UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Valencia Nanophotonics Technology Center

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In-flow and in-continuum refractive index sensing using a highly sensitive porous silicon ring resonator

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Outline

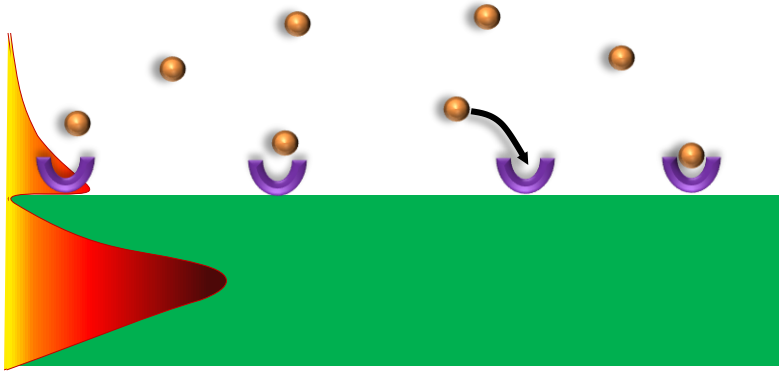
1. Motivation
2. Aim
3. PSRR fabrication
4. PSRR sensitivity characterization
5. Conclusions

Motivation
Sensitivity enhancement

Traditional planar photonic sensing structure

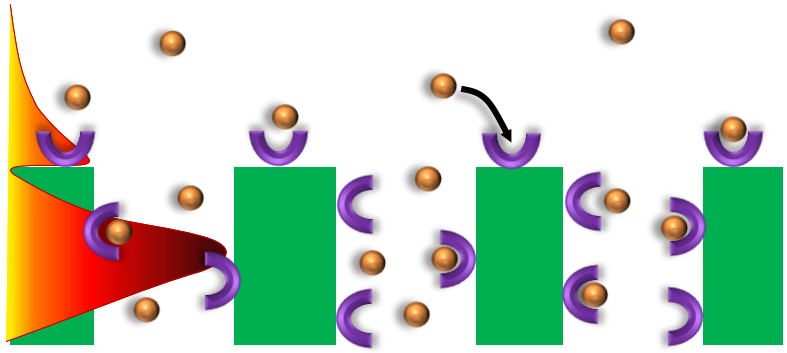
Only its external surface is typically used for sensing purposes

→ **Limitation**



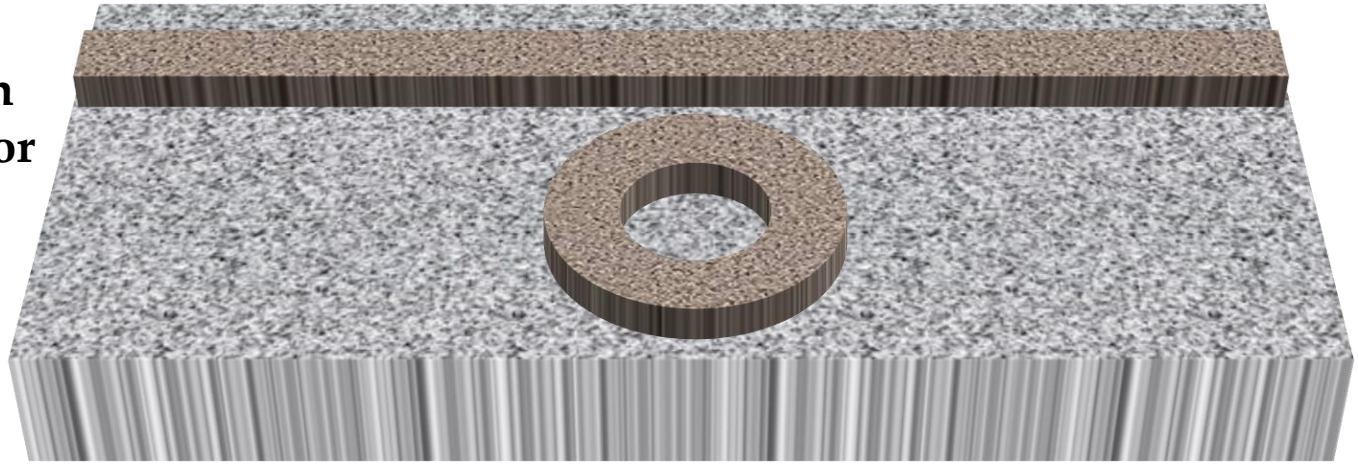
Porous silicon (PS) structure

allows to infiltrate the target analytes directly into the pores

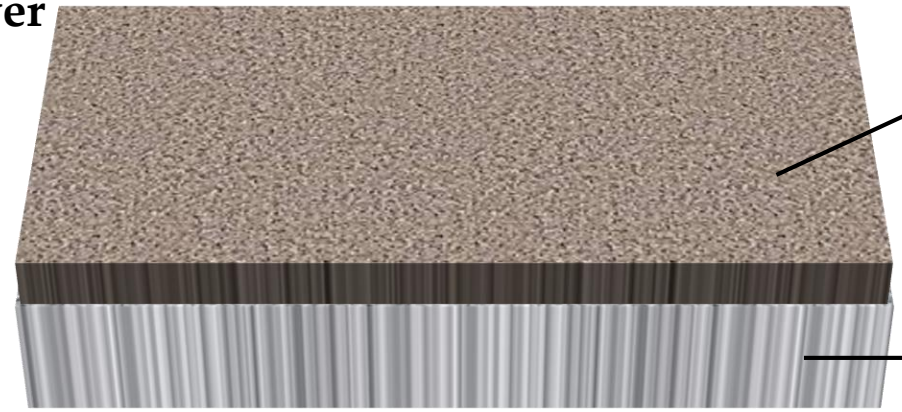


Aim

Porous Silicon Ring Resonator (PSRR)



High RI contrast PS double layer

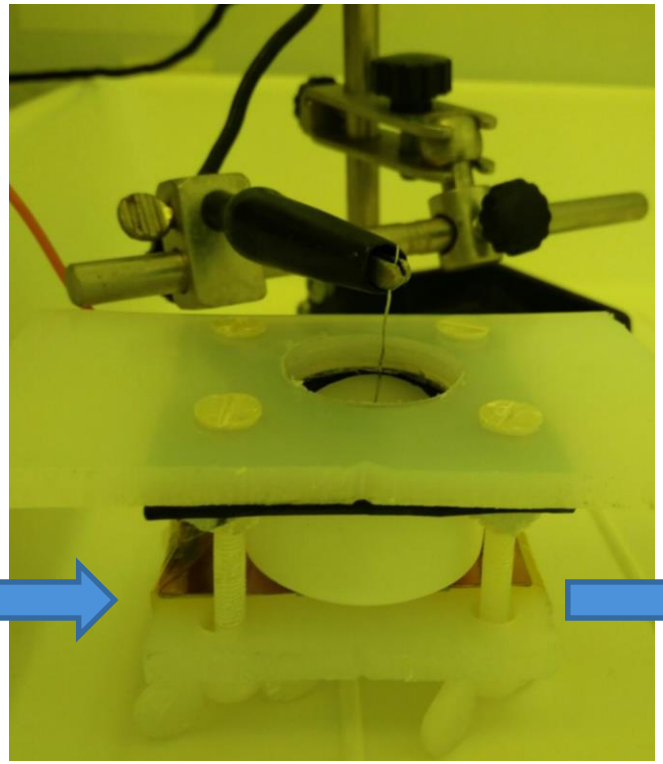


Top layer Low porosity → High RI

Bottom layer High porosity → Low RI

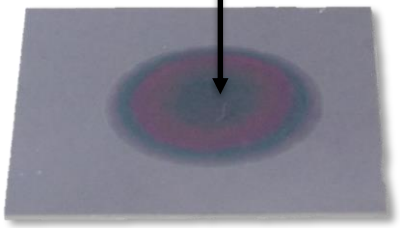
PS photonic structures - I
Double layer preparation

Electrochemical cell



Silicon sample

PS region

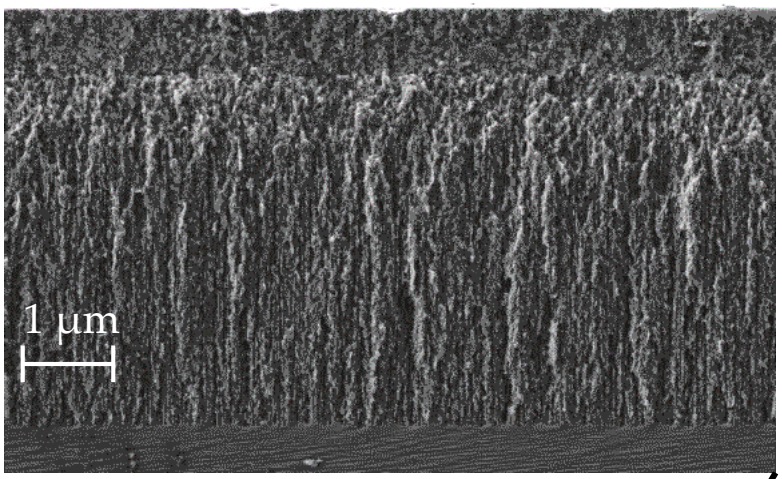


Before etching

Electrochemical etching

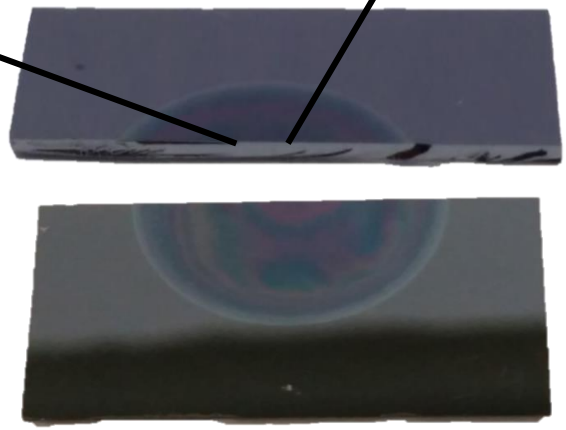
After etching

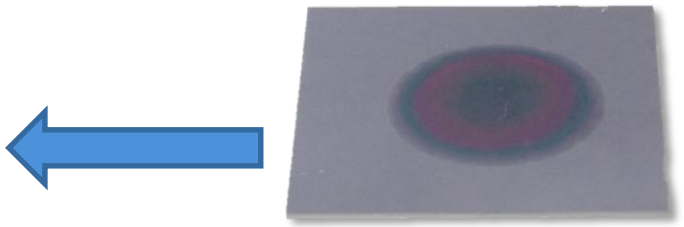
PS photonic structures - II
Double layer characterization



800 nm Porosity = 38%; RI = 2.48

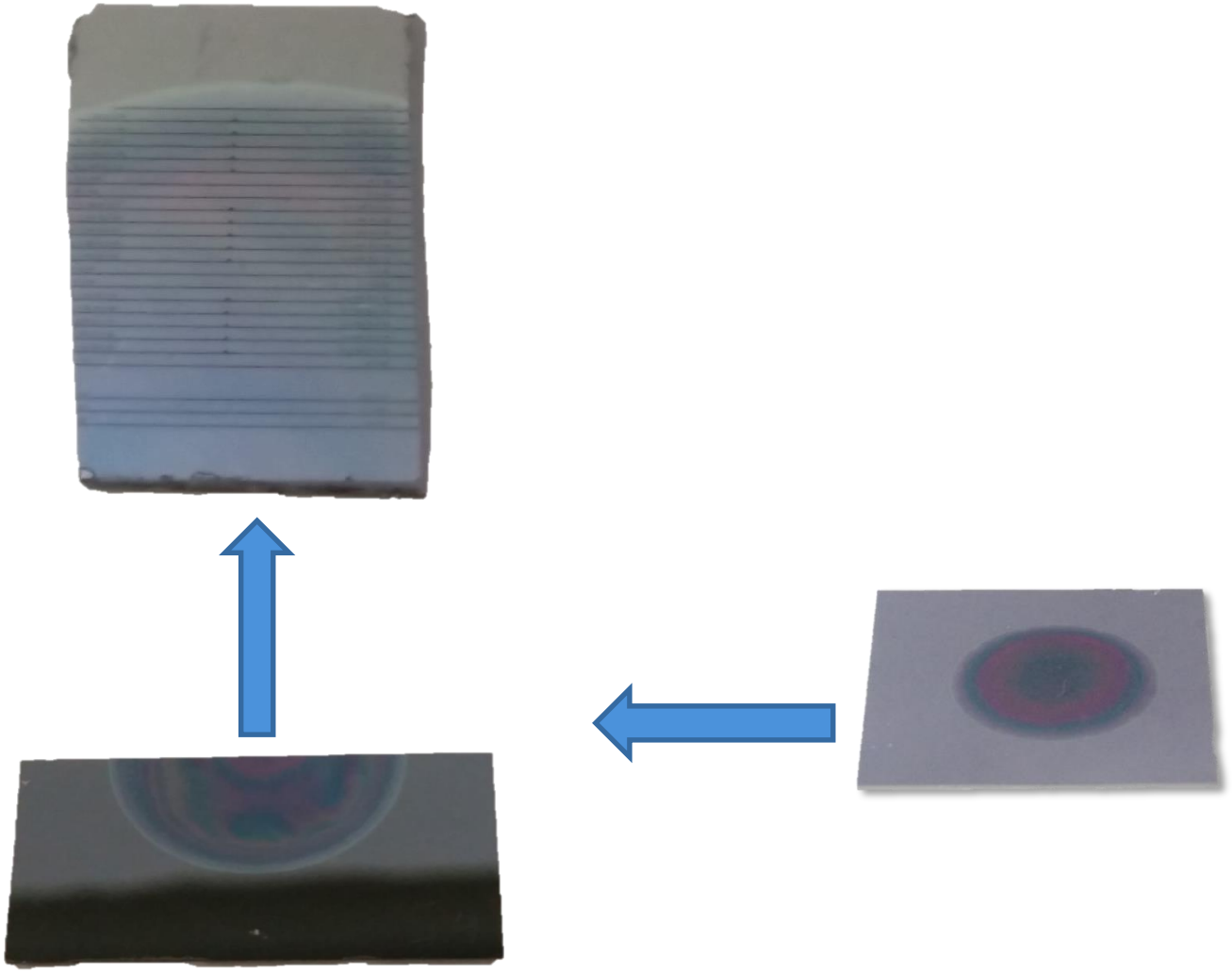
4300 nm Porosity = 63%; RI = 1.75





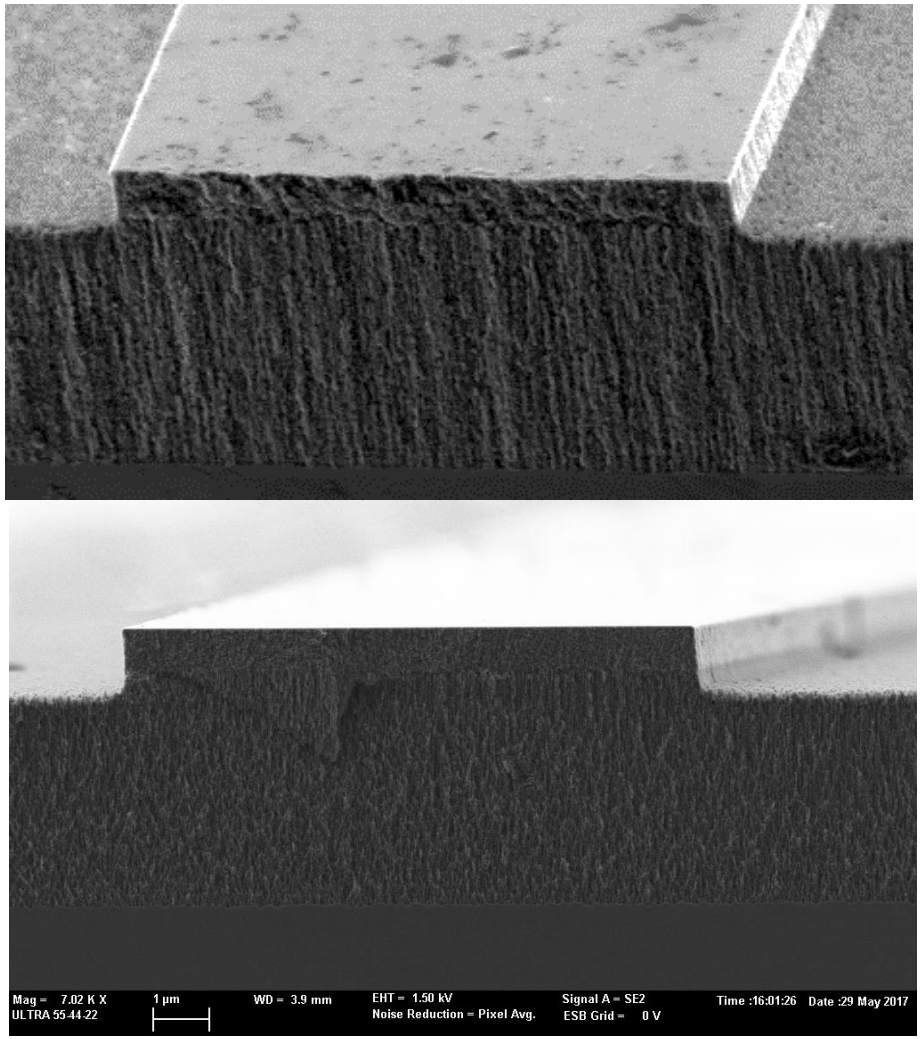
PS photonic structures - III

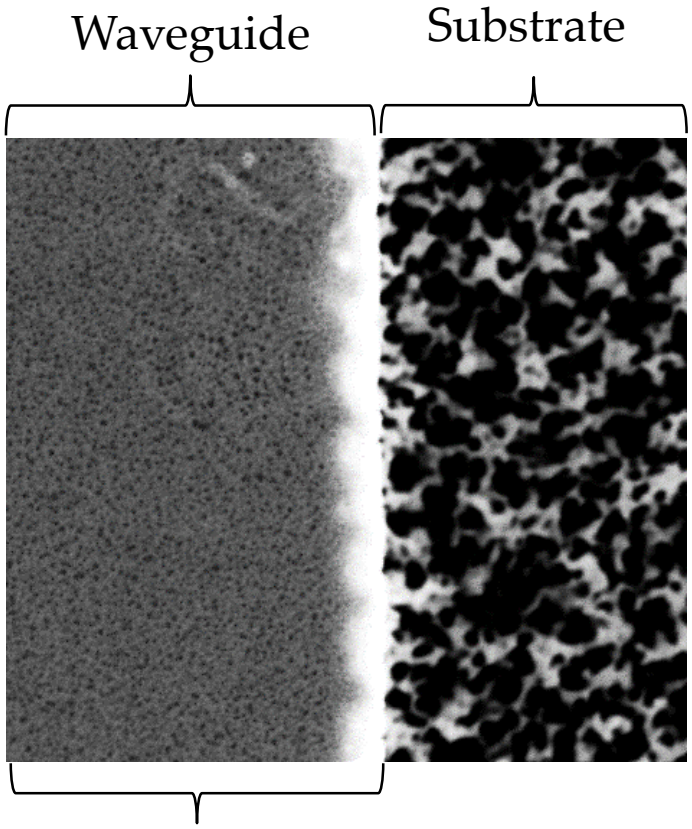
Fabrication



PS photonic structures - IV

Waveguide





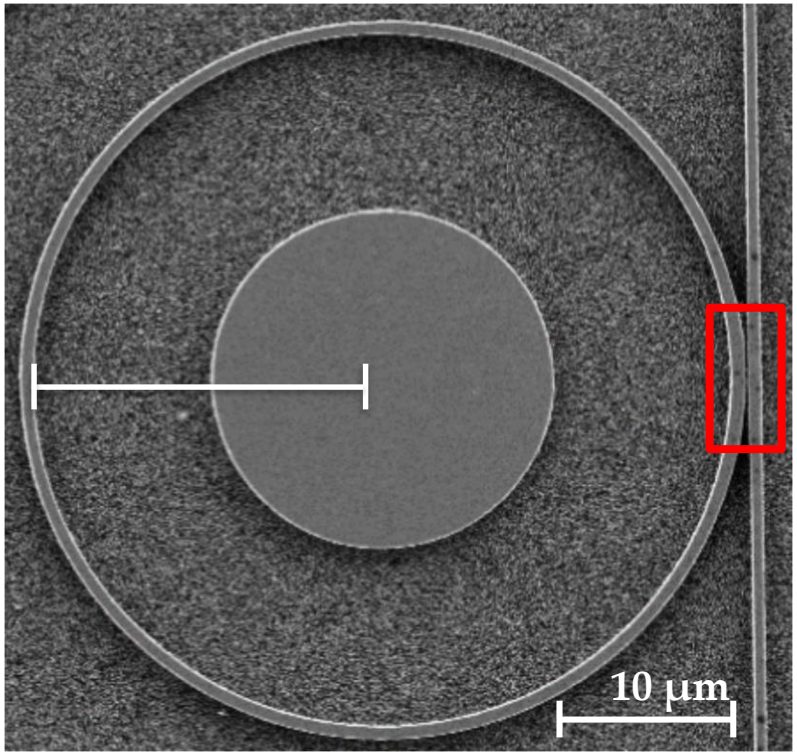
Avg pore diameter = 12 nm

PS photonic structures - V

Ring resonator

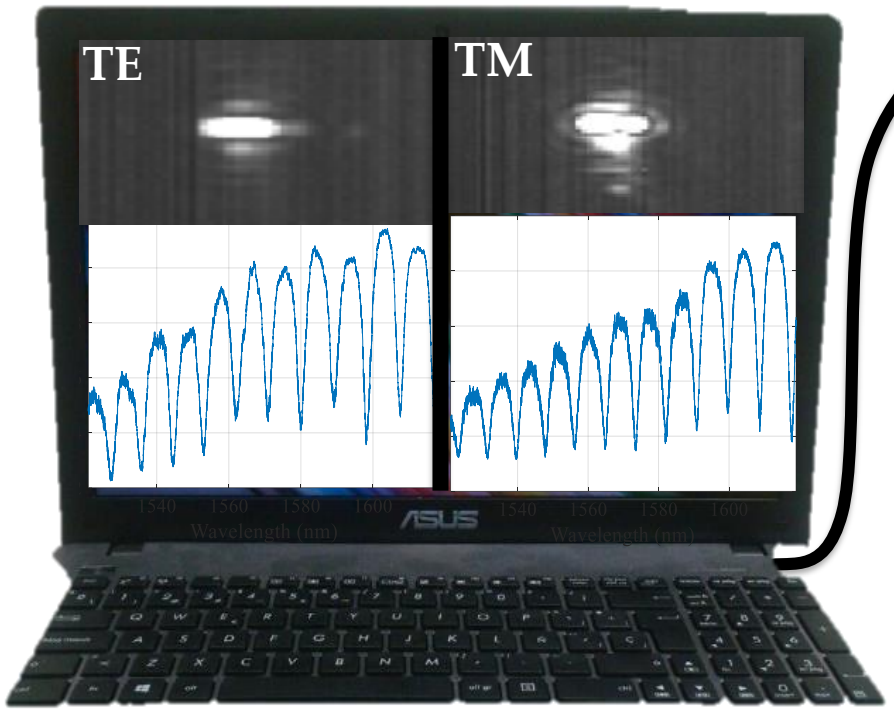
Waveguide width = 1000 nm

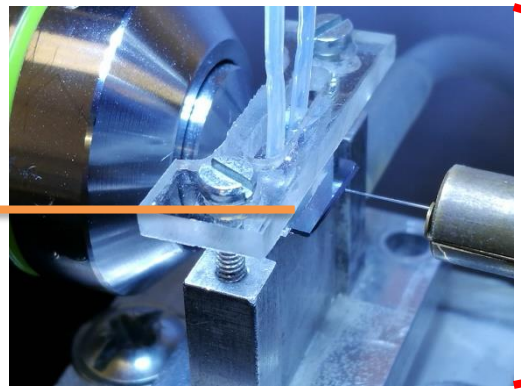
Radius = 20 μm

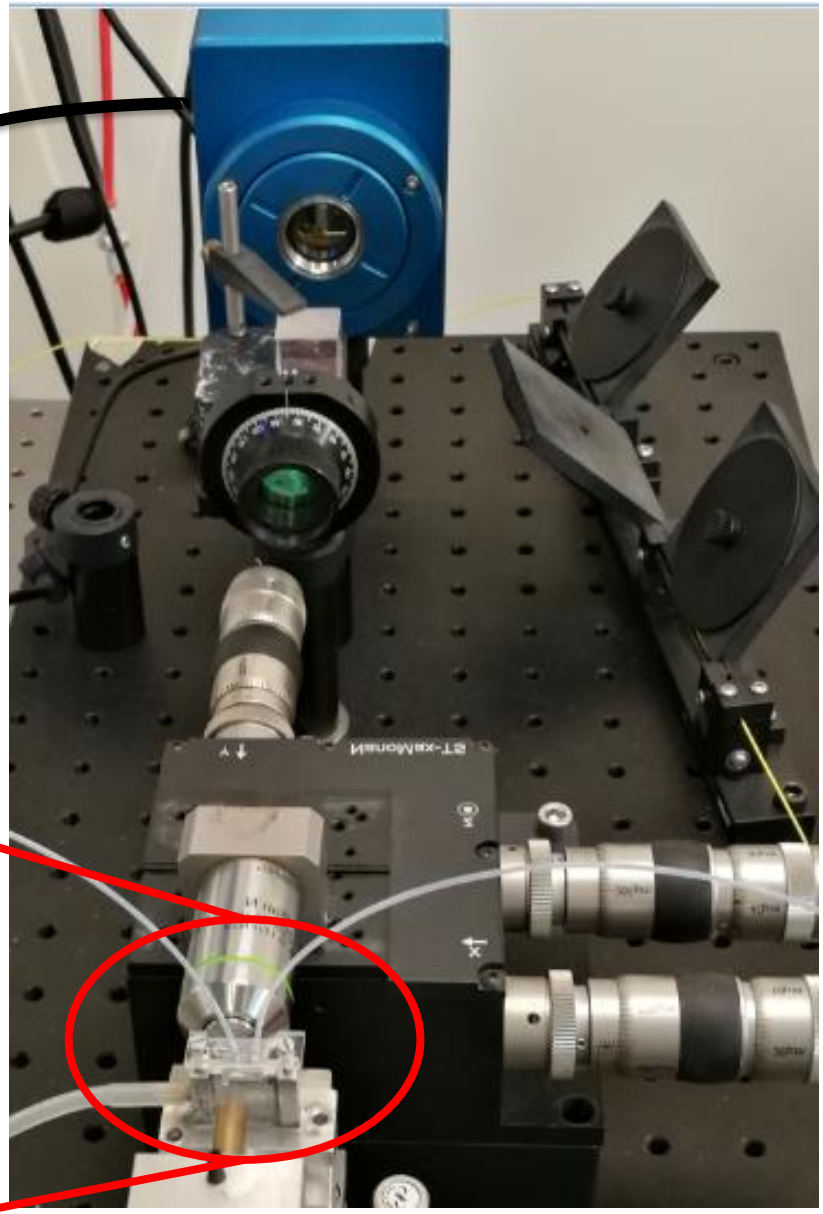


Coupling gap = 200 nm

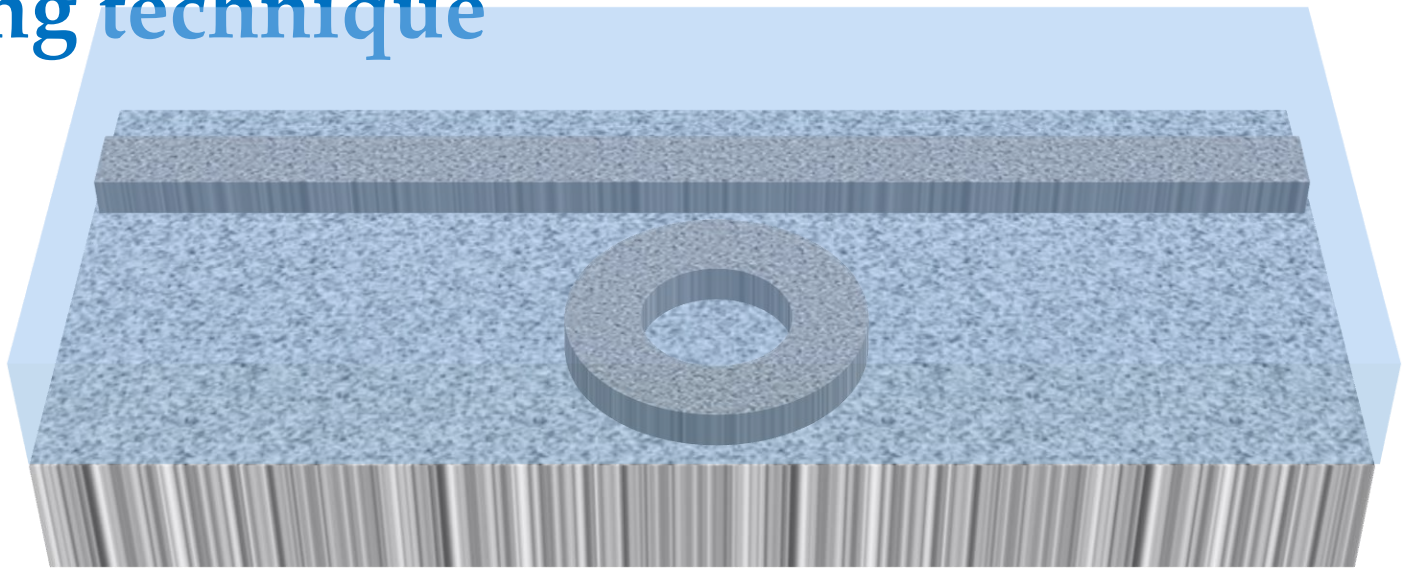
Experimental setup

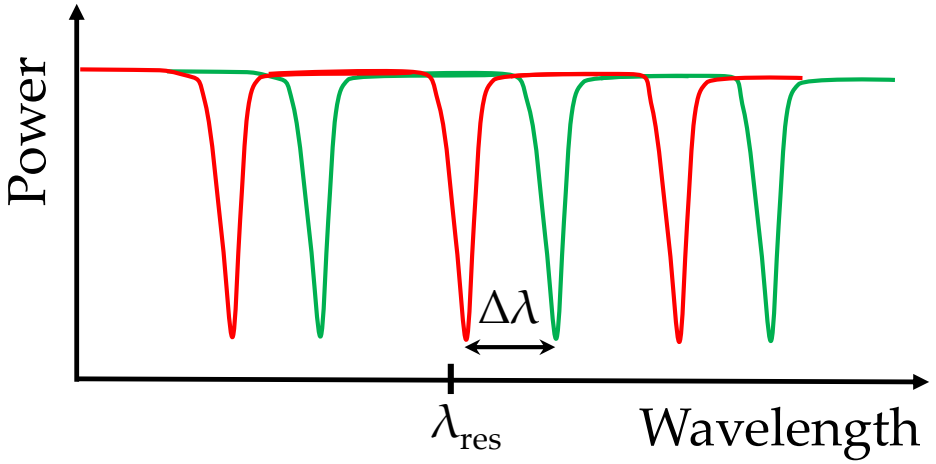


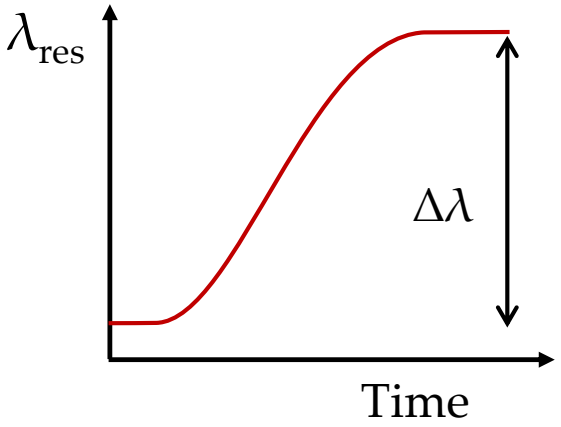




Sensing technique

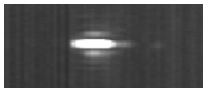


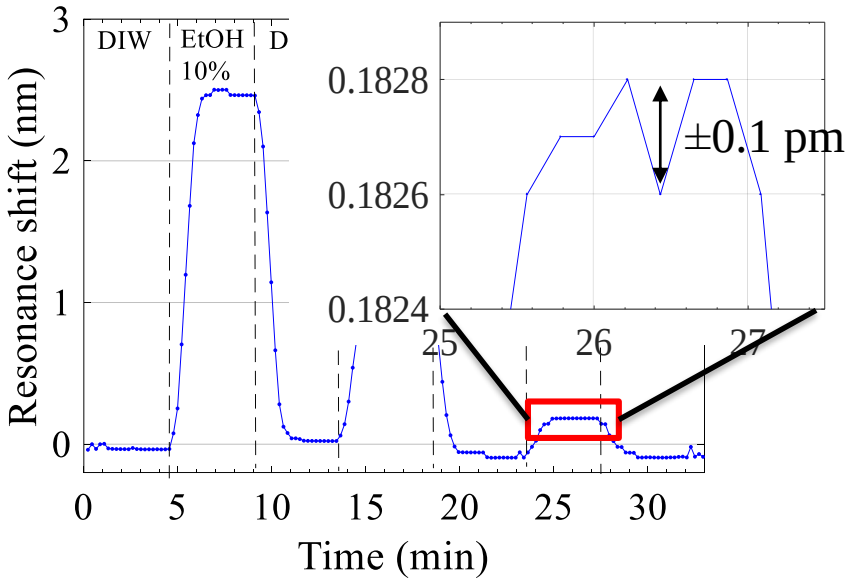




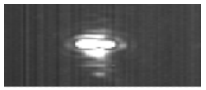
Sensitivity characterization

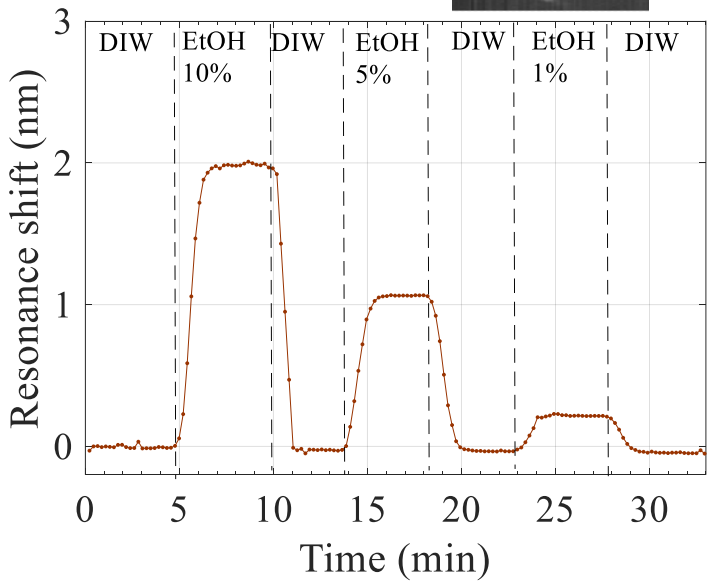
TE polarization





TM polarization





EtOH %	ΔRI
0	0
1	$6.6 \cdot 10^{-4}$
5	$3.3 \cdot 10^{-4}$
10	$6.6 \cdot 10^{-3}$

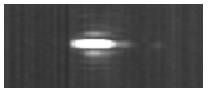
Sensitivity higher in TE than in TM polarization

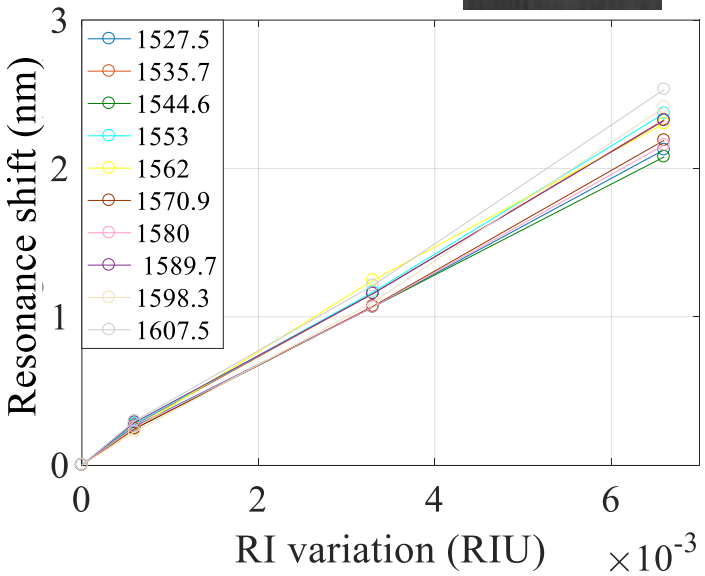
Sensitivity = 439 nm/RIU **4 fold the sensitivity of a traditional ring resonator**

Limit of detection = $2.27 \cdot 10^{-7}$ RIU

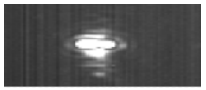
Sensitivity characterization

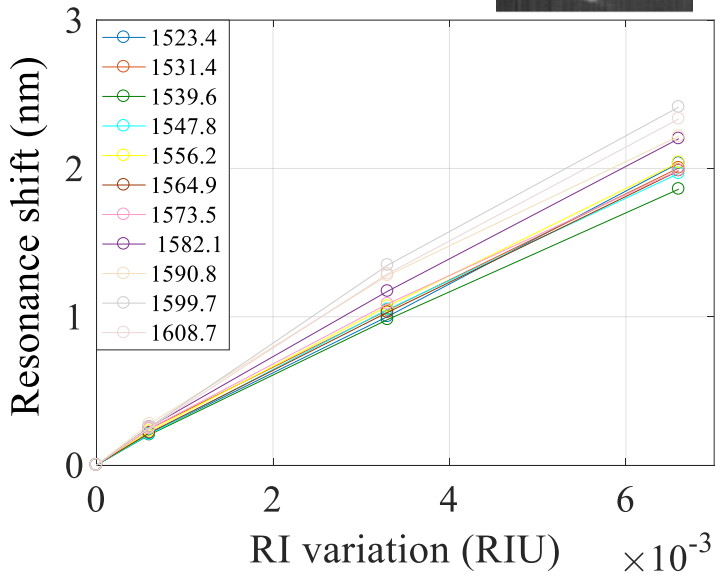
TE polarization





TM polarization





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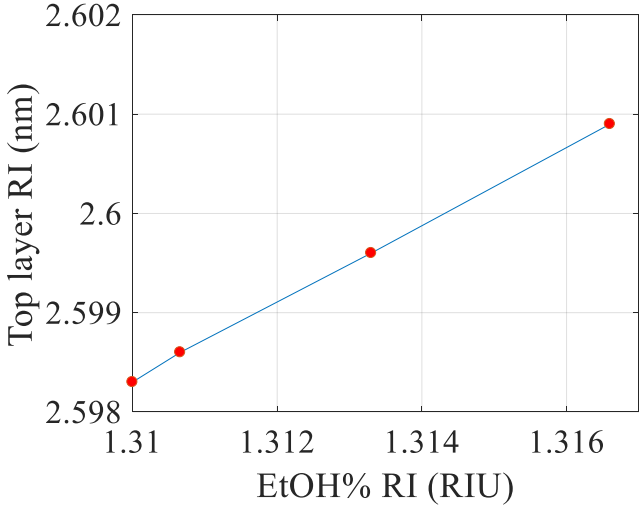

Conclusions

- PSRR fabrication
- PSRR optical characterization
  → *In TE polarization better light confinement than in TM*
- PSRR sensitivity characterization
  → *Sensitivity higher in TE than in TM*
  → *Sensitivity of 439 nm/RIU (4 fold the sensitivity of a traditional RR.)*
  → *Limit of Detection in the range of $2.27 \cdot 10^{-7}$ RIU*

Thank you for the attention