Laboratoire Matériaux et Phénomènes Quantiques

PhD thesis (+Master internship)

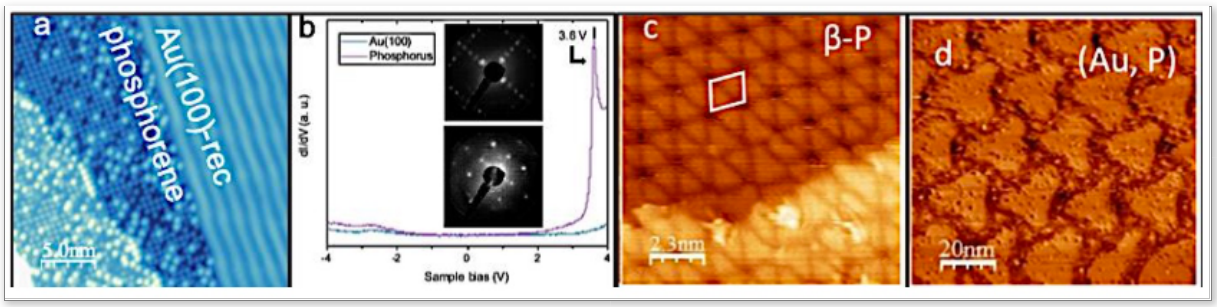
Phosphorene, growth and electronic properties

publié le 17 novembre 2022

Internship remuneration ? Yes
PhD thesis ? Yes
Grants : French National Research Agency (ANR project 2DPhostrainE)
Technic : STM and STM ; X-Ray diffraction ; ARPES and IPES
Qualities : experiments

Due of their high carrier mobility and a moderate band gap, black phosphorus thin films have attracted great interest in recent years for potential applications in several fields. Further theoretical predictions have also suggested that single layer of phosphorus atoms, called phosphorene, should have a very large number of possible two-dimensional (2D) allotropes. Each of them has modulable properties according on its atomic structure and the size or shape of low-dimensional phosphorene nanostructures. One of the most promising routes for epitaxial growth of new 2D-allotropes is to use take advantage of surface stresses induced by lattice mismatches with gold surfaces of different crystallographic orientations : Au (111), Au (100), Au (110). This strategy has already been successfully applied to stabilise new structures.

The goal of this internship + PhD proposal is to discover new phases, with innovative properties using a bottom-up strain engineering technique in order to master the formation of phosphorene 2D-allotropes. The originality of this proposal is to investigate even further the role played by the surface stress in gold sample using specifically their vicinal variants. A significant part of the master thesis will be dedicated to the preparation of the substrate surfaces and the subsequent deposition by thermal evaporation in a dedicated UHV chamber. The characterisation of the morphology and crystal structure will be achieved by room temperature scanning tunnelling microscopy (STM), LEED/Auger Electron Spectroscopy (AES) and Grazing Incidence X-Ray Diffraction (SOLEIL). Depending on the results obtained by the student, the electronic properties of this new materials will be investigated using low temperature (4 K) measurements by scanning tunnelling spectroscopy (STS). Moreover, a collaboration with the CEA and the LPS/Orsay will allow to study the electronic properties (XPS-ARPES, DFT) and the stability (DFT) of these 2D systems.



a) STM - Low coverage of P on Au (100) in p(2x2) on two Au terraces (left side). b) Scanning tunnelling Spectroscopy on Au (blue) and P/Au (red) dI/dV spectrum presents a peak in the empty states. Inset : Low Energy Electron Diffraction pictures of the Au (100)-rec and the low P coverage structure p(2x2). c) STM - Two β-P terraces and the (4x4)-P relaxed supercell commensurate with a (5x5)-Au. d) STM - (Au, P) alloy on an Au (111) terrace at low P coverage.

Voir en ligne : mailto:Yann GIRARD<yann.girard@u...

Post-scriptum :

PhD director : Yann GIRARD
Phone : (+33)1 57 27 62 99
e-mail : yann.girard@u-paris.fr