Master ICFP

Proposition de stage / Internship proposal

Date de la proposition : 11/10/2023

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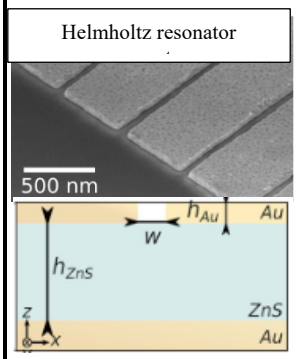
Nom du Laboratoire / *laboratory name*:
Etablissement / *institution* : Lab. Charles Fabry Code d'identification : UMR 8501
Site Internet / *web site*: https://www.lcf.institutoptique.fr/en/quantumnano
Lieu / *place*: 2 av Fresnel, 91127 Palaiseau

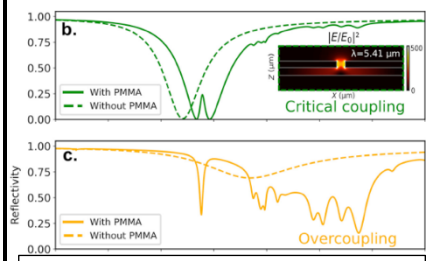
Titre du stage / *internship title*: **Broadband THz Plasmonic metasurface for sensing and modulation with 2D materials**



The project aims at developing a new kind of ***dynamically reconfigurable*** sub-wavelength plasmonic device. The main goal of the project is to implement **in the THz domain** a new paradigm **for filtering, sensing and dynamic modulation**.

Detecting an ultra small amount of matter requires to dramatically confine the EM field in order to improve light-matter interactions. Helmholtz resonators (see figure)**,** composed of a small (ultra-subwavelength) aperture on the surface of a large cavity, funnel light into the cavity through the aperture providing giant local electric field enhancement in the aperture. **Helmholtz resonators have been demonstrated as a powerful design for sensing applications.**

The traditional paradigm of sensing applications is to design a system displaying a high quality factor resonance at a target wavelength (an absorption line of a chemical species to detect). In presence of absorption, the resonant behavior of the system is perturbed. The detection signal that is monitored is limited to this **single target wavelength.**

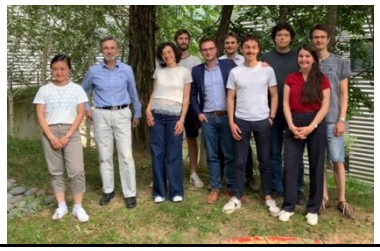


Spectral modifications with b) critically coupled sensors (narrow band detection) and c) overcoupled sensors (broadband detection)

We have recently demonstrated the possibility of detecting **several absorption lines** within the IR with **a single *broadband* resonator arising from Helmholtz's configuration** operating in reflection. When depositing a few nanometers layer of material, the reflection of the system displays notable dips at the absorption lines of the layer. This work has demonstrated a high sensitivity matching the state of the art **together with a large bandwidth.**

The goal of the project is to design sub-wavelength THz resonator arrays (plasmonic metasurfaces) inspired by Helmholtz's configuration. The internship will focus on the design of devices for molecular fingerprint measurements with a single resonator based metasurface in the THz domain.

A PhD can follow the internship after successful application to relevant funding sources. Other systems will be explored, such as devices to electrically modulate THz transmittivity over a larger bandwidth. To this aim, we will use ultrathin 2D materials such as graphene deposited on the surface of the resonators.



The *Quantum Nanophotonics and Plasmonics @Institut d'Optique* team investigates **the physics and engineering of spontaneous light emission** (fluorescence, incandescence, electroluminescence, at different scales (quantum regime with single photon and single atoms, collective effects, condensed matter).

Ref : Paggi, L.et al. Over-coupled resonator for broadband surface enhanced infrared absorption (SEIRA). Nat Commun **14**, 4814 (2023). https://doi.org/10.1038/s41467-023-40511-7

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : YES**			
Si oui, financement de thèse envisagé ou acquis / *financial support for the PhD* **?**			
Financement demandé / *Requested funding*	*X*	Nature du financement */Type of funding*	*EDOM/ONERA*