PhD position in optoelectronics:

Characterization of nanostructured thin films of ITO, GaN and TiO_2 in the terahertz domain

Large bandgap semiconductors, like ITO or TiO_2, exhibit smart optoelectronics properties that make them widely used, for example as transparent electrodes in optoelectronics display devices. They are also involved in other applications, such as photo-catalyzer in treatment of polluted water or air. Recently, nanostructured films of these materials have been employed to increase the efficiency of solar cells, light emitting diodes, and water depollution kinetic. For all these possible applications, the electrical properties of the layers, and more explicitly the dynamics of free carriers (electrons), have to be precisely measured and understood, regarding the fabrication process and therefore the microscopic structure and the composition of the material.

French National Research Agency (ANR) supports a 4-years project in which IMEP-LAHC in France and the National Tsing Hua University in Taiwan join their expertise and competences. Two kinds of application are targeted:

- with ITO (bandgap 3.7~3.9 eV) and GaN (3.4 eV), the interest lies in their excellent conductivity properties and transparency in view of potential applications in display, solar cells or components for the THz waves for the former. GaN and related materials are also key materials for optoelectronics and high-speed and high-power electronics.
- regarding TiO_2 (3.2 eV), the production of free carriers and their injection into water in contact will be studied, in view of understanding the processes involved in photo-assisted water catalysis.

Samples will be designed and fabricated in Taiwan, and then characterized by using different terahertz time domain spectroscopy (THz-TDS) techniques in France at IMEP-LAHC (Le Bourget du Lac). In a first step, all the samples will be measured on a very broadband THz-TDS system to determine their transmission and complex optical constants from 0.15 THz to 15 THz. In a second step, we will optically excite the semiconductors by pumping them near their bandgap energy (UV range) and monitor the evolution of their THz transmission. This UV pump-THz probe time-resolved spectroscopy technique will allow us to study the dynamics of photo-generated free carriers within a time-resolution of the order of few fs. Finally, in water catalysis, we will also investigate the sub-ps response of the selvedge water layer in contact with UV excited TiO_2 with an attenuated total reflection (ATR) THz-TDS system.

The PhD student will be in charge of building the experimental setup using amplified femtosecond laser and performing the experiments. Skills in optics, semi-conductors physics and optoelectronics, as well as a strong interest in applied research are expected. Visits at the Taiwanese partners are scheduled.

Contract duration: 36 months

Remuneration: 1600 euros (Tax free)

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