



# Silicon-on-Insulator Microring for Label-Free Biosensing

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### Introduction and motivation

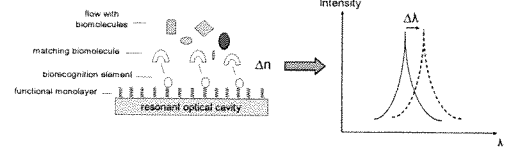
We develop a label-free biosensor, which directly detects a molecule binding to a receptor fixed on the sensor's surface.

Optical microcavities combine high sensitivity to surrounding changes with small dimensions, so they can be used for fast, sensitive and quantitative sensing of biomolecular binding in small amounts of analyte.

The fabrication of Silicon-On-Insulator microring with deep-UV lithography is suitable for cheap mass-fabrication needed for commercial applications.

Application areas: bacterial and virus detection, medical diagnostics, drug development, food and environmental control

### Principle of biomolecular sensing with optical microcavities



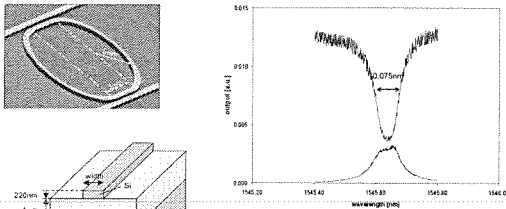
Whispering gallery modes (WGMs) occur when light in a microring with diameter  $D$  satisfies:

$$\lambda_{m,m} = \frac{n_e \pi D}{m}$$

$$m = 1, 2, \dots$$

Binding of biomolecules to the modified sensor's surface causes a measurable shift of the resonance wavelength due to a changing refractive index.

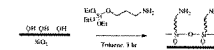
### SOI ring resonators fabricated with Deep-UV lithography



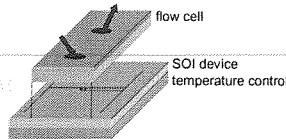
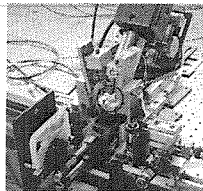
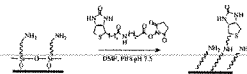
Pass and drop transmission spectra of the racetrack resonator, with Q factor of about 20,000. The fluctuations are due to the nonoptimal antireflective coating of the sample facets.

### Silicon surface modification

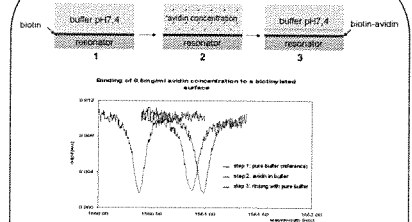
1. Cleaning and oxidation of the silicon surface
2. Silanization: surfaces are immersed in 50 mM APTES (3-aminopropyltriethoxysilane) in toluene. APTES is used to functionalize the silicon surfaces since it acts as a bridge between biomolecules and dielectrical surfaces such as silicon.



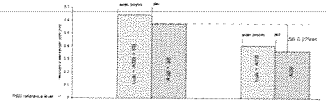
3. Biotin conjugation: biotin carrying an activated ester functionality (Biotin-LC-NHS) is chemically bound by reaction with the amino-functionalized surface.



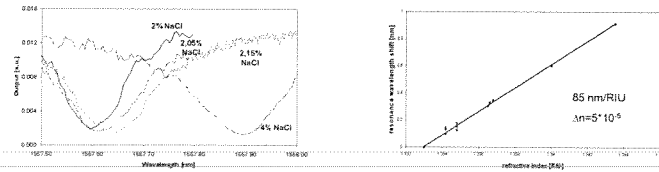
### Avidin-biotin binding tests



- Main problems:
- specific binding due to non-optimized chemistry
  - homogeneity of the functional layer



### Bulk sensing experiments



Measured pass-spectra of a SOI ring, immersed in liquids with different refractive indices.

Resonance wavelength shift for changing refractive index units.

### Conclusion and perspectives

SOI microrings fabricated with deep-UV lithography are suitable for sensitive biosensing. The silicon surface modification requires non-trivial chemistry and characterization techniques.

Bulk sensing experiments show a limit of detection of  $5 \cdot 10^{-5}$  Refractive Index Units (RIU) with a 5 micron racetrack resonator. With use of the avidin-biotin system, protein binding detection is proved.

This integrated SOI biosensor will be lined up in arrays for a proof-of-principle biosensor for multiparameter analyses.

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Posters list


### 1. $\mu$ TAS, integrated systems

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	KOLARI	KAI	VTT	Finland
2	A magnetic micro-actuator for biomolecule capture and manipulation			
	ROSTAING	HERVE	Tyndall National Institute	Ireland
3	EWOD based actuation for integrating complex biological protocols (DNA repair, PCR) on lab on a chip.			
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4	Low cost portable transducer			
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7	Construction of a lipid biochip and characterization of the cytochrome-c thiol/lipid mixed bilayer interactions			
	BAPTISTA	MAURICIO	UNIVERSITY OF SAO PAULO	Brazil
8	Identification of heptapeptide motifs specifically binding			
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10	Development of Novel Technologies for Species Differentiation and Food Authentication			
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13	Indium-tin oxide thin electrode films as a versatile substrate for applications in optical and electrochemical biosensors.			
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### 3. Cell analysis and manipulation



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