MASTER IN PHOTONICS – "PHOTONICS BCN"
ERASMUS+ "EUROPHOTONICS"

MASTER THESIS PROPOSAL

Dates: April - September 2019

Laboratory: Laboratory of Photonics and Integrated Optics
Institution: Institute of Microelectronics of Barcelona (IMB-CNM, CSIC)
City, Country: Bellaterra, Spain

Title of the master thesis: *Design and simulation of grating couplers for bio-polymeric thin film photonic circuits in sensing applications.*

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Keywords: refraction-grating, thin-film waveguides, bio-polymers, nano-imprint, numerical simulations.

Summary of the subject (maximum 1 page):

In the development of optical waveguide-based biosensors, one of the most challenging issues is the coupling of light from the light source to the optical device and subsequent decoupling to the phototodetector/spectrometer for the measurement. When working with thick waveguide structures, coupling/decoupling can be achieved by several strategies, with direct optical fiber coupling as one of the simplest and most commonly used. The coupling process is becoming more complex, however, when involving thin optical waveguides (< 5 µm), mainly due to the complexity to align the coupling structures to so thin optical elements. In this case, the use of photonic crystals or gratings is preferred for enabling light coupling/decoupling from out-of-plane and without the need of precise alignment to reach high coupling efficiencies.
For this master thesis we propose the design and simulation of waveguide grating couplers based on biopolymeric materials for the use in biosensors, enabling the coupling/decoupling of one or more wavelengths in the visible spectrum.

As most optical biosensors rely on visible light analysis for detection as a minimal-invasive tool, it is desirable to couple/decouple at least one wavelength in this spectral range. Nano-fabrication tools and techniques (e.g. Nano-imprint) will be employed for the fabrication of the gratings matched to these short (compared to telecommunication) wavelengths and achieve the necessary sub-micrometer feature sizes.

With this objective in mind, we look for a motivated and enthusiastic student with good team working skills to:

1. Design a waveguide grating based on a given set of wavelength, material properties and geometrical constraints.
2. Simulate coupling and decoupling in a 3D model and assess the angle dependency of coupling efficiency in different conditions of refractive index contrast.
3. Explore the possibilities of coupling several wavelengths simultaneously to the same waveguide.
4. Fabricate and test a prototype using micro- and nano-fabrication tools (e. g. Deep UV direct laser lithography, 2-photon 3D lithography)

To this end, the following prior knowledge/skills will be very welcome:

1. Knowledge of simulation programs (Comsol Multi-physics, Fimmwave, etc.)
2. Experience in optical waveguides
3. Experience in micro- and nano-fabrication technologies