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PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DOTA-2024-42**
(à rappeler dans toute correspondance)

Lieu : Palaiseau

Département/Dir./Serv. : DOTA/CIO

Tél. : 01 80 38 64 00

Responsable(s) du stage : Baptiste Fix

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DESCRIPTION DU STAGE

Thématique(s) : Optoélectronique, Nanophotonique et Physique de la détection

Type de stage : ☒ Fin d'études bac+5 ☒ Master 2 ☐ Bac+2 à bac+4 ☐ Autres

Intitulé : Broadband Plasmonic metasurface for sensing and modulation with 2D materials

Sujet :

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.

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.

This internship will be done in partnership with Benjamin Vest and Jean-Jacques Greffet from the Quantum Nanophotonics and Plasmonics @Institut d'Optique team who 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.

Est-il possible d'envisager un travail en binôme ? **Non**

Méthodes à mettre en oeuvre :

☒ Recherche théorique ☐ Travail de synthèse

☒ Recherche appliquée ☐ Travail de documentation

☒ Recherche expérimentale ☐ Participation à une réalisation

Possibilité de prolongation en thèse : **Oui**

Durée du stage :	Minimum : 3 mois	Maximum : 5 mois (6 mois sur dérogation uniquement)
Période souhaitée : 1er semestre 2024		

PROFIL DU STAGIAIRE	
Connaissances et niveau requis : nanophotonique / électromagnétisme	Ecoles ou établissements souhaités : Master 2 Recherche ou grandes écoles