Marie Curie ITN cQOM
Summary of the Scientific Achievements

Name of ER Fellow: Alessandro Surrente
Principal Investigator: Isabelle Robert-Philip
Academic / Industrial Institution: LPN-CNRS
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1. Description of research work

The goals of my fellowship at LPN-CNRS consisted in the fabrication and characterization of novel optomechanical resonators, based on thin semiconductors membranes where the photon confinement was provided by photonic crystal (PhC) structures. In particular, I studied two material systems: thin PhC membranes fabricated in a polycrystalline diamond and InP PhC membranes heterogeneously integrated on top of silicon waveguides.

Concerning the diamond based optomechanical resonators, I designed and fabricated the photonic crystal structures independently and I set up the optical bench for the interferometric measurements. Such measurements allowed to demonstrate improved mechanical properties of these suspended PhC resonators, owing to the superior mechanical properties of diamond. A significant increase in the mechanical quality factor could be shown, as compared to previously fabricated InP optomechanical resonators featuring the same geometry. As a side project, I also performed some photoluminescence (PL) characterization of diamond samples based on the bonding of a thick polycrystalline diamond layer on a silicon substrate. Such a procedure allows to increase the average grain size, thereby increasing the optical quality of the diamond layer. I demonstrated this improvement of the optical properties of the diamond layer by performing PL spectroscopy on PhC cavities etched on this substrate and by comparing these results with the PL spectra of PhC cavitites fabricated on an ordinary polycrystalline diamond layer.

As for the project involving the heterogeneous integration of InP PhC cavities on top of a Si waveguide wafer, such an approach allows for the precise control on the waveguide size and on the PhC cavity-waveguide separation, which is not permitted by the most commonly used approaches for addressing the optomechanical resonators based on PhC cavities. I was strongly involved in the systematic characterization of the optomechanical response of these devices, and I performed independently the data analysis, demonstrating that our system features a tailored coupling mechanism, with a coupling strength that could be changed as a function of the waveguide size.

2. Goals achieved

- Nanofabrication of diamond PhC optomechanical resonators
- Demonstration of improved mechanical and optical properties of polycrystalline diamond PhC devices
- Heterogeneous integration of InP PhC cavities as optomechanical resonators on top of Si waveguides
- Demonstration of an optomechanical coupling tunable via the geometric features of the optomechanical circuitry

3. Training received

- Annual CQOM meeting, Diavolezza, 1-5 February 2015

4. List of conferences attended

- META15, the 6th International Conference on Metamaterials, Photonic Crystals and Plasmonics, City College of New York, New York City, NY, USA, August 4, 2015 – August 7, 2015

5. Publications

- V. Tsvirkun, A. Surrente, G. Beaudoin, F. Raineri, R. Raj, I. Robert-Philip, and R. Braive, “Integrated III-V Photonic Crystal - Si waveguide platform with tailored optomechanical coupling”, Scientific Reports, in press