Master in Photonics – "PHOTONICS BCN"
Master ERASMUS Mundus "EuroPhotonics"

MASTER THESIS PROPOSAL

Starting full time from April 2025
Presentation at the end of July or beginning of September 2025

Laboratory: Department of Electronics and Biomedical Engineering
Institution: Universitat de Barcelona (UB)
City, Country: Barcelona, Spain

Title of the master thesis: Integrated optomechanical photonic crystal cavities based on silicon-on-insulator nanopillars for force sensing applications

Name of the master thesis supervisor and co-supervisor:
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Keywords: Cavity Optomechanics, silicon, optomechanical crystals

Summary of the subject (maximum 1 page):
Cavity optomechanics, highlighted by the prestigious journal Nature as one of the latest milestones in photonics, studies the interaction between electromagnetic and mechanical modes in optical resonators. Among the different possible realisations of optomechanical cavities, optomechanical crystals (OMCs) are probably those with the strongest potential from the technological point of view since they can be straightforwardly integrated in photonic integrated circuit platforms. Because of the periodic variation of the dielectric properties, OMCs behave as photonic crystals, thus being able to display photonic energy gaps of forbidden energies. By carefully introducing engineered defects within the periodical structure, it is possible to create photonic cavities leading to the comparison of spatially localized photonic states within the gaps. The specific optomechanical crystal cavity geometry that will be studied in this master thesis is composed by a set of silicon on insulator pillars. Each of these pillars can be understood also as a mechanical cantilever that can interact with the photonic cavity mode, giving rise to the optomechanical interaction.
The master student will be integrated into an on-going European project dedicated to the implementation of nanopillar-based OMCs in silicon chips that operate at room temperature in the near IR optical region, with applications in the sensing of the internal forces present in

tumorous tissues in response to drugs. In particular, the student will study the general response of these OMCs to forces and force derivatives, both from the numerical and from an experimental characterization point of view.

References (http://navarrourrios.com/Publications.html):

- J. Jaramillo-Fernandez, M. Poblet, D. Alonso-Tomás, C. Vinther Bertelsen, E. López-Aymerich, D. Arenas-Ortega, W. E. Svendsen, N. E. Capuj, A. Romano-Rodríguez, **D. Navarro-Urrios**, "Strong Cavity-Optomechanical Transduction of Nanopillar Motion", ACS Nano 18 (35), 24550-24557 (2024)
- **D. Navarro-Urrios** et al. Scientific Reports, 11 (1), 7829, (2021).
- J. Gomis-Bresco, **D. Navarro-Urrios** et al., "A one-dimensional optomechanical crystal with a complete phononic band gap", Nature Communications, 5, 4452 (2014)

Objectives:

- To understand numerically and experimentally the response of pillar-based optomechanical cavities to forces and force derivatives.

Outcomes:

Getting prepared for a PhD project and/or position. The final master report can culminate in a publication.

Additional information (if needed):

* Required skills: Some knowledge of waveguide and fibre optic operation is recommended. The work will involve experimental duties, so good skills and interest in doing laboratory work is also recommended.