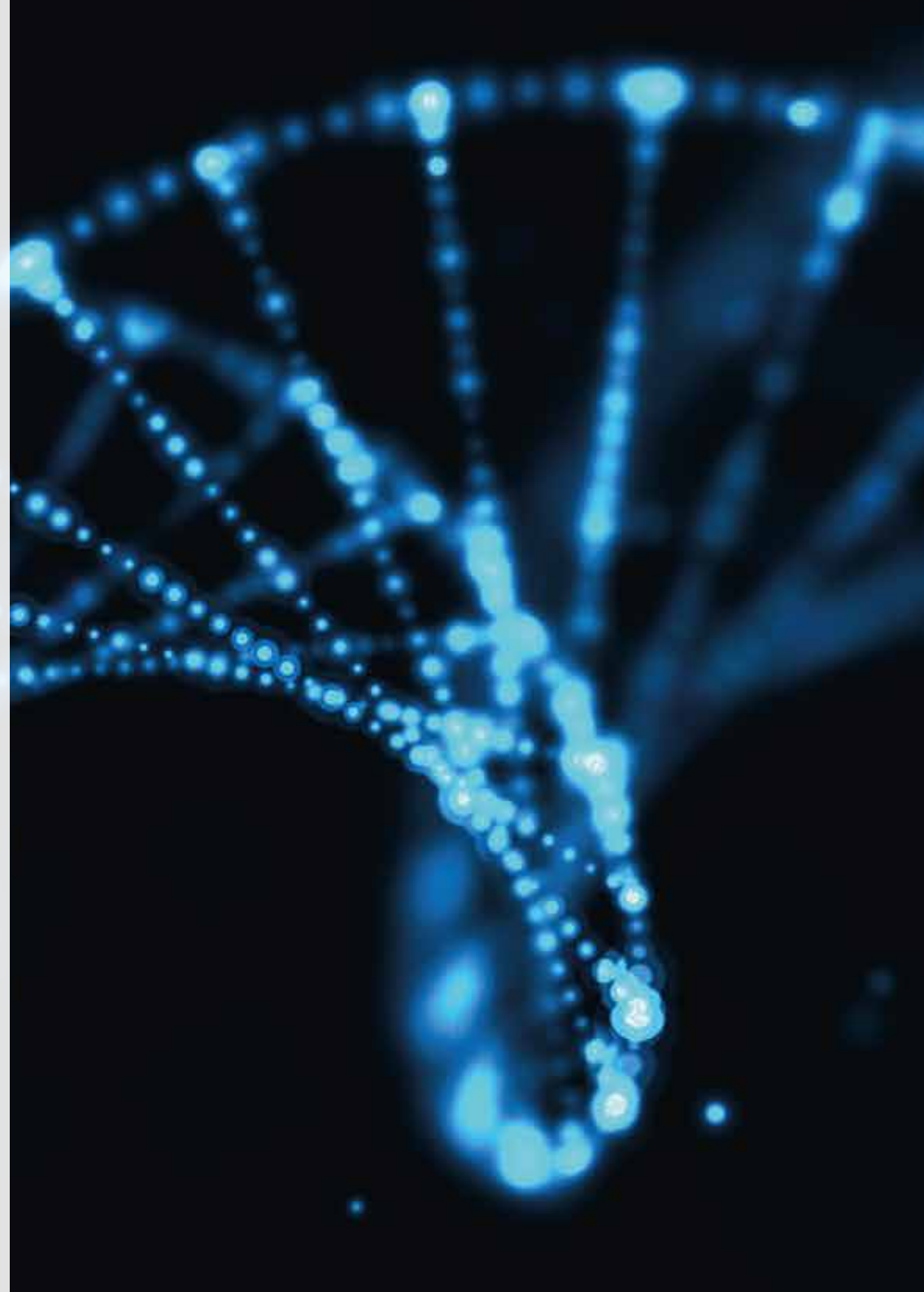
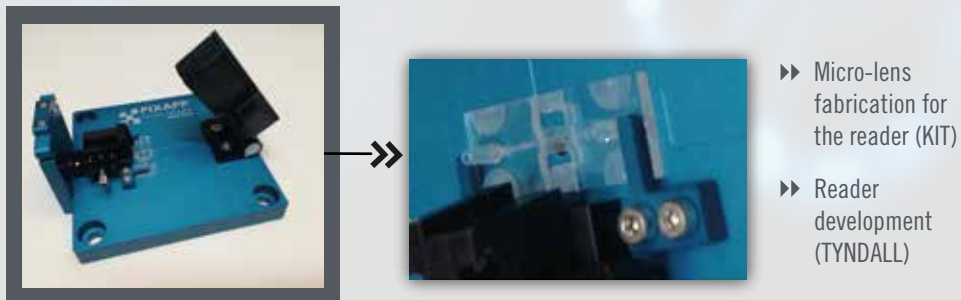
- Use beam expansion and focusing through microlenses to enhance the misalignment tolerance enabling manual cartridge exchange without active alignment.
- Tune the packaging process flow to ensure the stability of the bio-functionalization layers on the sensor.

The photonics packaging pilot line

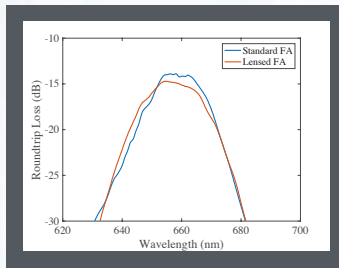
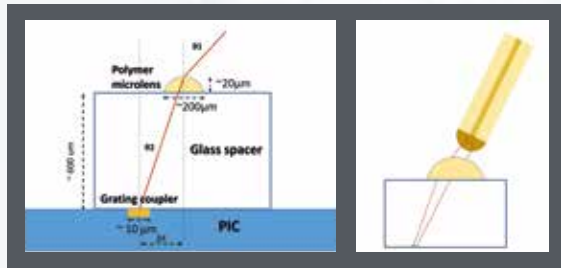
- ▶▶ PIC fabrication (IMEC)
- ▶▶ Surface activation (IMEC)
- ▶▶ Micro-lens assembly (IMEC)
- ▶▶ PIC Functionalization with antibodies (RANDOX)
- ▶▶ Design and manufacturing of microfluidic cartridges (MICROFLUIDIC-CHIPSHOP)
- ▶▶ PIC Assembly on cartridge (ARGOTECH)
- ▶▶ Contact bumps deposition (TYNDALL)



- PICs are realized in a standard SiN platform by the PIX4life pilot line
- Optical interfacing is done by integrating microlens arrays to collimate the input beam onto the desired beam diameter at the grating couplers
- Functionalized chips are assembled within a disposable microfluidic cartridge
- The chips are provided with contacts for electrical interfacing



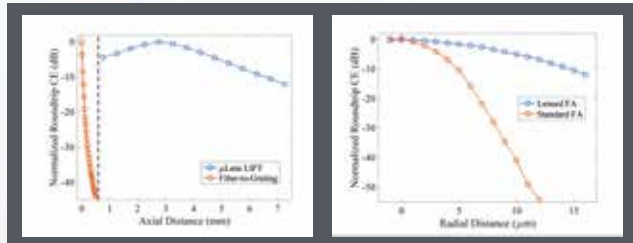
Tolerant Grating Optical Interfacing



Coupling efficiency using standard fibre arrays is very sensitive to misalignments and beam diameter variations. This has traditionally limited its use to applications where precise active alignments are at hand.

In order to relax the alignment demands and enable the possibility of exchanging the chip by simply positioning a cartridge into a reader, a pair of microlenses is introduced per optical port.

The interfacing is now realized through a beam greater than that provided from standard fiber. This system benefits from an increase in positioning tolerance at the expense of a reduced angular tolerance, yet with an analogous coupling efficiency compared to coupling with standard fibre arrays. The decrease in angular tolerance does not represent an issue for the application since it is a parameter that can be accurately trimmed in the reader setup.



Axial tolerance relaxed by 2 orders of magnitude

Radial tolerance relaxed by a factor 3

Packaging assembly flow compatible with bio-sensing assay

- A bioassay for CRP protein detection was performed on a completely assembled cartridge
- CRP antigen bound to the SiN waveguide causing a change in refractive index (thus shifting the output interference pattern)
- Demonstration of biosensing capabilities accomplished within the PIXAPP packaging assembly flow for clinically relevant CPR concentrations

