Postdoc position at LPEM-ESPCI Paris, PSL Research University

Electronic properties of strained antimonene and graphene/antimonene heterostructures

In the framework of a research project funded by the French ANR (Agence Nationale de la Recherche) the LPEM Laboratory of the ESPCI-Paris (UMR 8213) is seeking candidates for a postdoc position for two years in the field of electronic properties of novel 2D materials.

Since the isolation of graphene(Gr) in 2004, the research on 2D materials is experiencing an extraordinary rise [1]. Such materials, composed by single or few atomic layers, often display different physical properties with respect their bulk counterpart. Furthermore, their properties can be tuned by strain, by changing the number of atomic layers or by their mutual interaction with different 2D materials [1]. From an experimental point of view, two are the main objectives that drives this scientific field: *(1)* the **fabrication and characterization of novel 2D materials** which shows complementary properties to graphene (Gr) [2] and *(2)* the vertical stacking of different 2D crystals to form the so-called **van der Walls heterostructures** with the desired properties [1]. Recently, the isolation of phosphorene, a 2D allotrope of black phosphorous [3], has open the way to the study of others single layers of group 15 elements such as bismuthene and antimonene. Considering the electronic properties, **antimonene** is quite unique among 2D crystals due to its **strong spin-orbit interaction**, which can be responsible for topological properties of matter [4]. In fact, antimonene is a trivial semiconductor which can be tuned to a 2D topological insulator by strain [5]. In the perspective of using antimonene in van der Walls heterostructure a very interesting combination is **Antimonene-group14 heterostructures** (such as antimonene/Gr, antimonene/silicene etc..). In these systems, the typical Dirac like features of group 14 and the semiconducting properties of antimonene are preserved and can be manipulated by strain or by the interlayer distance [5].

The objectives of this project are located at the edge of this exciting research field. **We will first investigate the electronic band structure of antimonene under tensile strain**. Recent experiments have shown that antimonene can be prepared on single crystal metal surfaces and its strain depends on the substrate lattice. By using different substrates, we will therefore be able to tune the antimonene lattice constant and probe experimentally the existence of the predicted band inversion which should leads to a topological phase. The second objective is far more challenging. **We will produce and address the electronic band structure of a Gr/antimonene van der Waals heterostructure** where the antimonene layer is subjected to tensile strain. We will study specifically the possible transfer of spin-orbit coupling and topological protection from the antimonene to the well-known electronic properties of Gr.

The sample will be fabricated in ultra-high vacuum (UHV) environment to ensure the best possible quality of the different interfaces. The structural characterization will be performed by means of scanning tunneling microscopy (STM) and low energy electron diffraction (LEED). The resolution of the system band structure will be achieved by angle resolved photoemission electron spectroscopy (ARPES).
Our research team is composed of specialists in the study of electronic properties of surfaces and interfaces, superconductivity, self-organized growth of nanostructures in UHV, magnetism and spin-orbit interactions at surfaces. For our research activity, we develop and operate high performance scientific apparatuses working under ultrahigh vacuum, all connected to MBE cluster.

We are looking for a highly motivated postdoc with a PhD degree in condensed matter physics, material science or related discipline. The position requires good autonomy, a strong knowledge of ultra-high vacuum environment, and sample preparation by molecular beam epitaxy.
The position is founded for 2 years. The foreseen starting date is January 1st 2022 or later. Net salary before taxes 2834€/month.

Applications: mailto:sergio.vlaic@espci.fr

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[3] A. Castellanos-Gomez, *J. Phys. Chem. Lett.*, **6**, 4873 (2015).
[4] L. Fu *et al., Phys. Rev. B* **76**, 045302 (2007).
[5] P. Ares *et al., Adv. Mater.* **30**, 1703771 (2018). Y. Wang *et al., Phys. Chem. Chem. Phys.* **17**, 27769 (2015).