

PhD Position Available: On-Surface Synthesis of Functional Graphene Nanomesh

- **Context :**
 - Host laboratory: [Institut Mat riaux Micro lectronique et Nanosciences de Provence \(IM2NP, UMR 7334 CNRS\)](#)
 - Research team: [Nanostructuration \(leader: Ch. Loppacher\)](#)
 - Host university: Aix-Marseille Universit , France
- **Funding:**
 - Beginning / Duration : September 2022 / 3 years
 - Gross salary : 90.756 k  for three years
- **Thesis directors:** Sylvain Clair (sylvain.clair@im2np.fr) and Luca Giovanelli

On-surface synthesis is a newly developing field of research that aims at making use of well-defined solid surfaces as confinement templates to initiate chemical reactions.⁽¹⁾ The concepts of supramolecular chemistry are here applied to provide well-defined functional surfaces from the “bottom-up” self-assembly of nanometer-sized elementary building-blocks. The interest for creating covalent nanoarchitectures directly on surfaces is manifold. On-surface synthesis gives access to original reactions mechanisms in mild conditions that would be not easily accessible in standard chemistry conditions. Also, it represents an efficient route to the formation of robust organic networks and 2D polymers. Finally, the full range of available surface science techniques can deliver exquisite characterization of the different reaction processes with atomic precision.

The aim of the project will be to use the on-surface synthesis approach to create graphene nanomesh covalent networks (see figure). They consist in a graphene monolayer exhibiting a periodic array of holes in its atomic lattice. The electronic properties of graphene are strongly affected by such modifications, in particular a sizeable bandgap can be opened. The structure of the nanomesh will be finely tuned thanks to the design of the molecular precursors used (shape and symmetry, presence of heteroatoms) and/or the growth conditions. The control of the electronic structure of graphene represents a key issue for future applications of this exceptional 2D material.

- (1) Clair, S.; De Oteyza, D. G. Controlling a Chemical Coupling Reaction on a Surface: Tools and Strategies for On-Surface Synthesis. [Chem. Rev. 2019, 119, 4717-4776.](#)

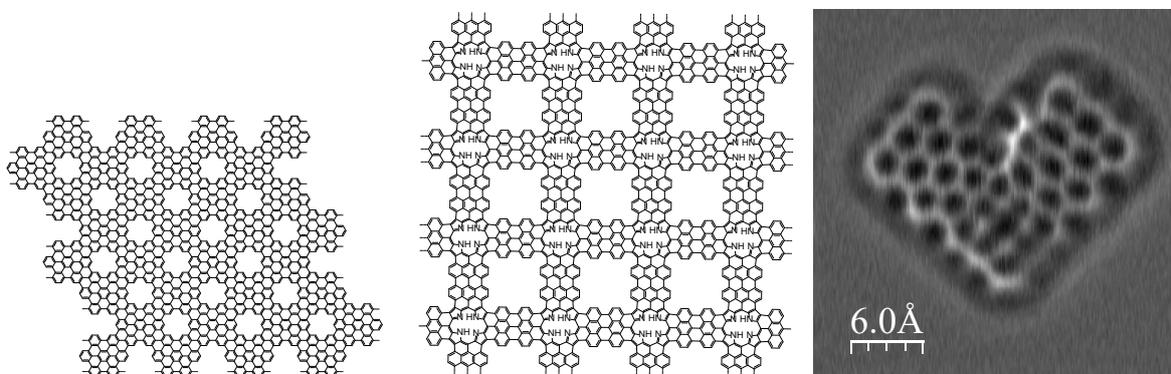


Figure : examples of graphene nanomeshes with a hexagonal (left) or square (middle) structure. Right: image of a precursor obtained in the laboratory with high resolution AFM at 9K.

The molecules will be deposited in ultrahigh vacuum (UHV) and characterized by high resolution scanning probe microscopy (STM/AFM) at low temperature (see figure), combined with spectroscopic measurements (ARPES/XPS/NEXAFS) performed at synchrotron radiation facilities.

The thesis will be carried in the Nanostructuration team at the Institut Matériaux Microélectronique et Nanosciences de Provence (IM2NP-UMR 7334) and in the framework of a collaborating ANR project involving CEA Saclay and ENS Paris-Saclay, France.

The candidate must have a good experience in material science and more specifically in surface science. Knowledge of the candidate in scanning probe microscopy, photoelectron spectroscopy and/or UHV technology will also be appreciated.

Keywords: Surface Science, Physical Chemistry, Scanning Probe Microscopy (STM/AFM), Photoemission spectroscopy, Synchrotron Light Source

Interested candidates are invited to send CV, motivation letter, diploma with transcripts and contact details of two referees to Sylvain Clair (sylvain.clair@im2np.fr).