iemn
Institut d'Electronique, de Microélectronique et de Nanotechnologie
UMR CNRS 8520

Master nanosciences-nanotechnologies specialty ETECH

Master2 and Engineer internship 2022-2023

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Research group : THz photonics

Title: Bridging optical trapping and dielectrophoresis, across the terahertz gap

Short video: https://youtu.be/B5_x22K-27w

Context: 2018 Physics Nobel Prize has been awarded to Arthur Ashkin "for the optical tweezers and their application to biological systems. OT's have now become indispensable in the biophysicists' toolkit. It allows label free experiments on single cells leading to several breakthroughs in biology as measuring the force of flagella of a bacteria or understanding DNA structure or RNA transcription by grafting them to a µ-bead. However, the investigation of systems at smaller scales is hindered by optical diffraction that limits the focusing and the subsequent optical forces. For this reason, the extension of free space OT below 50 nm, at visible wavelengths, for a dielectric target and biology compliant power, is extremely difficult.

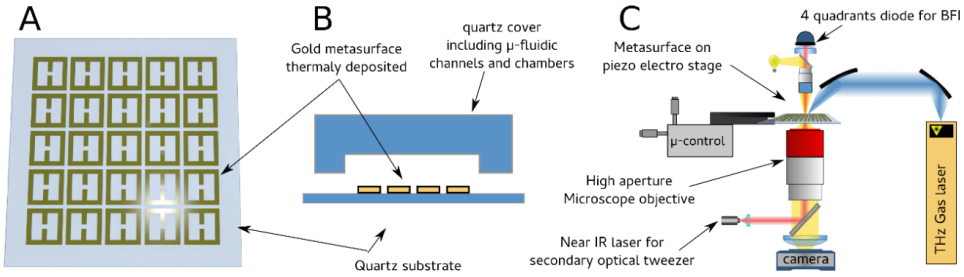

Figure 1: Left typical aimed metasurface , middle schematic of the cross section of the targeted sample, right THz optical setup

Objective: During this internship, we will propose a novel approach aiming at using longer wavelengths to rap smaller objects. Though it looks counterintuitive, in the Terahertz range, metals absorb 2 to 3 orders of magnitude less in the THz than in the visible or infrared ranges. Thus, they transduce light into heat 100 to 1000 time less giving rise to much weaker competitive forces and thus allow to use lasers that are more powerful. In this work, we will take the full benefit of these properties of metal to enable optical trapping in TeraHertz plasmonic metasurfaces where the photonic mode will be shrunk to few µm^3. The consequent huge gradient field will induce as huge optical force without the drawback of the thermal perturbation and thus better trapping. We aim at establishing a novel state of the art for optical trapping thanks to this approach.

Missions: The proposed work include a simulation part where the student will design the trap. It will be followed by a fabrication part exploiting the micro and nano fabrication facilities at IEMN. Then, the main part will use the optical trapping set up to perform the experiment and evaluate quantitatively the trapping. A data analysis will follow. Considering the quantity and diversity of the tasks of the project the precise work of the student will be discussed and will depend on the taste, capacity and will of the candidate.

Environnement : The student will work with a team of experienced researchers in the THz-Photonics group at IEMN Laboratory (https://photoniquethz.univ-lille.fr/en/). The group has a long lasting experience in the conception and realization of THz optoelectronic devices, and is fully equipped to carry out this project. The Laboratory hosts a 1500m2 clean-room with state of the art growth and fabrication facilities. IEMN is located in Lille, the capital of French Flanders, a vibrant city close to the Belgian border at 50 min by train from Paris-CDG airport.

We are looking for physics or engineering master student or equivalent. Having one of the following skills would greatly increase the chance of success of any application: *Experimental optics – Electromagnetism – Photonic simulation- Micro-nano fabrication*

Key words: TeraHertz, optical trapping, plasmonics, metasurfaces, - *Microfluidics*