Master in Photonics – "PHOTONICS BCN"
Master ERASMUS Mundus "EuroPhotonics"

MASTER THESIS PROPOSAL

Starting full time from April 2025
Presentation at the end of July or beginning of September 2025

Laboratory: Catalan Photonics for Energy (ENFOCAT)
Institution: Universitat de Barcelona (UB)
City, Country: Barcelona, Catalonia, Spain

Title of the master thesis: 2D nanomaterials for advanced gas sensors at room-temperature.

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Keywords: 2D materials, Functional materials, Gas sensors, Green hydrogen, Heterostructures, In-situ/Operando analysis, Photoluminescence (PL).

Summary of the subject (maximum 1 page): Green hydrogen and ammonia are carbon-free fuel solutions for the future decarbonized energy systems. The currently existing, marketed gas sensors do not meet the sensitivity, selectivity, stability, affordability, miniaturized size, communication capability, and low-power consumption needed for their ubiquitous use in green ecosystems to realize the safe decarbonization of the economy. This project will investigate a novel surface engineering technology for gas sensing to overcome these limitations. By applying novel coatings, using atomic layer deposition and molecular layer deposition techniques to the surfaces of two-dimensional nanomaterials, we will enable protection against moisture aiming to enhance selectivity and stability of the gas sensors. This will allow the development of gas sensors with a fundamentally different operating principle than the present marketed technologies, constituting novel openings with substantial societal, scientific, and technological potential.

Objectives: This master's project proposes the processing and microstructural, optical and electrical characterization of 2D nanomaterials obtained by CVD method. Regarding characterizations, the samples will be used using different techniques, such as X-ray diffraction, Raman spectroscopy, electron microscopy (SEM, and HRTEM), and X-ray photoelectron spectroscopy. Regarding sensing properties, electrical measurements will be carried out in AC and DC mode using two a Keithley electrometer and a Solartron impedance meter. In these experiments, the samples will be exposed to different types of reducing and oxidizing gases in order to evaluate their selectivity. To study the effect of photoactivation, the samples will be irradiated with different wavelengths (UV and visible) using commercial LEDs. These results obtained by this technique will be complementary to the results of DC, providing useful information on the mechanisms involved in the sensing process.