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PhD research proposal

Graded Photonic Crystals Devices for Graded Index Optics

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General framework

On the one hand, Graded Photonic Crystals (GPC) allow to efficiently control the flow of light thanks to the shape of their photonic bands, which we verified by demonstrating a "photonic mirage" at wavelength scale [1]. In the other hand, GRaded INdex (GRIN) optics is undergoing a renewal because it allows to downsize optical systems, opening a new way to optical design [**?**]. But GRIN optics was limited by a lack of easy to implement fabrication techniques. Nanotechnology enables to efficiently fabricate photonic crystals, which we will implement to fabricate GPC for GRIN optics.

Previously, we experimentally made the evidence of a "photonic mirage" from a GPC, which demonstrates their ability to efficiently curve the *flow of light* (see fig. 1. We are designing, numerically simulating and characterising GPC devices (see fig.2) [2, 3]. More specifically, we have conceived a GRIN flat lens which we have characterised in the microwave [4]. Recently, we have designed and simulated a Luneburg lens [5] (see fig.2). We conceive thin and thick flat GRIN lenses. For the sake, we engineer the *equi-frequency* curves which convey the dispersion properties of photonic crystals. Our aim is to go further up to the optical domain. The experimental evidence of such devices is an end in itself because it is a technological challenge to fabricate such GPC. Nevertheless, we will investigate the great variety of applications of GPC flat lens, which concerns Photonic Integrated Circuits, Lab on Chip, optical pumping of organic materials, OLED, biophotonics, fluorescence of cells, etc.

PhD work plan

GPC devices will be designed, fabricated and characterised at the Centre de Nanosciences et Nanotechnologies (C2N). This work will concern numerical simulation and optical design, nanotechnological processes and optical characterisation. These devices will operate at telecommunication wavelengths (1,55 μm). The *Silicium On Insulator* (SOI) channel of the C2N will be involved, because "state of the art" photonic crystal -based devices have already been fabricated in its clean-room [7]. These devices require the technological mastery of the position, of the size and of the shape of the patterns, which is adapted for the realisation of GPC devices. The size of the patterns of these latter is of several tens of nanometers, which will be challenging. The devices will be also characterised at the C2N. GPC devices operating in the near infrared (NIR) spectrum will also investigated (from 1 to 20μm) because, in this domain, lies a lot of molecular signatures, which is fruitful for NIR spectroscopy, chemical sensing, polluant detection, etc.

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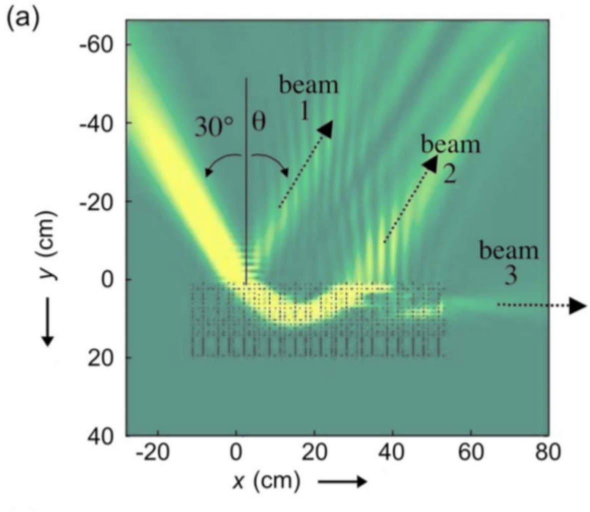

FIGURE 1 – Mirage photonique : le cristal photonique courbe la propagation du champ électromagnétique [1].

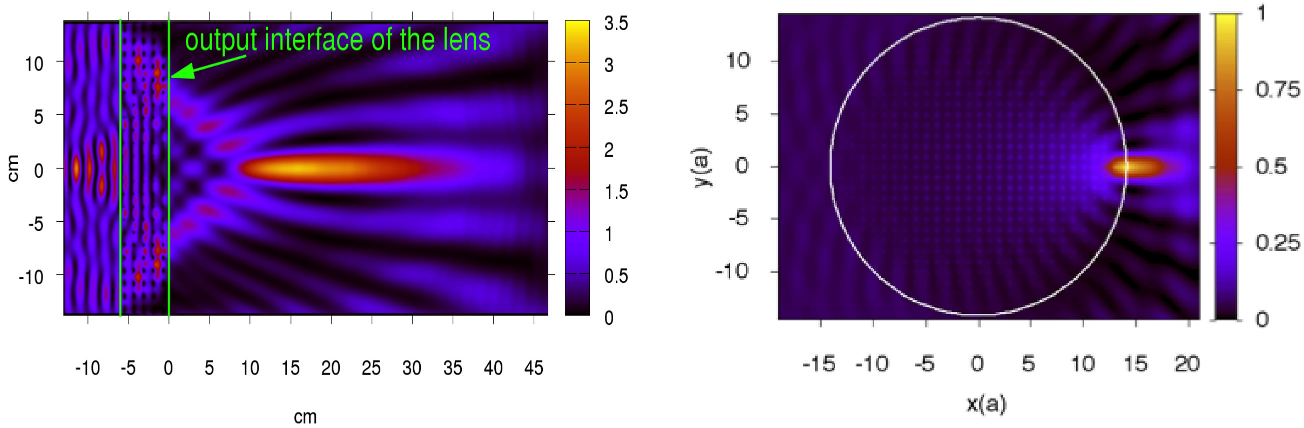

FIGURE 2 – Left : Focusing by a GPC GRIN flat lens [2] ; right : focusing by a Luneburg lens [5]

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