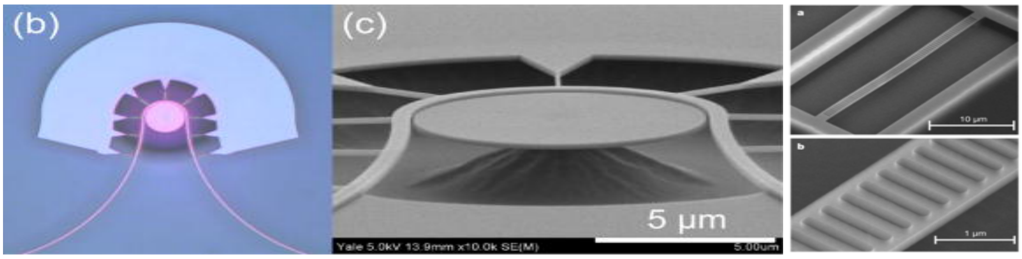
Optomechanics on silicon

(Photonics Research Group, Ghent University)

Already back in the 16th century Johannes Kepler suggested that mechanical effects from solar radiation cause comet tails to point away from the sun. Today optical forces are widely used to precisely control or measure the position of micrometer to nanometer size particles. Especially in biology, *optical tweezers* are used to manipulate living cells, DNA and bacteria using the gradient of the electromagnetic field in strongly focused laser beams. Recently people realized that also the strong gradient in the evanescent field around an integrated waveguide can induce a force on its environment. Following the initial theoretical proposal this idea was confirmed by several groups. In our own work [1][2] we demonstrated for the first time that the force induced between two waveguides can be controlled and results both in repulsive and attractive forces. Recently there were several proposals in literature to use optomechanically controlled devices for realizing novel optical functionalities such as switches and optical delays. This work may also have important results in quantum optics and quantum computing.



For most of the applications mentioned above, optical resonators with high mechanical resonance frequency are necessary, allowing phonon-photon coupling to occur. Our current resonators are limited to a few tens of MHz. Recently several proposals for resonators with frequencies in the order of 1GHz have appeared. The figures below show a disk resonator exhibiting > 1GHz mechanical resonances (Tang Lab, Yale) and a Photonic Crystal (Painter Group, Caltech) cavity showing even higher frequency operation. We believe these can be further increased. The objective of this PhD-project is first to design, fabricate and fully characterise such an improved cavity. In a next step optical and phononic coupling between such a cavity and a waveguide or between multiple cavities will be targeted. The work is strongly multi-disciplinary covering photonics, (quantum)optics and nanomechanics.

This PhD-topic is carried out in the context of the EU-funded Marie Curie training network cQOM ("Cavity Quantum Optomechanics"), coordinated by Prof. T. Kippenberg (EPFL) and having partners from throughout Europe. Workshops and exchanges with the most prestigious groups working in the domain of cavity optomechanics in Europe are planned.

According to EU-rules, candidates should not have resided or carried out their main research activity in Belgium for more than 12 months in the last 3 years.

Next to the standard PhD allowance, candidates will receive a monthly allowance for covering living and travel costs, making this a very competitive position.

More information:

- Contact Prof. D. Van Thourhout (dries.vanthourhout@ugent.be)
- See also: http://photonics.intec.ugent.be

[1] D. Van Thourhout, J. Roels, Optomechanical device actuation through the optical gradient force, Nature Photonics (invited), 4(4), p.211-217 (2010)

[2] J. Roels, I. De Vlaminck, L. Lagae, B. Maes, D. Van Thourhout, R. Baets, Tunable optical forces between nanophotonic waveguides,Nature Nanotechnology, 4, p.510-513 (2009)

In the context of the EU-funded Marie Curie training network cQOM ("Cavity Quantum Optomechanics), we have a vacancy for a PhD student. The student will carry out research towards cavity quantum optomechanics devices integrated on a silicon photonic IC platform. For enabling efficient phonon-photon coupling we will investigate optomechanical resonators with GHz-range mechanical resonance frequency. Next photonic and phononic coupling between such a cavity and a waveguide or between multiple cavities will be targeted. The work is strongly multi-disciplinary covering photonics, (quantum)optics and nanomechanics.

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