PhD Thesis subject: **Design and study of metallic and dielectric meta-surfaces for improving OLED performances**

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Meta-materials are periodic metal-dielectric structures with subwavelength dimensions that resonantly couple to the electrical and / or magnetic components of the electromagnetic field of an incident wave and exhibit properties that do not occur in nature. This type of artificial material has attracted a great interest over the past ten years and has given rise to revolutionary electromagnetic and photonic phenomena. In particular, the ultra-thin dimensions of meta-surfaces in the direction of propagation of the wave can considerably reduce the undesirable losses. Meta-surfaces also allow spatially varying optical response (eg, scattering amplitude, phase and polarization) and shaping optical wave fronts with different design. Besides, dielectric meta-surfaces allow unique functionalities when coupled to Mie resonances and low ohmic losses.

In addition, a better knowledge of the interaction between light and matter at sub wavelength scale allows to effectively managing the interaction between organic emitters and plasmonic nanostructures or metasurfaces. One of the most important parameters of this interaction concerns the LDOS (the density of states), which is related to the complex optical response of a plasmonic-nanostructure is given by a large band of extinction and an abrupt phase transition at the resonance wavelength. Unlike the intensity, the phase transition is much more sensitive to the slight changes of the physical environment properties. Thus, we suggest probing the LDOS (the local state density) of the system by measuring the nanotructure polarizability (or the phase displacement created by the nanostructure). This could be achieved using the QLSI (Quadriwave Lateral Shearing Interferometry) technique.

Therefore, in the line with the study of plasmonic effects conducted by the PON team to improve the performances of organic optoelectronic devices, we propose to design and study meta-surface nanostructures, as well as their utilization in organic light sources (OLED and LEC devices) for optical beam shaping. The main objective will be to use these nanostructures for the improvement and control of OLED emission. To this end, we will focus on two types of meta-surfaces: mirrors and flat lenses. We will study two families of materials: noble metals and dielectrics, in particular ITO and / or ZnO.

Generally speaking, this work concerns theoretical and experimental studies mainly dealing with the development at the LPL of a new setup based on QLSI technique.

The objectives of this work could be summarized as following:

- Design and investigation of metasurfaces for beam shaping;
- Development of a new setup based on QLSI technique;
- Investigation of LDOS using quantum approach of plasmonic effects: study of simple and comlex organic emitter-nanostruce systems within OLED and LEC;
- Design and stuty of OLED and LEC devices containing metasurfaces;
- Development of a new generation of OLED devices toward organic laser diode studies.