Project S4. Synthesis and electronic structure of one-atom-thick hexagonal boron nitride on curved crystals: toward boron nitride nanostripes

Contact person: **Frederick Schiller** (frederikmichael.schiller@ehu.eus)

Two-dimensional and one-dimensional materials are attracting strong interest due to their promising electronic, magnetic, or mechanical properties. Among them the heavily investigated graphene, a material that was once supposed to replace silicon in device fabrication. Graphene devices have been realized in certain applications (Sensoring, Biomedicine), but it cannot be used in electronics because it lacks a semiconducting band gap. Hexagonal boron nitride (hBN) is the isostructural semiconducting counterpart of graphene, and hence of fundamental importance in the development of nanolectronics applications. Yet the synthesis and electronic characterization of 2D hBN monolayers and 1D nanostructures, such as nanostripes, is poorly developed, requiring intensive search of appropriate growth substrates and fine characterization using surface science techniques. Our group has recently demonstrated that hBN can be grown on curved Ni and Rh crystals, leading to homogenous coating and one-dimensional nanostripe arrangement. The candidate will focus on the exploration of the structure and the electronic properties of such hBN nanostructures, using Scanning Tunneling Microscopy, Low-Energy Electron-Diffraction and Angle-Resolved Photoemission in our laboratory, as well as X-ray absorption and core-level photoemission in European Synchrotron radiation facilities.

Project S13. Bringing functional molecular systems onto non-metallic surfaces

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We are looking for highly motivated candidates, physicists or chemists, with a background in solid state physics, surface science or physical chemistry to take up an experimental PhD position in the area of functional molecular carbon-based nanomaterials. In this challenging PhD project, several strategies will be explored to bring graphenic nanoscale materials onto non-metallic surfaces under ultra-high vacuum (UHV) conditions. The study of their structural and electronic properties will be done with surface sensitive characterization tools such as scanning tunneling microscopy/spectroscopy (STM/STS) and X-ray photoelectron spectroscopy (XPS). Specific graphenic nanoscale materials can be grown with atomic precision on metallic surfaces by means of on-surface synthesis. Nevertheless, the use of such materials as functional units in various technological applications as spintronics or optoelectroncis, requires non-metallic substrates as their support. In this PhD project both the direct synthesis on non-metallic substrates as well as transfer by atomic layer injection will be explored focusing on the study of the yet unexplored properties of nanographenes-transition metals dichalcogenides heterostrucutres and photopolymerisation on oxides. The successful candidate will be integrated in a multidisciplinary national collaborative project and in the international working environment of the NanoPhysics Laboratory.

Project S17. Exploring Superconductor/Ferromagnetic Interfaces in quantum applications

Contact person: **Celia Rogero** (celia.rogero@csic.es)

We are looking for highly motivated PhD students with background in solid state physics, superconductivity and magnetism to work in the framework of a multidisciplinary European Collaborative Project. Daily work will be conducted at NanoPhysics Laboratory, with frequent visits to synchrotron installations as well as to Nanogune. We propose a challenging experimental PhD project, which endeavours to delve into the knowledge of certain quantum technological areas, in particular, those that arise from the coupling between a ferromagnetic insulator (FI) and a superconductor (S). The exchange field at the FI/S interface that leads to the splitting of the superconducting density of states can be exploited in applications such as thermoelectricity, superconducting spintronics, radiation sensors, quantum phase batteries, or non-volatile memory element. In this project, we will correlate the coexistence of this exchange splitting in S/FI structures with the layer-by-layer growth conditions, the interface quality and the use of conventional and novel materials. This fundamental study will combine the most atomically precise growth techniques with the most sophisticated, structural, spectroscopic, magnetic characterization techniques operating under ultra-high vacuum (UHV) conditions, such as low temperature scanning tunneling microscopy and spectroscopy (STM, STS), or X- ray photoemission and Magnetic Dichroism spectroscopy (XPS, XMCD).

Project S18. Understanding catalytic reactions in-operando at the atomic scale: curved surfaces at ambient pressure

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Catalysis is extremely important in industrial processes with notorious relation with energy and environmental problems. However, the most relevant catalytic reactions are still optimized following a trial-and-error philosophy. Further improvement requires a rational atomic-scale understanding through new sample designs and techniques that can bridge the gap with real catalyst materials. In a bid to model industrial nanoparticles in-operando, our Lab investigates curved metal surfaces exposed to millibar pressures of reactants, using novel atom-sensitive techniques that operate under such ambient-pressure conditions, such as X-ray photoemission. The candidate will focus on the exploration of the structure and electronic properties of curved crystal surfaces, and their interaction with chemically active gases, such as CO, O2 and CO2, using Scanning Tunneling Microscopy and X-ray Photoemission in our laboratory. This work will be combined with Ambient Pressure X-ray photoemission experiments performed in Synchrotron Radiation facilities over the world to examine the interaction of millibar mixtures of reactants and products with such curved surfaces.