

Marie Curie ITN cQOM

Summary of the Scientific Achievements

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Academic / Industrial Institution: Gent University
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1. Description of research work

The aim of this ongoing PhD is to realize optomechanical cavities using CMOS compatible methods, in order to experimentally demonstrate the link between Brillouin scattering and Optomechanics as predicted in (van Laer, Phy Rev A, 93(5), 2016). Such structure will also be studied to explore its potential as an optical delay line.

CMOS compatibility enable low cost if mass produced. Moreover, this technique offers the possibility to fabricate long waveguides with extremely good control of the cross section (no stitching effect like in E-beam lithography) limiting inhomogeneous broadening of the mechanical resonance. It also appears as the most promising platform in order to realize arrays of coupled cavities (in order to address applications such as entangled photons generation, synchronization or topological insulators) thanks to the high degree of reproducibility between different devices.

It has been chosen to focus our work on devices using TM polarized light since they offer better power handling due to lower two photons absorption and are less sensitive to inhomogeneous broadening (CMOS process offer much better control over the waveguide thickness than over its width) .

2. Goals achieved and/or progress towards them

- Demonstration of free standing TM ring resonator (figure 1) with an optical Q factor,

$Q > 50\,000$ (figure 2) using IMEC passive platform and CMOS compatible under etching post process.

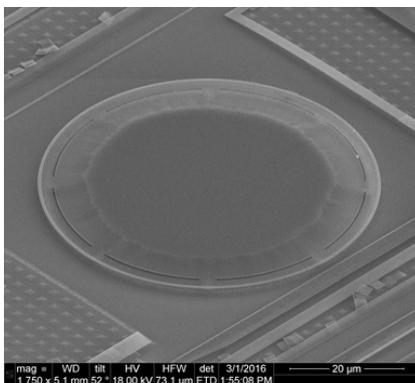
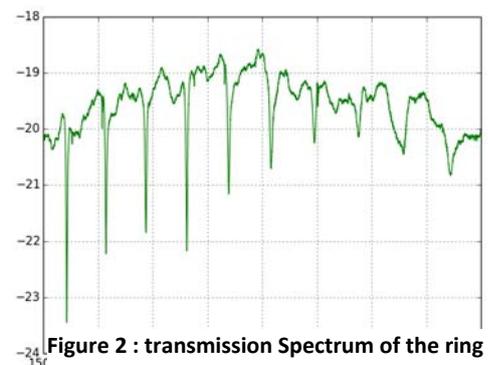


Figure 1: Free standing TM micron ring (SEM picture)



Several design iterations were needed to tackle post process issues such as tailing contamination, anisotropies of the under etching and bucking.

Measuring the optomechanical coupling of this device is obviously our next goal.

- Theoretical study of mechanical coupling between Si Waveguides via thin silicon membrane using finite element simulation (presented at CLEO US 2016).

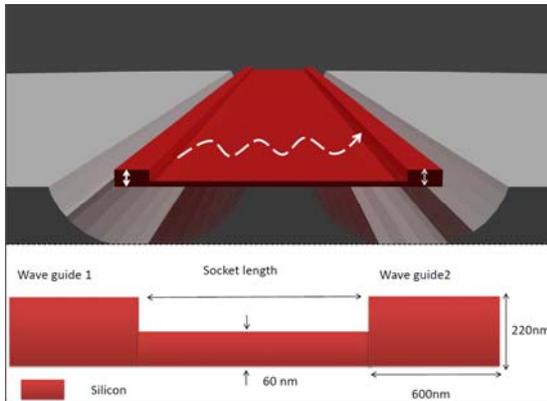


Figure 3 : cross section proposed design

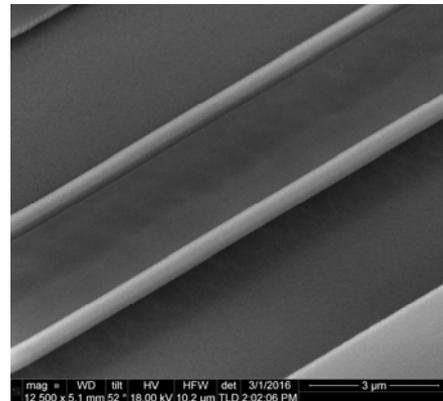


Figure 4 : under etched waves guides coupled via a socket layer

We investigate the possibility to transfer the phonons generated via Brillouin scattering using CMOS compatible technics. We theoretically show that non-evanescent mechanical coupling could be achieved using the recently implemented Socket layer (60 nm thick Silicon) proposed by IMEC (figure 3). Such structures have been designed, delivered and post processed (figure 4) and are currently characterized.

- Theoretical study of dispersive/dissipative coupling in Hybrid Si/SiN structures using finite element simulation. Independent electrostatic tuning of dispersive and dissipative coupling in such structures have also been done using multi-physics finite element tools. Several geometries have been studied in order to maximize coupling and coupling tuning, minimize induced scattering (maximizing the optical Q) while still being compatible with our clean room facility tools.

3. Training received (complementary/soft skills, ITN workshops attended)

Complementary/soft skills:

World Intellectual Property Organisation,
Singapore's IP Academy to Conduct
Singapore, 25 June 2014

Summer School on Intellectual Property

University of Ghent
Doctoral school
October 2014

Project management training

ITN workshops attended:

University of Ghent May 17 - 19 2016	From Photonics Research to the CMOS-fab
Diavolezza 1 - 5 February 2015	2015 cQOM Diavolezza workshop
Vienna 14 - 15 May 2015	Levitation in (Quantum) Physics
Paris, 2-4 April, 2014	Laser Stabilization and high-sensitivity displacement sensing
Lausanne, 21-23 July 2014	Finite Element Modeling Workshop
Erlangen, 7-9 October 2013	Theory of cavity optomechanics
Munich, 10 October 2013	Taking an idea to a product

4. List of conferences attended

Diavolezza 2015
CLEO US 2016, San Francisco (Silicon socket layer for highly tunable phonon-phonon coupling in integrated circuits)

5. Publications (with links)

Two planned articles about on-chip Brillouin scattering:

- on TE Silicon Nitride waveguides on pillar
- on asymmetric TM silicon waveguides

6. Career plans after ITN

- Currently completing PhD based on 1 year extra grant from UGent
- Plan after the PhD:
 - R&D in photonics related industry
 - IP/ tech transfer oriented career