M2 Internship offers

i-Lum team, light engineering and conversion

Nanophotonics, Photovoltaics, Optoelectronics

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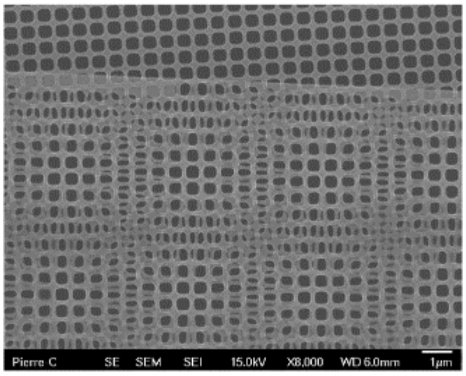

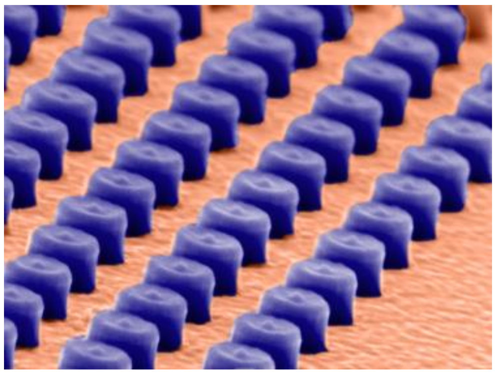

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M2 Internship offer

Optimized diffraction and photon recycling for shining LEDs

Research team: i-Lum, light engineering and conversion

Main Location: Ecole Centrale de Lyon

Keywords: Photonic crystals, Light extraction, FDTD simulations

Profile: Optics/Photonics

Duration: 4 – 6 months.

Context
LEDs and LASERs are nowadays widespread in daily life applications. This leads to a huge energy consumption and use of an important amount of critical and costly material. Therefore, increasing their efficiency (emitted optical power vs injected electrical power) and using low-cost materials and technological processes are a major research topics.

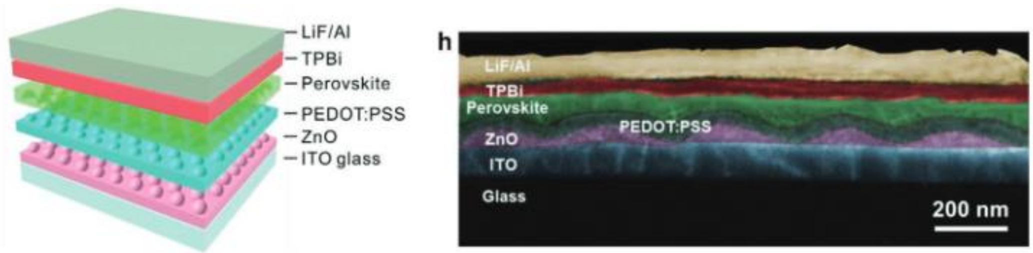

Figure 1. Examples of patterned LED using low cost materials and processes (from [1]): sketch of the stacked materials (left) and SEM cross section of a fabricated sample.

Nanophotonic structures, especially consisting of a periodic, optical wavelength scale patterning of the emitting material, embedded into a stack of layers, can drastically enhance the light extraction from the material, and thus the efficiency [1]. This results from the diffraction phenomenon that also strongly influences the radiation pattern, i.e. the directions where the light is emitted. Another phenomenon, “Photon Recycling”, can also boost the extraction [2], [3]. Both phenomena require an appropriate geometry of the pattern and the stack. Its design requires thus the calculation of the extraction efficiency using a rigorous electromagnetic simulation.
Widely used Finite Difference Time Domain (FDTD) simulation method suits to derive key properties such as light extraction efficiency (LEE) of these devices, but mostly excluding the photon recycling effect.

Research subject
The aim here is to calculate the LEE and the related far field radiation pattern taking into account photon recycling in the active material, in order to provide guidelines for an optimized overall LEE that takes advantage of both diffraction and recycling.

Work plan
After getting trained on a commercial FDTD distribution, the intern will develop a physical model and corresponding simulation methodology of a given device, which involves various simulations and

suitable post-treatment of the intermediate simulation results to derive the final results.
Within this internship, the case of hybrid perovskite LEDs will be considered, since these are low-cost materials that can exhibit a large recycling effect.

Profile
The student will have a background in photonics and will show some interest for simulation work.

Possible perspective
This internship may be followed by a PhD on microLEDs starting in September / October 2024.

References

[1] Y. Shen *et al.*, « High-Efficiency Perovskite Light-Emitting Diodes with Synergetic Outcoupling Enhancement », *Advanced Materials*, vol. 31, nº 24, p. 1901517, 2019, doi: 10.1002/adma.201901517.
[2] C. Cho *et al.*, « The role of photon recycling in perovskite light-emitting diodes », *Nat Commun*, vol. 11, nº 1, p. 611, janv. 2020, doi: 10.1038/s41467-020-14401-1.
[3] C. Cho, Y. Sun, J. You, L.-S. Cui, et N. C. Greenham, « Enhanced Photon Recycling Enables Efficient Perovskite Light-Emitting Diodes », *Advanced Functional Materials*, vol. n/a, nº n/a, p. 2411556, doi: 10.1002/adfm.202411556.

Contacts

Emmanuel DROUARD - emmanuel.drouard@ec-lyon.fr

M2 Internship offer:

Bio-inspired and sustainable photonic sensors

Research team: i-Lum, light engineering and conversion

Main Location: La Doua Campus

Keywords: Bioinspiration, Photonics, Sensing, Biopolymers, Sustainability

Profile: Material science, Physics, Optics

Duration: The expected training period (4-6 month) will be from February/March to July/August 2025.

Scientific context:

Photonic devices offer a great range of properties that are highly interesting for (bio)molecular sensing, as they can support resonances that are sensitive to their environment, while offering compatibility with physiological solutions and great possibilities for compact biomolecular screening using array-based sensing techniques. However, a lot of sensors used for biomolecular analysis tend to be single-use, and end up incinerated or in landfills, in order to avoid cross-contamination. This means that "standard" photonic sensors that are based on silicon technologies have a very high environmental impact due to their fabrication, with respect to their ultra-short life time. In order to reduce this environmental impact, alternative materials and technological processes can be envisaged. At INL, we propose to explore a new strategy based on nanoimprint lithography, a technique that consists in applying a mold on a soft material to directly pattern the reliefs of the desired devices into the material layer. Our choice of materials goes towards bio-sourced and biodegradable polymers, e.g., chitosan, an abundant biopolymer that can be extracted from seafood wastes. Here, the challenge lies in the fact that polymers are materials with a low refractive index, which usually results in poor photonic properties when considering the "standard" concepts of silicon-based photonics. Hence, alternative photonic concepts have to be proposed in order to obtain resonant devices with a high sensitivity, which could be applied as sensors.
Inspiration from natural structures is a route towards achieving this goal. Numerous animal or vegetal species presenting optical properties such as coloration or iridescence can be observed in nature (feathers, insect wings, leaves or petals…); these optical properties are due to a one, two or three-dimensional structuration of matter at submicronic scale [1], leading to optical resonances. In this internship, we propose to use such a natural structure as a mold to fabricate a photonic device in chitosan, and to study its properties for sensing.

Objectives of the internship:

The proposed internship will follow two main objectives. The first objective consists in identifying a natural structure with promising properties, using a methodology that will combine bibliographic studies on natural photonic structures and numerical simulations of their chitosan-replicated counterparts. The second objective is the experimental replication and study of the chosen natural structure. For this purpose, we will use a two-step replication process that is currently under development at INL (replication of the natural structure into a PDMS mold, followed by imprint of the PDMS mold into the chitosan layer). The optical resonances of the chitosan devices will then be studied using micro-reflectivity measurements, in air but also in various aqueous solutions to evaluate their potential for sensing.

Scientific impact and applications:
Although the optical properties of natural nanostructures have already been widely studied, and the underlying light-matter interactions are well-understood, their experimental mirroring is a real challenge that still requires to set up highly-complex designs and technological processes in order to obtain the targeted performances. Hence, the development of alternative original processes enabling, at the same time, to simplify the technological fabrication and to replicate the exceptional optical properties that can be observed in nature, will constitute a major scientific advance in the area of bio-inspired photonics. This could pave new ways for the implementation of bio-inspired nanostructures in several domains of application. Additionally, the demonstration of such nanostructures in sustainable materials will be a crucial milestone for the future developments of eco-friendly photonic devices.

Integration @INL:
The proposed internship will be conducted in the i-Lum team at INL, in close partnership with the DSE team for their expertise on chitosan-based devices. The experimental work will be conducted using Nanolyon facilities.

Possible perspective
This internship may be followed by a PhD via Doctoral School application.

Supervision / Contact:
Céline Chevalier : celine.chevalier@insa-lyon.fr
Cécile Jamois: cecile.jamois@insa-lyon.fr
Xavier Letartre : xavier.letartre@ec-lyon.fr

[1] G. Jacucci, et al., Light Management with Natural Materials: From Whiteness to Transparency, Adv. Mater. 2021, 2001215

M2 Internship offer:

Light-trapping and conductive nanopatterns for Perovskite and Colloidal Quantum Dot-Based Solar Cells

Research team: i-Lum, light engineering and conversion

Locations: La Doua Campus, Ecole Centrale de Lyon

Keywords: Solar cells, Halide perovskites, Nanofabrication, Nanoimprint, Nanophotonics

Profile: Material science, physico-chemistry, thin film technologies

Duration: 4-6 month.

Context:
For future tandem solar cells, combining two halide perovskite absorbing layers is a very promising solution, combining solution-based processes and high efficiency. This internship is part of the ANR NBG_SolarCells project, which aims to develop innovative perovskite solar cells capable of absorbing near-infrared (NIR) photons. The goal is to design solar cells using lead-free or low-lead materials, such as Sn-Pb perovskites and $AgBiS_2$ colloidal quantum dots. A pivotal stage in this undertaking involves creating nanopatterns that function simultaneously as contact layer, light-trapping structure and a supportive framework for these dynamic substances. This action aims to boost charge collection effectiveness and the overall efficiency of the solar cell.

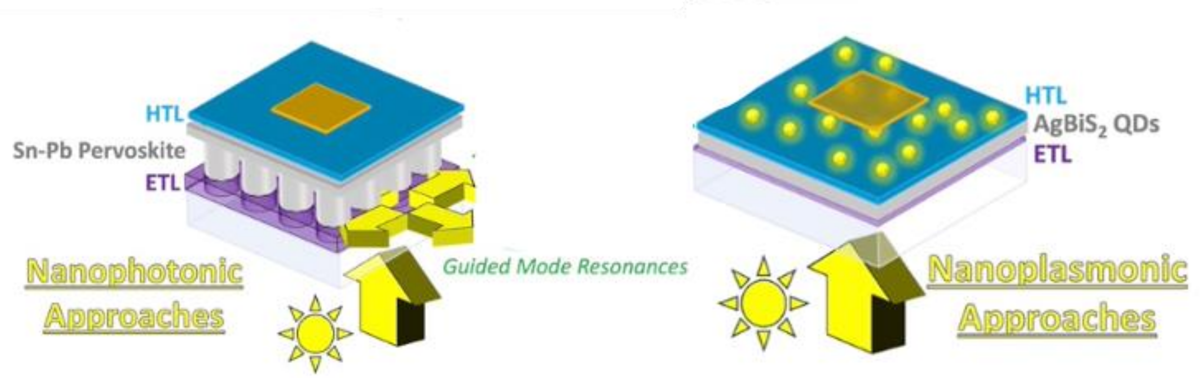

Figure 1: Schematic exhibiting the two NBG solar cell systems and proposed approaches .

Internship objectives:
The student will participate in the fabrication and optimization of nanostructures using the Nano-Imprint Lithography (NIL) process available at the NanoLyon platform. This process allows the creation of well-defined, low-roughness patterns, suited for charge transport layers (ETL and HTL) in photovoltaic devices. The main tasks will include:

- Fabrication of nanostructures for electron transport layers (ETL) based on SnO_2 and hole transport layers (HTL) using polymer (PTAA or doped PTAA).
- Fabrication of the master stamps to perform the NIL step, using laser interference lithography and dry etching.

- Optimization of NIL process parameters (pressure, temperature, etc.) to ensure nanostructures are tailored to the active materials.
- Characterization of the nanostructures to assess their quality and compatibility with perovskite and colloidal quantum dot absorbers.

Candidate profile:

We are looking for a Master's student (M2) with a background in physical chemistry, ideally in materials science applied to thin-film photovoltaic technologies. The applicant should have a foundational understanding of thin-film deposition methods and material characterization techniques, such as electron microscopy and spectroscopy. Scientific curiosity, teamwork skills, and a strong interest in experimental research are essential qualities for this internship.

Integration at INL:

The research will primarily be conducted within the Nanolyon technological platform, including cleanroom facilities for Micro-Nano Fabrication spread across the two INL sites, La Doua campus (Villeurbanne) and Écully.

Supervision / Contact:

Céline Chevalier : celine.chevalier@insa-lyon.fr

M2 Internship offer:

An unconventional usage of anti-reflection coatings: design of robust coupling structures for photonic integration

Research team: i-Lum, light engineering and conversion

Main location: Ecole Centrale de Lyon

Keywords: Photonic integrated circuits, Optical modelling and design, Laser sources

Profile: Physics, Optics

Duration: 4-6 month.

Project description:
Photonic integrated circuits (PICs) enable the miniaturization of devices for numerous critical applications, many of which require a light source. While future advancements may simplify the fabrication and manipulation of directly integrated sources, the photonics industry at large currently relies heavily on external laser sources. Unfortunately, a well collimated and aligned laser source is often an expensive and rare luxury in many application settings. Furthermore, when the in-coupling technique mainly relies on geometrical structures and/or arrangement (eg. lenses, gratings, butt coupling), the coupling efficiency becomes extremely sensitive to positional and angular misalignment / spread, which often translates to low fabrication yields. Instead of relying mainly on geometry, we wish to more exploit matter. More specifically, we aim to exploit how light propagates within a simple descending index multilayer stack / graded index layer in order to obtain a high efficiency waveguide in-coupling structure that is robust to misalignment errors and also suitable for sources with a large beam spread.
During the internship, the student will design robust coupling structures using available software based on FDTD or finite elements based methods while taking into account the constraints of the planned technological platform.

Candidate profile:
The student should have a solid background in physics and/or optics, with a taste for numerical modelling.

Scientific supervisors:
This is a joint master thesis topic done in collaboration between INL and ams-OSRAM which will offer co-supervision on the topic
For INL: Xavier Letartre: xavier.letartre@ec-lyon.fr and Christian Seassal
For ams-OSRAM: Dr. Aimi Abass and Dr. Rasoul Alaee

Institut des Nanotechnologies de Lyon UMR CNRS 5270
http://inl.cnrs.fr

M2 Internship offer:

Next-Generation Customizable Inorganic Charge Transport Layers for High-Efficiency Photovoltaics

Research team: i-Lum, light engineering and conversion

Main location: La Doua campus

Keywords: Solar cells, thin films, transparent and conductive oxides, sustainability

Profile: Material science, thin film technologies, characterization

Duration: 4-6 month.

Contact: Erwann Fourmond, Erwann.fourmond@insa-lyon.fr

Context:
The photovoltaic market is currently dominated by crystalline silicon technology, particularly the so-called PERC (passivated emitter and rear cell) architecture. This architecture has also been developed in our laboratory over the years. PERC cell fabrication involves several steps, one of which includes high-temperature diffusion of dopants to establish the emitter and back surface field (BSF). A notable advantage of this design is that it reduces the metal-semiconductor (Si) contact area, thus minimizing recombination losses at these interfaces. The highest efficiency currently achieved with PERC technology at the cell level is around 25% [1]. In this configuration, the main loss is still due to recombination at the Si/metal interfaces. To improve efficiency, recombination must be reduced by further minimizing the contact areas, which complicates the process.

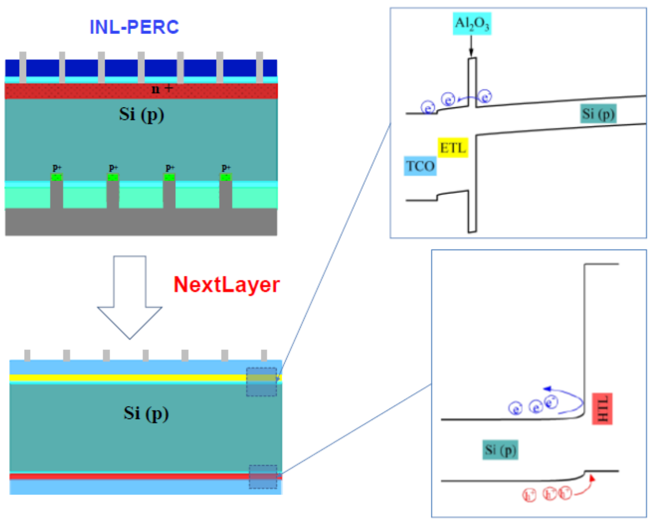

Figure 1: Moving from classic PERC structure (above left), to selective contact structure (below), with band-diagram example for Electron Transport Layer (ETL) with an Al2O3 passivation layer and transparent conductive oxide (TCO) on front side, and Hole Transport Layer (HTL) on back side.

In response to the difficulties presented by PERC design, a new approach has been adopted with heterojunction architecture. This architecture incorporates selective charge transport layers (CTLs) located between the silicon and the metal contact (Figure 1). This structure does not need a classical p-n junction, and thus eliminates the necessity of direct dopant diffusion or implantation into the silicon wafer. This new concept has considerably improved the efficiency of silicon-based solar cells, with a 26.8 % yield and a significant improvement in output voltage [1]. Transition metal oxides (TMOs) have emerged as promising candidates for both hole and electron-selective contacts in both n-type and p-type silicon heterojunction solar cells, inspired by research on perovskite and organic solar cells. These TMOs offer multiple benefits: the employment of a low-temperature process, a wide band gap, and temperature resistance – essential when considering a tandemdesign with top cells that are deposited at high temperatures >500°C, like chalcogenides (CIGS and CZTS). Typically, hole-selective contacts use materials with a high work function like molybdenum oxide (MoOx), tungsten oxide (WO_x), vanadium oxide (VO_x), and nickel oxide (NiO_x), while electronselective contacts favors materials with a low work function like zinc oxide (ZnO), tin oxide (SnO_2), and titanium dioxide (TiO_2) [2–5]. As shown in Figure 1, the approach to be developed in this internship focuses on a transition from high-temperature process technology to lower-temperature processes which are more environmentally friendly, more efficient and cost-effective. The aim is to implement appropriate CTLs with perfect band alignment to facilitate selective charge extraction, minimize recombination on interfaces and further improve solar cell efficiency.

Workplan:
The objective is to develop and analyze well-controlled CTLs on silicon surface. The M2 student will work on the deposition and optimization of TMOs layers, after training in NanoLyon facilities. He/She will have access in that objective to the following equipment:

- Deposition of TMOS contacts on silicon, using Atomic Layer Deposition and/or e-beam evaporation. UV-Lithography will also be used for contact structure formation.
- Optical and electronical characterization of the layers, using spectroscopic ellipsometry, Hall effect measurements for mobility and resistivity, and kelvin-probe analysis for work function extraction.

Contact: Erwann Fourmond, Erwann.fourmond@insa-lyon.fr

[1] Green, M. A. et al. Solar cell efficiency tables (version 62). Prog. Photovolt. Res. Appl. 31, 651–663 (2023).
[2] Ibarra Michel, J., Dréon, J., Boccard, M., Bullock, J. & Macco, B. Carrier-selective contacts using metal compounds for crystalline silicon solar cells. Prog. Photovolt. Res. Appl. 31, 380–413 (2023).
[3] Allen, T. G., Bullock, J., Yang, X., Javey, A. & De Wolf, S. Passivating contacts for crystalline silicon solar cells. Nat. Energy 4, 914–928 (2019).
[4] Wang, Y. et al. Dopant-free passivating contacts for crystalline silicon solar cells: Progress and prospects. Eco-Mat 5, e12292 (2023).
[5] Liu, S. et al. Nickel Oxide Hole Injection/Transport Layers for Efficient Solution-Processed Organic Light-Emitting Diodes. Chem. Mater. 26, 4528–4534 (2014).

M2 Internship offer:

Electrically-driven Phase Change Materials Devices for Reconfigurable Nanophotonics

Research team: i-Lum, light engineering and conversion

Main location: Ecole Centrale de Lyon

Keywords: Photonic integrated circuits, Multiphysics modelling and design, Electrical engineering
Profile: Physics, Optics

Duration: 4-6 month.

Context:
Nanophotonics is a mature field of research enabling the control of light via the nanostructuration of matter, with industrial applications ranging from telecoms to sensors as well as clean energy. Many optical components require local control of the direction, magnitude or phase of the electromagnetic field. This is particularly the case for programmable circuits, LIDARs or spatial light modulators (SLMs), which allow, among other things, optical computing, remote sensing and beam shaping. Most of these devices rely on thermo-optical effects, mechanically operated mirrors or liquid crystals, which fundamentally limits their operating speeds, sizes and integrability. As these components become crucial for self-driving cars, head-up displays or adaptive optics, it is necessary to transform them towards on-chip integration and mass production, which means finding new integrated optical modulation strategies.

Goals:
In this internship position, we propose to use the potential of phase change materials (PCMs) to dynamically control the optoelectronic response of photonic devices. More specifically, we will use chalcogenide-type materials such as GeSbTe, Sb_2S_3 and Sb_2Se_3, whose atomic arrangement can be changed in a controlled manner by an optical or electrical signal. This reversible amorphous-crystalline transition results in a very wide modulation of the refractive index, especially at near infrared wavelengths.
Our overall goal is to develop the selective electrical addressing of individual pixel elements of a nanophotonic device to actively write, erase and reconfigure integrated nano-devices in real time. For this it is necessary to develop a functional low-loss integrated PCM platform for photonics, with potential applications for optical computing, beam shaping and holographic display.

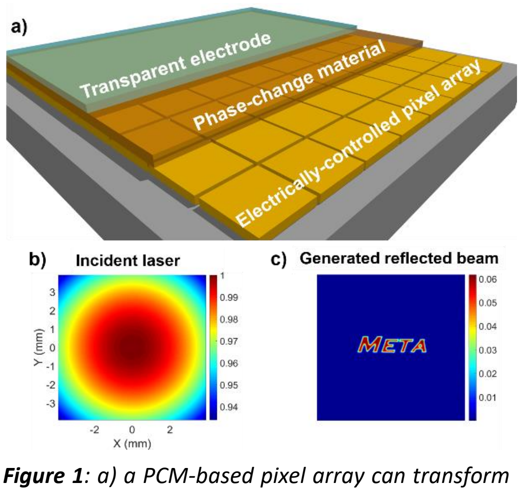

***Figure 1**: a) a PCM-based pixel array can transform an incident Gaussian beam, (b) to an arbitrary reflected wavefront; c) Here, each PCM-pixel is encoded to reflect the word 'META' in the far-field.*

This internship therefore aims to unlock the following scientific roadblocks: (i) design efficient integrated micro-heaters on-chip using multiphysics modelling; (ii) Fabricate and characterize PCM-based devices whose phase is electrically-controlled via integrated micro-heaters

Expected original contributions:
Controlling the individual state of each PCM-based pixels will enable real-time programmable photonic circuits or on-demand writing of metasurfaces for applications ranging from holographic displays to adaptive optics. Unlike existing solutions at the micrometric scale (liquid crystals, micro-mirrors, etc.), phase change materials will allow working at the nanometric scale with a much higher speed. Integrated reconfiguration techniques based on the selective control of PCM-based elements via electrical pulses may lead to a breakthrough in the field of reconfigurable photonics, promising innovative devices such as compact LiDARs for autonomous vehicles, components for beam shaping for biological analysis or even new types of displays for the augmented / virtual reality.
The candidate will take advantage of the stimulating scientific environment of INL, as well as of the scientific and technological facilities available in the lab, hosted in particular by the Nanolyon technology platform.

Profile
The candidate must have a strong background in Materials science, electrical engineering and photonics, with a strong motivation for Multiphysics designs, technological and experimental work as well as good social skills to carry out her/his researches in a dense collaborative context. The candidate will receive a solid training in nanofabrication in a clean room environment. Likewise, he / she will develop skills in electro-optical characterizations of nanophotonic devices.

Possible perspective
This internship can be followed by a PhD via an already funded ANR grant.

References:
- "Programming multilevel crystallization states in phase-change materials thin film"
A. Taute, S. Al-Jibouri, C. Laprais, S. Monfray, X. Letartre, N. Baboux, G. Saint-Girons, L. Berguiga, and S. Cueff, *Optical Materials Express* 13, 3113 (2023)
- "Dynamic control of light emission faster than the lifetime limit using VO_2 phase-change",
S. Cueff, D. Li, Y. Zhou, F. J. Wong, J. A. Kurvits, S. Ramanathan, and R. Zia.
Nature communications **6** (2015)
- "Reconfigurable Flat Optics with Programmable Reflection Amplitude Using Lithography-Free Phase-Change Materials Ultra-Thin Films",
S. Cueff, A. Taute, A. Bourgade, J. Lumeau, S. Monfray, Q. Song, P. Genevet, B. Devif, X. Letartre and L. Berguiga
Advanced Optical Materials 9, 2001291 (2021)
- "Tunable Mie-resonant dielectric metasurfaces based on VO2 phase-transition materials"
A. Tripathi, J. John, S. Kruk, Z. Zhang, H.S. Nguyen, L. Berguiga, P. Rojo Romeo, R. Orobtchouk, S. Ramanathan, Y. Kivshar, S. Cueff, *ACS Photonics* 8 (4), 1206-1213 (2021)

Contacts:
Sébastien Cueff sebastien.cueff@ec-lyon.fr
Nicolas Baboux nicolas.baboux@insa-lyon.fr
Lotfi Berguiga lotfi.berguiga@insa-lyon.fr

M2 Internship offer:

Holographic metasurfaces for sensor applications

Research team: i-Lum, light engineering and conversion

Main location: La Doua campus

Keywords: Nanophotonics, metasurfaces, phase sensors, dispersion diagrams

Profile: Physics/engineering, Optics/Photonics

Duration: 4-6 month.

Context:
In Nanophotonics, light can be controlled by structuring matter at a subwavelength scale, as in photonic crystals (or metasurfaces). By trapping light at a given wavelength that gives rise to a resonant effect, the photonic crystal becomes a photonic sensor highly sensitive to its environment. The presence of objects (such as molecules) at the photonic crystal-liquid interface modifies the resonance, inducing a wavelength shift. This variation makes it possible to detect the presence of biomolecules. For early disease diagnosis, the detection of these molecules in small quantities remains a current challenge. Therefore, there is still a need to improve the sensitivity and detection limits of photonic sensors.
To characterize the light-controlling properties of a photonic crystal, spectroscopic measurements and/or dispersion diagrams are usually carried out. These provide information on the mode of reflection, transmission or emission, depending on the wavelength and on the excitation direction of the photonic crystal. In general, dispersion measurements are intensity measurements. At INL, we are adding phase measurement to the dispersion diagram, as this provides additional information that is little explored in Nanophotonics. For example, metasurfaces can possess special phase properties, such as a phase singularity. A phase singularity is characterized by a reflectivity that tends towards zero in intensity and exhibits a sharp phase jump at resonance. Under certain conditions of angular phase distribution, these photonic crystals could boost the phase sensitivity and reduce the detection limit in sensor applications. Hence, the study of phase and amplitude dispersion diagrams will pave the way to understanding the behavior of these photonic crystals when used as sensors.
In this context, we have developed a new approach for sensor applications, i.e., a holographic micro-reflectivity measurement system that provides access to the complex reflectivity of the photonic crystal (amplitude and phase) [1]. Our aim is to extend the functions of our measurement system, from a reflectivity measurement for a given angle and wavelength, to a system that measures the reflected light for a range of wavelengths and a range of angles in both the x and y directions of space. In other words, a system able to measure 3D amplitude and phase dispersion diagrams.
For sensor applications, it will enable us to study the evolution of resonance in the dispersion diagram. The phase dispersion measurements will provide a better understanding of the behavior of the phase singularities when the resonance is modified by the presence of molecules in the near-field of the photonic crystal. Obtaining complex 3D dispersion diagrams (amplitude and phase) and their evolution in a sensor application is highly original, and to our knowledge has never been done before.

Objectives and workplan:
The aim of this experimental internship is to study photonic crystals by measuring their 3D dispersion diagram and to see how it evolves when the refractive index of the liquid medium changes above the photonic crystal.
The first step will be to reproduce reflectivity measurements at a given wavelength for an angle distribution in the x,y plane, and then to obtain a 3D dispersion diagram by varying the laser

wavelength. More particularly, we will study photonic structures with ultra-flat bands, meaning that the reflectivity spectrum evolves very slowly as a function of angle. The purpose of this first step will be to calibrate the holographic phase measurement setup and to compare it with the theoretical band diagram.

In a second step, we will apply the setup to sensing. For this purpose, we will vary the liquid environment in contact with the photonic crystal by injecting glucose solutions of different concentrations with a micro-fluidic system. The effect of the refractive index variation on the dispersion pattern will be studied, with particular emphasis on its phase.

Scientific profile and competences:

The nature of the proposed work being mainly experimental, the candidate must have an engineering degree or a Master's degree in physics or engineering science. A strong interest in experimentation is required to successfully complete this internship. Basic knowledge of optics and photonics is required. During the internship, the student will become familiar with the concept of nanophotonics, optical and holographic experimental techniques and the methods used in photonic sensors. If the student so wishes, he/she could also acquire skills in photonic numerical simulation. The student will have the opportunity to evolve within the i-Lum team in an environment that integrates different facets with theoretical, technological and experimental aspects.

Supervision / Contact:

Lotfi Berguiga, lotfi.berguiga@insa-lyon.fr
Cécile Jamois, cecile.jamois@insa-lyon.fr
Taha Benyattou, taha.benyattou@insa-lyon.fr

[1] Théo Girerd, Fabien Mandorlo, Cécile Jamois, Taha Benyattou, Lydie Ferrier, and Lotfi Berguiga, “Optical sensing based on phase interrogation with a Young’s interference hologram using a digital micromirror device”, Optics Express 32.3 (2024), pp. 3647. DOI 10.1364/oe.507643.