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## Design and characterization of polymer-based photonic integrated circuits operating in the visible region for environmental detection application

Miguel Diez, Simon Joly, Laurent Oyhenart, Vincent Raimbault, Laurent Béchou, Corinne Dejous

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# GPU – Environnements

Design and characterization of polymer-based photonic integrated circuits operating in the visible region for environmental detection application

M. Diez, S. Joly, L. Oyhenart, V. Raimbault, L. Bechou, C. Dejos

## Overview

Polymer-on-glass is a suitable platform to develop biochemical photonic sensors. In this work we present our advances on design and fabrication of optical sensor operating at  $\lambda=505\text{nm}$ . Enabling a tolerant and reliable fabrication process of these devices lays the groundwork for future low-cost biosensors.

## Design Optical Microring Resonator (OMR)

### OMR Radius

A round trip length below the coherence of the source

- Free Spectral Range
- Low bending losses

### Coupling Area, Gap

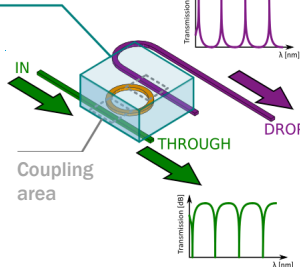
- Critical coupling criterion
- High Quality factor

### Waveguide profile

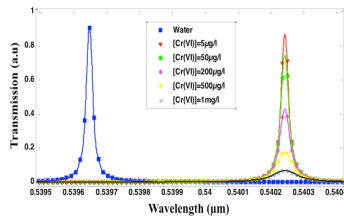
- Monomodal conditions @ 540nm
- Strong evanescent field in the sensing area

→ radius = 20  $\mu\text{m}$ , gap = 250nm, w = 350 nm, h = 350 nm

### Sensing area



Simulation results at the drop port output for different concentrations of Cr (VI)



- Resonance is clearly observed @ 540nm
- Only peak attenuation caused by absorption coefficient

→ The real part modification of the refractive index responsible of wavelength shift is negligible at such concentration range.

## Label-Free Optical Sensor

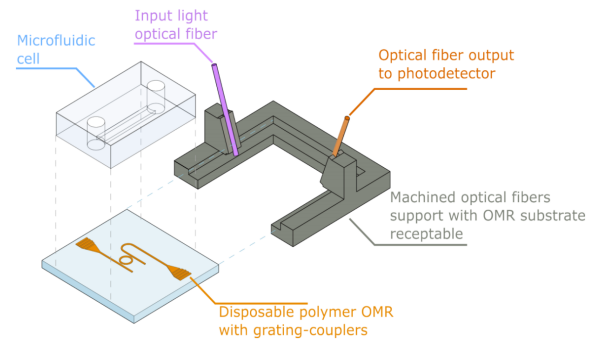
### Microfluidic Cell

### Integrated Sensor

## Concept

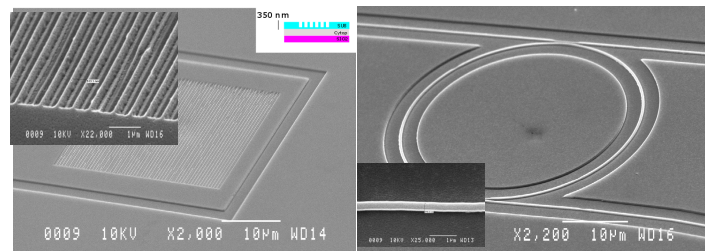
### Challenges

- ✓ Miniaturization : Portable device
- ✓ Fast analysis
- ✓ Keep good selectivity and sensitivity
- ✓ Liquid environmental detection
- ✓ Low cost

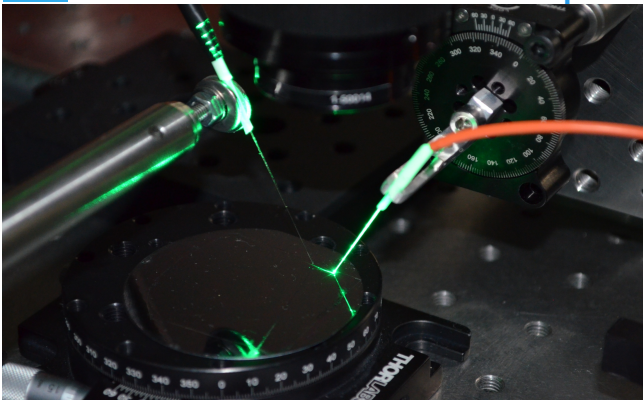


## Fabrication

### Thermal-UV Nanolithography (NIL)



## Characterization set-up



- Nano-waveguides of 350x350 nm have been designed and manufactured with polymer.
- Short period grating couplers (280-500 nm) were manufactured in the same fabrication step.
- Optical characterizations of the device are in progress.
- Active collaborations with Tecnalia, the LAAS and the ENS/LPQM (CNRS) running project and ANR in submission) offer new application possibilities.

### References

- [1] D. Kim, P. Popescu, M. Harfouche, J. Sendowski, M.-E. Dimotsantou, R. Flagan, and A. Yariv, "Onchipintegrated differential optical microring biosensing platform based on a dual laminar flow scheme," in *CLEO : Science and Innovations*. Optical Society of America, STu4K-7 (2015).
- [2] F. Meziane, V. Raimbault, H. Hallil, S. Joly, V. Conédéra, L. Béchou, D. Rebière, C. Dejos, "Study of a polymer optical microring resonator for hexavalent chromium sensing," *Sensors and Actuators B: Chemical*, 209, 1049-1056 (2015).

## Conclusions