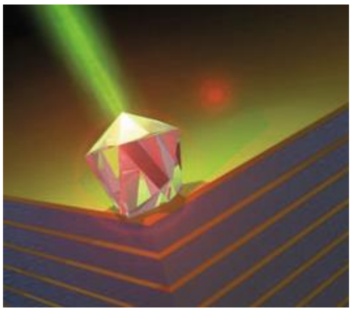

METAL-DIELECTRIC STRUCTURES FOR AMPLIFICATION OF LIGHT EMITTED BY 2D SEMICONDUCTORS

Recent advances in nanofabrication techniques and optical characterization have allowed the realization of artificial structures known as metamaterials (MMs) that have anomalous (optical) electromagnetic properties, beyond those found in natural materials. The ability to alter the electromagnetic response of these MMs has led to innovative proposals and applications such as materials of negative refractive index [1], invisibility [2], and imaging systems with resolution below the light wavelength [3]. An emerging type of MMs are the so-called hyperbolic metamaterials (HMMs), whose name has the origin of the equation that determines its spatial dispersion. Particularly important in the present project is the application of HMMs to define nanoscale optical cavities [4] and the control of spontaneous emission of quantum emitters [5].

The most recent works are combining these HMMs with planar photonic structures in order to improve the emission of light by Purcell effect of 2D semiconductors such as MoS_2 and WS_2, where the emission into free space is improved [6]. This type of combination could be of great interest for the achievement of strong coupling between the emitter and the photonic structure that amplifies its radiation [7], which is of crucial importance for the future development of quantum light sources in the field of quantum Telecommunications and Computing. In the present project, the choice of light emitters is also important and, therefore, we propose the most novel ones according to current scientific trends: 2D semiconductors. After graphene, achieving and studying atomic monolayers of some semiconductors (chalcogenides, dichalcogenides and others) has been a scientific revolution for the development of new types of electronic and photonic / optoelectronic devices that deserve to be exploited [8], a research field in which we have also recently contributed with the study of 2D-InSe and the improvement of its emission by nanotexturization of its surface [9]. In the present project we want to give experimental evidence of the stimulation of radiative decay (Purcell effect) of emitting nanomaterials integrated in HMM structures, being 2D semiconductors, mainly WSe_2 [10] and h-BN [11], the nanomaterials chosen for that purpose.

The PhD research project will be developed in UMDO group (see below contact details) at the University of Valencia. The main purpose in this PhD project will be the design and fabrication of HMM structures, followed by the subsequent integration of emitting materials (2D semiconductors), in order to demonstrate the enhancement of spontaneous emission due to 2D-exciton recombination or by localized excitons / levels, which lead to classical and quantum light emission, respectively. Classical light devices would lead to efficient lasers and quantum light devices will be the basis of future developments for quantum Telecommunications and Computing. These studies will be developed by the PhD student by using micro-photoluminescence techniques at low (and room) temperatures, including quantum interferometry experiments (Hanbury-Brown&Twiss). The coupling of the propagation modes in the HMM with the free space can be done by following several strategies, such as the use of diffraction gratings or optical waveguide structures fabricated on top of the HMMs. The PhD student will contribute also to theoretical modelling of HMM structures and interaction with emitters in order to explain experiments.

The PhD project have a duration of 3 years and the salary of PhD student will be of 22.192,80 € / year including National Health Insurance. The PhD student will be integrated the Program of PhD in Physics at the University of Valencia (www.uv.es/docfisica).

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