PhD proposal 2025-2028

Institut des Nanosciences de Paris
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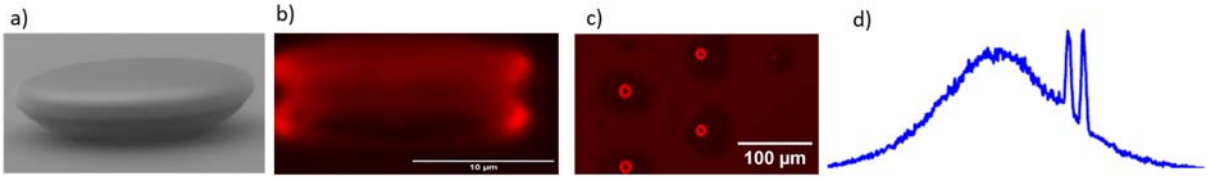
Title: Excitonic whispering gallery mode laser in high pumping regime

Keywords: laser, quantum dot, whispering gallery mode, exciton

Scientific description:
In nanophotonics and quantum technologies, photon sources are a ressource which can be integrated into a chip. Cylindrical dielectric microdisks make excellent resonators in which optical gallery modes can propagate at the air/dielectric interface.
Using optical lithography, we have fabricated gallery-mode resonators on which we have deposited fluorescent nano-emitters, colloidal quantum dots. These are CdS/CdSe/CdS semiconductors in a spherical core/shell/shell configuration. Of nanometric dimensions, their fluorescence wavelength depends on their size. They can emit single photons, are resistant to photobleaching and are bright under strong excitation. We have deposited these quantum dots in high concentration on microdisks, and excited them with a green laser. The excitons thus created enabled us to achieve a significant gain. We were therefore able to create gallery modes excitonic microlasers. [1].



a) microdisk optical cavity C b) Fluorescent gallery mode (side view split by substrate reflection) c) Gallery mode (top view) d) Laser mode and fluorescence spectra

The aim of this PhD will be to study these gallery-mode lasers, and to understand their characteristics as a function of their size, of the excitation when it is close to the laser threshold or more higher... In particular, we will be interested in the behavior of these lasers far from the threshold, when the excitation laser is intense. Under these conditions, the resonant gallery mode intensity is high. If if coupling to the excitons is sufficiently strong, emission will be modified by exciton-photon interaction. We will study these strong coupling configurations in relation to theoretical predictions.

[1] C. Kersuzan et al, *ACS Photonics*, *11(4)*, *1715-1723 (2024)*

Techniques/methods in use: fluorescence, microscopie, spectroscopie
Applicant skills: optics and/or nanophotonics

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