Internship on integrated photonics for undergraduate master students.

Design and characterization of polymer-based photonic integrated circuits operating in the visible region: biosensing applications in water

Up to now, extensive research has been done in semiconductors technology providing photonic integrated circuits (PICs) with a specific emphasis on optical IR communication wavelengths. In counterpart, visible integrated optics is less investigated mainly due to the high absorption losses in silicon. However, polymer-based optical waveguide devices provide an alternative approach to support the next generation of PICs and optical sensors operating in the visible range. In this context, applications can focus on visible signal treatment or sensing. For example, integration of multi-analyte sensors could come from the hybridization of polymeric microfluidic channels and optical resonant devices at dedicated wavelengths [1][2][3]. Among other advantages, polymers present low absorption for operation in the visible spectrum and low-cost production through thermal-UV nanoimprint lithography. Currently, our efforts have been focused on sensitivity study and manufacturing of polymer-based PICs (PBPICs) for visible operation in the clean room facilities of the LAAS (France) and Tecnalia (Spain). In parallel, we have developed an appropriate set up to perform optical measurements of the devices which are composed of optical nanowaveguides (350nmx350nm), grating couplers to perform the light in/off-coupling, and microring resonators. Our goal is to achieve accurate optical characterizations of the devices at two different visible wavelengths 505nm and 632nm. In addition, measurements of the sensing capability of the PBPICS in presence of an analyte are expected. These results would greatly contribute to the establishment of straightforward low-cost sensing methods based on microcavity spectrometry. Finally, it would lead us to the packaging of the final prototype by means of the integration of appropriate sources and detectors in the same microsystem.

We are looking for outstandingly motivated master students (fourth or fifth year) in applied physics or electronic and telecommunication engineering with a strong background in physics. Experience with lasers and optical systems is preferred, but we are willing to train the most motivated candidates. Successful students will work on the state of the art of PBPICS and will perform finite difference time domain (FDTD) simulations of the aimed structures (light coupling, waveguide and resonators). Working on the optomechanics of the set-up can be expected in order to improve the optical characterizations (as coupling efficiencies, spectrum, polarization) with/without diluted analytes (e.g water contaminants) in reference solution. Despite of the experimental profile of this research, exploratory work of active or passive cavities (photonic crystals, DFB/DBR lasers, optofluidics) can be done depending on the background and preferences of the candidate. The host laboratory is the IMS located at Bordeaux (France) within the team ONDES with a large background in failure analysis of optoelectronic devices and on microsensors. The internship duration must be from 2 to 6 months with a monthly remuneration. Candidates must send a CV with a short motivation letter explaining their interest and coursework to miguel.diez-garcia@u-bordeaux.fr and simon.joly@u-bordeaux.fr. Recommendation letters would be also considered.

REFERENCES

[1] D. Kim, P. Popescu, M. Harfouche, J. Sendowski, M.-E. Dimotsantou, R. Flagan, and A. Yariv, “Onchipintegrated differential optical microringbiosensing platform based on a dual laminar flow scheme,” in CLEO : Science and Innovations. Optical Society of America, 2015, pp. STu4K–7.

[2] F. Meziane, V. Raimbault, J.-L.Lachaud, H. Hallil, D. Rebière, and C. Dejous, “Integrating optical ring resonator in electrowetting on dielectric digital microfluidic chips,” in XII International Conference on Optical Chemical Sensors & Biosensors, 2014, p. 2p.

[3] R. Landgraf, A. Finn, R. Kirchner, T. Haugwitz, F. Deicke, W.-J.Fischer, and S. Arndt, “2.4. 2 polymer microring resonator directly patterned by multilevel-nanoimprint : Integration into biosensor system with a miniaturized microfluidic system,” Tagungsband, pp. 259–267, 2012.