

PhD position opening on the following topic:
Elaboration and study of physical properties of graphenic carbon nitrides nanostructures

Host laboratory 1: Institut de Chimie Moléculaire et des Matériaux d'Orsay (ICMMO), Saclay, France

Host laboratory 2: Institut d'Électronique, de Microélectronique et de Nanotechnologies (IEMN), Lille, France

Starting date: October 2026

Contract duration: 36 months

Keywords: organic chemistry, physical chemistry, surface science, scanning probe microscopy (SPM)

Context of the research project

The discovery of novel 2D materials with unique electronic band structures has generated significant interest in understanding how modifications in their morphology and elemental composition can influence their physical properties. A major objective in this field has been to develop alternatives to conventional top-down fabrication methods of tailored graphene-based structures, which originally exhibit semimetallic electronic properties. In this context, bottom-up approaches based on on-surface reactions of molecular precursors (e.g., via Ullmann coupling and cyclodehydrogenation) have proven to be highly efficient for the growth of nanostructured one- and two-dimensional graphenic architectures on metal surfaces with tunable electronic properties, ranging from semimetallic to semiconducting behavior. By the same time, advances in solution-phase molecular chemistry also made possible the synthesis of extended 2D conjugated networks.

Building on these advances, the proposed PhD project will focus on the synthesis of suitable molecular precursors, followed by the growth of porous 2D carbon nitride (C_xN_y) layers using two complementary approaches: traditional wet chemistry (i.e., the Fittig reaction) and UHV-based on-surface synthesis as described above. Particular emphasis will be placed on investigating the atomic structure, chemical composition, electronic and vibrational properties of the resulting CN-based materials, grown or drop-casted on different substrates.

Candidate profile

The candidate should have a strong interest in experimental work. Knowledge of organic chemistry, ultra-high vacuum (UHV) techniques and Scanning Probe Microscopy (SPM) would be clear advantages for this project.

One part of the study will be conducted in ultra-high vacuum (UHV) condition:

- ✓ Substrate's preparation and molecular precursors deposition on these surfaces by molecular beam epitaxy;
- ✓ Elaboration of graphene-based nanostructures via on-surface reaction of the precursors;
- ✓ Exploring their structures at atomic scale, chemical composition and electronic properties with scanning tunneling microscopy (STM), X-ray photoemission spectroscopy (XPS), scanning tunneling spectroscopy (STS).

The candidate will also be responsible for studies at ambient conditions:

- ✓ Synthesis of molecular precursors and their use for the growth of 2D CN-based layers, along with the characterization of both precursor and resulting materials using conventional techniques;
- ✓ Study of their vibrational and optical properties, along with evaluating their suitability for use as active layers in sensors and transistors.

The candidate should be able to work both independently and in a collaborative environment (i.e. interact with physicists, chemists and theoreticians). Good communication skills and knowledge of English are required since the candidate will participate in the dissemination of his/her research to the international community: publications in scientific journals, conferences, general public communication, etc.

Working environment

The project will be carried out jointly at the Institut de Chimie Moléculaire et des Matériaux d'Orsay (ICMMO, Saclay) and the Institut d'Électronique, de Microélectronique et de Nanotechnologies (IEMN, Villeneuve d'Ascq). It will involve several research groups, including the ECI group at ICMMO and the NCM/EIPHY groups at IEMN.

The candidate will have access to a chemistry laboratory at ICMMO equipped with all the necessary facilities for molecular synthesis and characterization. In addition, the project will benefit from the advanced infrastructure available at IEMN, including (i) a multi-physics characterization platform (PCMP) and (ii) a 1600 m² ISO6 cleanroom. In particular, the candidate will work within the Pôle Microscopie en Champ Proche (PCP), one of the core facilities of the PCMP platform. The PCP brings together state-of-the-art equipment dedicated to the

topographical, physical, and electrical analysis of surfaces, covering length scales from 100 μm down to the atomic level, including techniques such as STM, AFM, and KPFM.

To apply

Interested candidates are invited to send a CV, motivation letter and contact details of the referees to

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