Master thesis proposal

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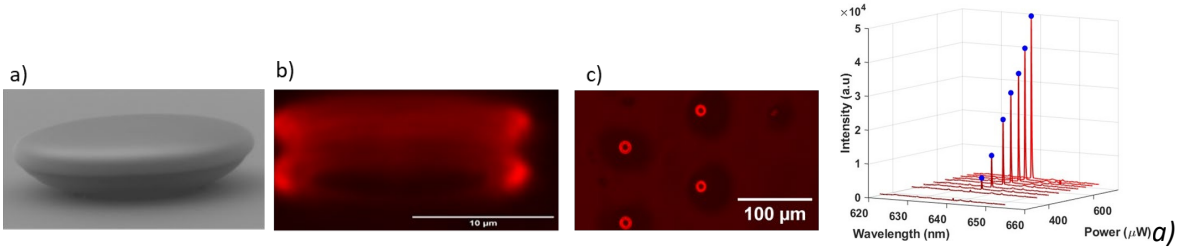
Title: Excitonic whispering gallery mode laser in high pumping regime

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, in order to achieve a sufficient gain. We were therefore able to create gallery modes excitonic microlasers. [1,2].



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 internship will be to study these gallery-mode lasers, as a function of their size, shape or when two cavities are coupled. 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 its 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)*
[2] C. Kersuzan et al, *ACS Nano, 19, 42, 37444 (2025)*

Techniques/methods in use: fluorescence, microscopy, spectroscopy
Applicant skills: optics and/or nanophotonics

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Possibility for a Doctoral thesis: Y , **funding** : Doctoral school