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PhD Offer on Integrated Nonlinear Photonics

The Near-field Optics Group at Université de Bourgogne Franche-Comté invites applications for a PhD position on integrated nonlinear photonics. Only candidates with a Master degree (or equivalent) and a strong background in nonlinear optics, nanotechnologies and/or nanophotonics should apply. The selected candidate will be invited to support his/her application by an oral presentation examined by the scientific council of the laboratory in June 2018.

Please contact benoit.cluzel@u-bourgogne.fr

Submission documents:

(a) A cover letter where you introduce yourself, your past research and your career goals
(b) A full CV including undergraduate details
(c) A transcript of your academic records

The position is for 3 years. Starting date: October-2018.

Context: Since few years, integrated photonics has benefit from the rise of new materials with ultra-high optical nonlinearities and compatible with current nanofabrication technologies from micro and nanoelectronics industry. For instance, devices such as photonic crystals, metamaterials, integrated waveguides, and whispering gallery mode resonators can be fabricated in silicon nitride, chalcogenide glasses or lithium niobate which has opened new routes towards a large set of functionalities on a chip (frequency combs, optical parametric oscillators, supercontinua sources to name just a few) operating with a moderate power. However, right now, only few groups in the world from famous institutes (Harvard, Cornell, NIST, EPFL) dominate these nanofabrication processes.

Since two years, the Near-Field Optics Group from ICB lab has built an international collaborative network with institutes dominating the most advanced nanotechnology processes (CEA LETI, ETHZ, MIT) in order to fabricate such highly nonlinear integrated devices. The nanofabrication processes have been developed in close collaborations with these groups and most of them are now well mastered since the first fabricated devices exhibit performances that compete with the international state-of-the-art. The fabricated devices also show a very high complexity in terms of modal landscape and nonlinear interactions between optical modes.

> *The objective of this PhD is to explore experimentally the spatio-temporal dynamics of nonlinear propagation and interactions of optical modes involved in such highly nonlinear integrated devices.*

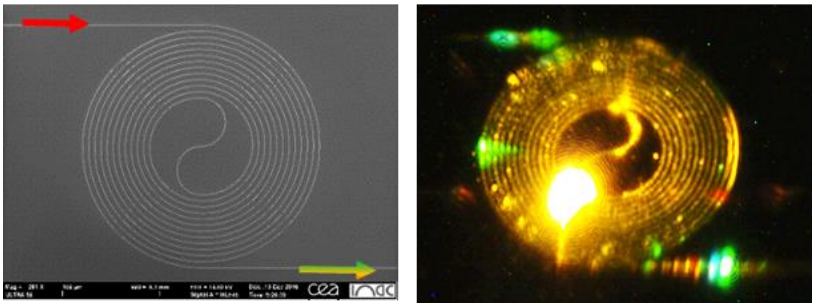

Figure : (Left) SEM view of an Archimedean spiral designed in NFO group and fabricated at CEA LETI in Grenoble. (Right) Microscopic view of the supercontinuum generation inside the spiral due to the propagation of an infrared femtosecond light pulse.

For instance, the above figure shows an Archimedean spiral made of silicon nitride which supports the generation of a 2 octave spanning supercontinuum from visible to midinfrared wavelengths. Preliminary studies by hyperspectral near-field microscopy have shown that a large number of modes is participating to the generation of such a supercontinuum which raises several questions about the underlying physical processes.

Thesis organization: This PhD will be hold in the Near-Field Optics Group which has a worldwide recognized know-how in nanophotonics and in near-field microscopy. The PhD student will also benefit from the strong links between the NFO group and the Solitons, Laser and Optical Communications Group of the lab for modelling the nonlinear propagation. The student will be in charge of the design (numerical modelling) of the nanophotonics devices in regards to the desired nonlinear functionalities and to the inevitable nanofabrication constrains. He/She will interact directly with the groups working with the nanofabrication facilities in clean room at CEA LETI and ETHZ mainly. He/She will conduct the nonlinear experiments by nonlinear propagation spectroscopy and hyperspectral near-field imaging in order to resolve the spatio-temporal dynamics of propagating and interacting modes.

Outputs: During this PhD thesis, the student will acquire advanced skills in designing integrated photonic devices by numerical modelling, in optical experimentation at the nanoscale as well as in nonlinear optics. He/She will also learn some basics about nanofabrication. It is expected that the student will benefit from the strong relationships between the NFO group and the nanofabrication groups in order to better prepare his/her network in the academic world. This PhD will lead to publications in high-ranking scientific journals. The student will participated to national and international conferences where he/she will present his/her results. At last, he/she will join the young and NFO group where he/she will develop research works in an international environment.