PHOTONIC CHIP INTEGRATION STRATEGIES FOR MICRO-FLUIDIC CARTRIDGES
Technology Transfer to Industry
APPLIED RESEARCH
Development of deep technology bricks through public funding

Valorization through direct industry mandates following a full cost model (time and material)

TECH TRANSFER
CSEM AT A GLANCE

We are a public-private, non-profit Swiss technology innovation center

We enable competitiveness by developing and transferring world-class technologies to the industrial sector

1984
FOUNDED

600
SPECIALISTS in 2023

100.4
MIO TURNOVER in 2022

> 50
VENTURES since 1984
TOOLS FOR LIFE SCIENCES

Cell microsystems

Biomonitoring

Enabling personalized health

Lab automation

Artificial Intelligence

Cells

Organoids

Tissues

Body fluids

Drugs
(e) Lateral flow assay (LFA)

Electrochemical sensors

Photonic integrated circuit (PIC)
PIC INTEGRATION

(e)Lateral flow assay (LFA)

Electro chemical sensors

Photonic integrated circuit (PIC)
COMPLEMENTARY DIAGNOSTICS PHOTONICS PLATFORM

- Protein signature detection
- Use case: Breast and prostate cancer
- Functionalized PIC integrated in microfluidic sample preparation cartridge
- Integrated sample preparation
- Liquid stored on cartridge
- On cartridge valving
AQUA CULTURE PATHOGEN DETECTION

• Pathogen detection

• Reduction of antibiotics by correct treatment

• Liquid stored on cartridge

• Hybrid PIC with only electrical interface to instrument

• On cartridge heating
INTERFACES

- **Fluidic interface**
  - Exposure to liquids
  - Sealing

- **Photonic/Electronic interface**
  - Dry
  - Allow access to wave guides
FLUIDIC INTERFACE: PIC INTEGRATION METHODS

On-Channel method

- Simple bonding
- Waste of chip area
- Flow profile not ideal

In-Board method

- Challenging bonding
- Smallest chip possible
- Ideal flow profile
- Separate components
PIC INTEGRATION METHODS

On-Channel method

In-Board method
PIC INTEGRATION METHODS

On-Channel method

- Fluidic interface (adhesive seal)
- Photonic interface (wave guides)

In-Board method

- Electronic interface
- Fluidic seal not shown
ADHESIVE BONDING APPROACHES

Bond material
- Epoxy
- Acrylate
- Silicone
- Cyanoacrylate

Curing mechanisms
- UV exposure
- RTV
- moisture
- UV pre-exposure for opaque components

UV pre-exposure

Adhesive dispensing → UV exposure → Bonding
MANUFACTURING

Class 10’000 clean room
Automated pick and place
+/- 20um alignment accuracy
Chip integration
Tape bonding
DISPOSABLE VS RE-USABLE

DISPOSABLE
- **Single** sterilisation cycle
- and/or **single cleaning cycle**
- Short term exposure to test fluid
  - Toxicity
  - Impact on signal through leaching
- Leak tight

RE-USABLE
- **Multiple** sterilisation cycles
  - **Steam!**
- Multiple cleaning cycles
- Multiple exposures to test fluid
- Repeated mechanical loading
- Leak-tight or hermetic
STERILISATION / AUTOCLAVING/CLEANING

- Leak tightness, mechanical function and non-toxicity might be compromised by repeated sterilisation
- Leaks may endanger the operator, damage the instrument and the electronics
- CSEM’s view:

<table>
<thead>
<tr>
<th>Encapsulation</th>
<th>Many Autoclave cycles (&gt;10)</th>
<th>Few autoclave cycles (2-5)</th>
<th>Many EtO</th>
<th>Single EtO</th>
<th>Corrosive environment</th>
<th>Alcohol cleaning</th>
<th>Diluted NaOH</th>
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<tbody>
<tr>
<td>Tape bonding</td>
<td>X</td>
<td>High risk</td>
<td>Low risk</td>
<td>Low risk</td>
<td>✓</td>
<td>Low risk</td>
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<td>✓</td>
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<td>Metal soldering</td>
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</tbody>
</table>

*Used to create hermetic seals in long-term medical implants (pacemakers etc.)
CSEM = ONE STOP SHOP

Idea

Prototyping

Validation

Packaging

Tech Transfer

Concept development

Workshop

Up to BSL2

Clean room
Discover our Life Science Brochure

https://www.csem.ch/pdf/157550
FACING THE CHALLENGES OF OUR TIME