Master 2 "Photonics, Complex and Quantum Systems (PhoCQS)": Research Training 2025-2026
Master 2 "Matter Molecules and their Environment (MME)": Research Training 2025-2026

Appel à sujet de stage recherche / Call for research training subject

Laboratory: Centre de recherche sur l'heteroépitaxie et ses applications (CRHEA

Supervisor: Samira Khadir - Samira.Khadir@crhea.cnrs.fr

Tél : 0493957810

Collaborator(s): Esben Ravn Andresen (PhLaM) et Hervé Rigneault (Institut Fresnel)

Topic: Photonique

Master 2: select the master and the most appropriate option

X□ Master 2 PhoCQS (GP-IKS)	□ Master 2 MME (GP-SCP)
X□ Option Complex and Quantum Systems	□ Option Condensed Matter
	□ Option Condensed Matter/Pharma
	□ Option Dilute Matter and Spectroscopy
	□ Option Atmospheric Sciences
	□ Option Modeling at the molecular & atomic scales
Return subject to : christophe.szwaj@univ-lille.fr	Return subject to : sebastien.merkel@univ-lille.fr

Title : Design, fabrication and characterization of metasurfaces for miniaturized endoscopes

Endoscopy imaging techniques have attracted much attention thanks to their capability to non-invasively image deep in the living tissues surpassing the conventional imaging techniques limited by absorption and scattering. Their recent miniaturization allowed their application not only for probing hollow organs but also for dense living media such as in the brain [1]. For example, thanks to their ability to perform without additional imaging optical lenses, multicore fibers are very promising for further miniaturization and flexibility of endoscopic systems [2]. Although good performances have been achieved on miniaturized endoscopic systems, there is still non-solved issues that limit their use for clinical application. Most of these problems are related to the beam shaping through the fiber in order to focus and scan the light at the distal end of the fiber. Currently, bulky systems including scanning mirrors and SLM (spatial light modulator) are used.

Our aim to explore the possibility of integrating metasurfaces inside the endoscope in order to improve its performances. Metasurfaces are miniature, flat optical components made of arrangements of scattering objects (meta-atoms) of subwavelength size and periodicity capable to control the properties of the reflected and transmitted light in amplitude, phase, and polarization [3, 4]. During the last decade, metasurfaces have been studied and used for various applications. However, despite the various advantages of metasurfaces, their implementation in miniaturized endoscopes is still scarce.

The master student will work on the design, fabrication, and characterization of a metasurface. For the design, she/he will use numerical tools based on full-wave solvers such as Lumerical FDTD. She/he will be trained in nanofabrication using the cleanroom facilities. The fabricated metasurface will be characterized using SEM for morphology and optical setups available in the lab. In addition to the supervisor and collaborators, she/he will interact with a PhD student working on a related topic.

This master internship may be followed by a PhD starting in September 2026.

References:

1. A. Lombardini, et al., Light Sci. Appl. 7, 10 (2018).

2. E. R. Andresen, et al., Opt. Express 21, 20713 (2013).

3. P. Genevet, et al., Optica 4, 139-152 (2017).

4. S. Khadir, et al., ACS Photonics, 8, 603 (2020)

Key words: metasurface, miniaturized endoscope

- Titre de la mission en français : Conception, fabrication et caractérisation de métasurfaces pour les endoscopes miniaturisés.

Mots clés: métasurface, endoscope miniaturisé