Post-doctoral Fellowship : Intercalation of 2D materials

Where

Laboratoire Matériaux et Phénomène Quantique (MPQ CNRS UMR 7162) Paris (France). Laboratoire des Sciences des Procédés et des Matériaux (LSPM CNRS UPR 3407) Villetaneuse (France)

Funding

Funding by the Labex SEAM « Science and Engineering for Advanced Materials and devices » for 12 months 2022-23 (starting 09/22). The salary is commensurate with experience

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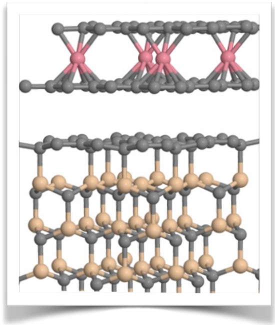
Key words

Spintronics, 2D materials, graphene, heterostructure, scanning tunnelling microscopy and spectroscopy, high resolution Raman, epitaxial growth, chemical vapour deposition.

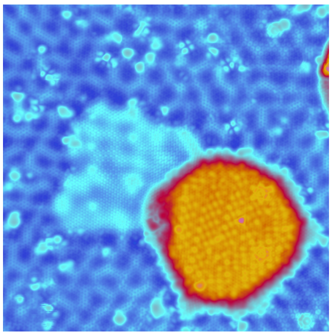
We look for

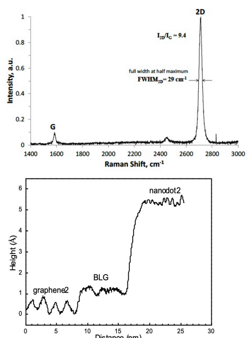
The candidate will hold a PhD diploma in nano-physics with strong skills in experimental research, knowledge of epitaxial growth such as MBE and ideally an experience in CVD, scanning tunnelling microscopy and/or Raman spectroscopy skills are a must, a solid background in surface physics is required.



Introduction and Context

The impact of foreign species intercalation on various properties of graphene is well known, but the intercalant itself can also exhibit unexpected properties induced by its confinement. Beyond the modulation of graphene properties in synergy with the intercalant, the creation of new 2D or 3D shapes in order to create new properties, requires the control of graphene growth and intercalation kinetics. Moreover, in the realm of spintronics and quantum technologies, the increase of the spin-orbit coupling of graphene by proximity effect with a heavy metal (such as gold) as well as the controlled injection of spin-polarised current by contact with a ferromagnetic element (such as cobalt), require a control of the objects formed at the scale of a few tens of nm. So, it is of tremendous interest to study the electronic, magnetic and optical properties of various configurations of this kind of materials. A silicon carbide wafer is the ideal platform to obtain the intercalation of atomic clusters under epitaxial graphene. For exemple, we have recently developed a new method to synthesise cobalt nanodots of low dimension intercalated below graphene on SiC. Interestingly, those dots are obtained on the Si face but on the C face only 3D islands are obtained. Thus, the substrate itself is the key parameter for varying the shape and the organisation of these confined structures, especially the so-called buffer layer.





Topics

The main objective of this project is the synthesis under ultra-high-vacuum environment and the study of hybrid systems Co/graphene, Au/graphene and Au-Co/graphene made on SiC(0001), allowing the control of the shape and the density of various configurations thanks to the monitoring of, on one side, the graphene defects density and, on the other side, the density of passivated Si dangling bonds below the buffer-layer.
The candidate will have to study the joint influences of various controllable parameters that drive intercalation. First of all, the density of defects (the entrance gates of the atoms) which will lead to a more or less important quantity of intercalated atoms. For that he will use Argon sputtering. The amount of defects will be measured initially by STM and then a more precise characterisation campaign of the type of defects can be envisaged using low temperature STM/STS measurements at MPQ (Paris), *i.e.* atomic structures and local density of states, as well as high resolution Raman spectroscopy at LSPM (Villetaneuse). The second parameter (actually twofold) is the annealing temperature and the temperature at which the deposition of the species to be intercalated takes place. In a first step, it will be post-evaporation annealing, *i.e.* from the clusters formed on the surface. Auger electron spectroscopy (AES) and X-ray photoemission spectroscopy (XPS) will be used to macroscopically quantify the quantity of post-synthesis intercalated atoms. The third parameter is related to the influence of Si-C bonds underlying the buffer layer structure. To this end, he will compare the growth patterns of intercalated nanodots in samples with and without a pre-existing buffer layer. (*i.e.* samples with one or two graphene layers). This last part will take place mainly at LSMP where a new inductive furnace will be installed and a dedicated CVD protocol will be optimised.

Experimental environment

The experimental environment is as follows. At MPQ, UHV chamber equipped with an ion gun, evaporators, LEED-Auger system and a VT-STM. At LSPM, interactions between 2D and ferromagnetic materials will be studied by the μBrillouin technique of inelastic light scattering. High resolution Raman spectrometry equipment with 5 Laser Kits [355nm, 473nm, 532nm, He Ne - 632.8 nm and 785nm] dedicated to Raman and photoluminescence spectra acquisition and mapping.

References

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