Marie Curie ITN cQOM
Summary of the Scientific Achievements

Name of Fellow: Katharina Schneider
Principal Investigator: Dr. Paul Seidler
Academic / Industrial Institution: IBM Reasearch Zurich
Start Date of ITN Fellowship: 1.10.2014
End Date of ITN Fellowship: 31.5.2016
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1. Description of research work

My first project was the optimization of a silicon 1D slotted photonic crystal to exploit its optomechanical properties in the fields of communication, sensing or transduction of photons from the microwave to the optical domain. The objectives for the optimization were to achieve a high optomechanical coupling strength g_0, a mechanical resonance frequency Ω_m of several GHz and a high optical quality factor Q_o. My work included the simulation, fabrication and characterization of the photonic crystal cavity.
My current research focuses on systems that can coherently convert electrical signals at radio frequencies (RF) to optical signals. This has recently gained interest because of the prospect of linking superconducting quantum computers to the world outside their cryostats in a quantum coherent fashion. This might be of interest considering the limited number of quantum computers that so far exist and that in the future will be initially available for client computation. For remote access to such a quantum computer, it would be advantageous to communicate via optical signals rather than RF signals because of the reduced loss of coherence over long distances.

2. Goals achieved and/or progress towards them

We developed a one-dimensional silicon photonic crystal cavity in which a central slot is used to enhance the overlap between highly localized optical and mechanical modes. The optical mode has an extremely small mode volume of 0.017 $(\lambda_{vac}/n)^3$, and an optomechanical vacuum coupling rate of 310 kHz is measured for a mechanical mode at 2.69 GHz. With optical quality factors up to 1.2×10^5, fabricated devices are in the resolved-sideband regime. The electric field has its maximum at the slot wall and couples to the in-plane breathing motion of the slot. The optomechanical coupling is thus dominated by the moving-boundary effect, which we simulate to be six times greater than the photoelastic effect, in contrast to most structures, where the photoelastic effect is often the primary coupling mechanism.

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

- ITN workshop Diavolezza, 31.1.-4.2.2016
- ITN workshop Rueschlikon, 30.11.-1.12.2015
- ITN workshop Diavolezza, 1.-5.2.2015,
- Winter School “New Materials From Physics To Application”, 2.-6.3.2015, Champery

4. Participation and role in dissemination and outreach activities

- EPFL Photonics day 2015, Lausanne, Poster presentation

5. List of conferences attended

- EMN Light Matter Interactions 2016, Singapore
- Frontiers in Nanophotonics 2015, Ascona, Switzerland

6. Publications (with links)

K.Schneider, P.Seidler, "Strong optomechanical coupling in a slotted photonic crystal nanobeam cavity with an ultrahigh quality factor-to-mode volume ratio", arXiv:1606.02491, to be published in Optics Express

7. Plans after ITN

I shall remain with IBM until the completion of my PhD studies, which is foreseen in September 2017.