Marie Curie ITN cQOM
Summary of the Scientific Achievements

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Academic / Industrial Institution: Gent University
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End Date of ITN Fellowship: 11.10.20015
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1. Description of research work

I have focused my research on two subjects:

1) A cheap and sensitive mass sensor. By measuring the change in mechanical resonance frequency that occurs when a protein attaches to the surface of a cantilever it is possible to calculate the mass of said protein. If the cantilever is an optical waveguide it is possible to sense the vibrations as they change the transmission through the device. Slot waveguides(SWGs) are and efficient way to drive the vibrations.

2) CMOS-compatible optomechanical crystals. To bring an integrated photonic chip to market it is important to be able to be able to fabricate them using a scalable method, such as UV-lithography.

2. Goals achieved and/or progress towards them

I have measured a series of optomechancial crystals (OMCs) fabricated using UV-lithography, at that moment previously published OMCs were all fabricated using e-beam lithography. UV-lithography is preferable as it is possible to scale up the fabrication and take full advantage of the cost efficacy of the CMOS-industry. The best crystal measured showed an optical Q of 70 000 and an optomechanical coupling of 560 kHz.

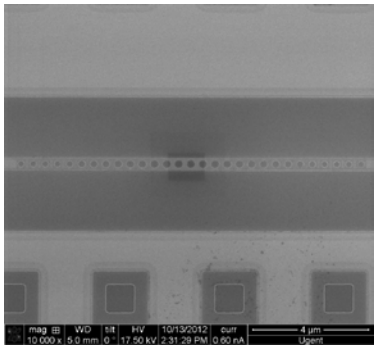

Figure 1: SEM of optomechanical crystal.

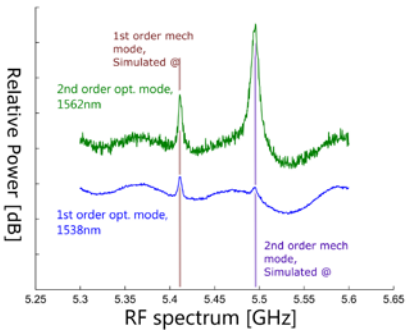

Figure 2: ESA measurement of the spontaneous vibrations in an optomechanical crystal.

A mass sensor has been fabricated and measured but further measurements are required to publish the results. Analytical calculations show that it should be able to resolve masses as small as 11 kDa.

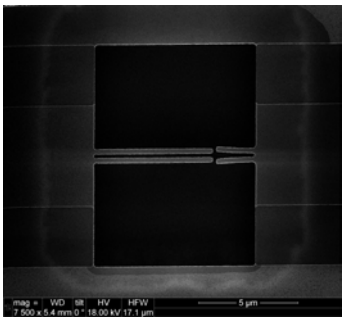

Figure 3: SEM image of cantilever mass sensor

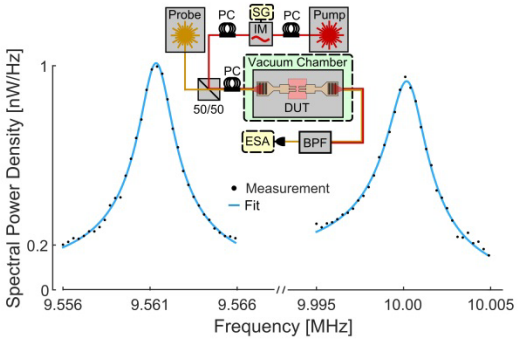

Figure 4: ESA measurement of stimulated vibrations in the mass sensor.

I have also designed a new version of a mass sensor in where two weakly coupled cantilevers have the potential of being much more sensitive to mass. The success would be reliant on how similar we manage to make the resonance frequency of the two cantilevers. The design is being fabricated in a high resolution MPW by IMEC.

For the same MPW I have designed a pair of slotted photonic crystals coupled via a tuning fork. An array of different tuning forks with varying mechanical coupling should enable us to study the onset criterions of synchronization. The photonic crystal pair is designed to be thermo-optically tuneable so that in the stronger coupled case it should have a stronger second order mechanical coupling than what has previously been published.

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

ITN CQOM Workshops:

- 2013 cQOM Diavolezza workshop
- Fundamental Noise Sources; Hannover, June 2013
- Theory of Cavity Optomechanics; Erlangen, October 2013
- Taking an idea to a product; Munich, October 2013
- Laser Stabilization and high-sensitivity displacement sensing; Paris, April 2014
- Finite Element Modeling Workshop; Lausanne, July 2014
- 2015 cQOM Diavolezza workshop
- Levitation in (Quantum) Physics; Vienna, May 2015
- Taking Research Idea to Product; Zurich, November 2015
- From Photonics Research to CMOS-fab; Gent, May 2016

ePIX fab Silicon Photonics Training

Soft Skills:

- UGent doctoral school courses in Management,
- Scientific Communication and Scientific Presentation
- Dutch language course

4. Participation and role in dissemination and outreach activities

Participation in Gent Light festival

5. List of conferences attended

IEEE Benelux Annual Symposium 2013

6. Career plans after ITN

plan to finish my PhD by the end of 2016. As to what I do after, it is entirely dependent on the options I can find when I have completed my PhD. Potentially a postdoc position should I find a project which suits my interests I go into industry.

The ITN has provided me with an opportunity to visit several companies across Europe. They have shown me that it is possible to find interesting problems in an industrial environment.