

## Summary of the scientific achievements for the Marie Curie ITN cQOM

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The aim of my thesis was to extend an optomechanical coupling between a mechanical resonator and cold atoms. We used the advantages of a membrane in the middle of a Fabry-Perot cavity in order to enhance the coupling between the two systems. The first step of this project was consisted of fabrication a resonator that has a large quality factor and excellent optical properties at the same time. We chose worked with SiN membranes which have a mechanical quality factor  $\sim 10^6$  and negligible absorption at working wavelength 1064 nm but its reflectivity is just 20%. As the optomechanical coupling has a strong dependence on the reflectivity of a resonator the second step was to try to increase it by using the photonic crystal structure. This part included modelling, numerical simulations and finally the development of fabrication process. Finally we achieved more than 99.9 % of reflectivity. It allows to increase dispersive optomechanical coupling almost by 10 times.

During this time characterisation setup of new structures was built. It gave possibilities to measure Q-factor and reflectivity of photonic crystals membrane.

The next step was to build a cavity with the membrane in the middle which serves as a prototype of the final setup but just easier to handle, it allowed to prove the influence of the membrane with the photonic crystals on optomechanical coupling, and finally we can deduce scattering losses of fabricated structures which can limit finesse of system which is responsible for strength of interaction between the membrane and the atoms.

Besides the main project I was also involved in development of the new type of resonator as tensile strained semiconductor membranes to create an alternative to SiN membranes. These membranes have more delicate fabrication process which required a lot of working time in clean room to achieve successful etching process of epitaxial grown structures. Studies of optical and mechanical properties of these membranes were also made. The most recent work was consists of development an integrated system with optomechanical membrane over a Bragg mirror.

***Scientific outputs:***

ITN workshop Theory of cavity optomechanics, Erlangen (Germany), 7.-9. October 2013

ITN workshop Taking an idea to a product, Munich(Germany) , 10. October 2013

ITN workshop Laser Stabilization and high-sensitivity displacement sensing, Paris (France), 2.-4. April, 2014

ITN workshop Finite Element Modeling, Lausanne (Suisse), 21-23 July, 2014

International Seminar on Nano Mechanical Systems 29/06/14-31/06/14, Paris (France), poster

Journée de la Matière Condensée 24/08/2014-29/08/14 , Paris (France), poster

Journée Nationale en Optique guidée 29/10/2014-31/10/14, Nice (France), poster

Cleo/Europe-EQEC 2015 21/06/2015-25/06/15, Munich (Germany), abstract is submitted for oral presentation