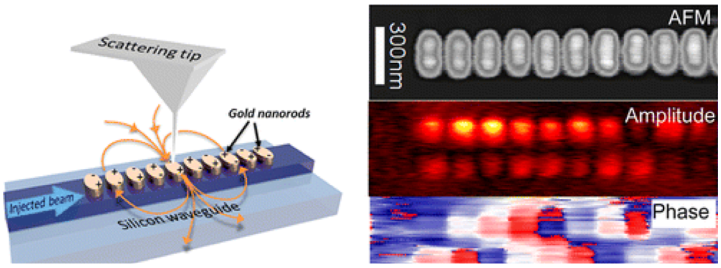
PhD position in NanoPhotonics

Nanostructure-waveguide interaction: application to nearfield optical microscopy for the characterization of photonic integrated circuits

Figure 1: Nearfield optical imaging of a nanostructured integrated pghotonic waveguide. Left: AFM topography and experimental cartography of the complex optical nearfield [4].



The last two decades have seen the development of several revolutionary methods that have allowed access to optical information exceeding the diffraction limit, reaching previously inaccessible scales of the order of some ten nanometers. These technics include near-field optical microscopy (SNOM) and advances in fluorescence microscopy, which were rewarded by the Nobel Prize in Chemistry in 2014 [1].

Beyond the applications of these imaging techniques in the field of biology, they promise many breakthroughs in other fields such as materials physics and photonics at the nanoscale. Indeed, these methods open the local characterization of the Density of Optical States (LDOS), which represents a major stake for the understanding and control of the processes of energy transfer and light-matter coupling. So far, several experimental and theoretical tracks in this aim have been explored with varying degrees of success.

Recently we develop a new approach where we use of the local phase to access to the LDOS [2,3]. However, the experimental demonstration and the performance of this new strategy remain to be evaluated. In this thesis, a first stage will be, in collaboration with the experimental team, to simulate the experimental configuration envisaged, and the exploration of other possible configurations. This work will be carried out in the framework of the FDTD calculation methods (Lumerical software) and in interaction with the collaborators in charge of the manufacturing and characterization stages on the NanoMat platform [http://www.nanomat.eu].

On the application side, the manufacturing techniques accessible on the NanoMat platform makes it possible to control the energy transfer at the nanoscale and thus to engineer the energy transfer of some molecules, or a single molecule.

The Laboratory of Nanotechnology, Instrumentation and Optics (LNIO) is tasked with the development of nano-optics, which addresses a number of technological, scientific and socio-economic challenges. Researchers at LNIO are working on new concepts and approaches, developing both innovative instrumentation and nanocharacterization and nanomanufacturing methods.

Skills: For this project, good knowledge in Electromagnetism and Optics are mandatory, with experience in numerical simulation and/or knowledge in programming language such as fortran and/or Matlab. A taste for Physics and theory is require, together with good communication skills.

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Key-Words : **Fluorescence, plasmonics, LDOS, phase, Simulation, energy transfer at nanoscale.**

Bibliography:

[1] **2014 Nobel Prize in Chemistry** to Eric Betzig, Stefan Hell and William E. Moerner for their pioneering work in "super-resolution" fluorescence microscopy corroborates its promise for many investigations in physics, chemistry, materials science and life.

[2] E. Castanie, **R. Vincent**, R. Pierrat, and R. Carminati. Absorption by an optical dipole antenna in a structured environment, Intern. J. of Opt. 2012, 452047 (2012).

[3] R. Prasad, and **R. Vincent**, 'Resolving phase information of the local optical density of state (LDOS) with scattering near-field probes', Phys. Rev. B **94**, 165440 (2016).

[4] *Observation of near-field dipolar interactions involved in a metal nanoparticle chain waveguide* Apuzzo, A., Février, M., Salas-Montiel, R., Bruyant, A., Chelnokov, A., Lérondel, G., Dagens, B., **Blaize, S.** Nano Letters, **13** (3), pp. 1000-1006. (2013)