Doctoral Training Programme in Functional Advanced Materials (DOC-FAM)

DocFam+ (DOCtoral training programme in Functional Advanced Materials: Towards a Better Future) is a new doctoral programme for the recruitment of 26 excellent doctoral researchers led by the Institute of Materials Science of Barcelona (ICMAB-CSIC).

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Job Title: PhD Student - Engineering quantum properties of 2D materials by 1D and 2D superlattices

Description of the project/group:

Since the rise of graphene, the field of 2D materials has rapidly evolved, with the discovery of over 200 different materials bringing semiconductivity, magnetism, superconductivity, or non-trivial topology to the portfolio of functionalities. An efficient and tunable way of engineering these properties is by proximity effects with other materials. This strategy, which relies on interfacial interactions, can effectively induce, for instance, superconductivity, magnetism or spin-orbit interaction.

This project seeks to exploit proximity effects to manipulate the quantum properties of isotropic 2D materials by introducing periodic anisotropic potentials through their integration with various types of nanoscale 1D and 2D superlattices in vertical stacks. The resulting heterostructure is expected to behave as an excitonic superlattice that can be conceived as an interacting array of single quantum emitters, or turn the otherwise isotropic layer into a tunable anisotropic material for electronic, spin and thermal transport.

The project will comprehend the synthesis of 1D and 2D superlattices, fabrication of heterostructures, atomic scale characterization of the emerging properties, and correlation of the latter with macroscopic observables in devices.

Principal responsibilities:
The student will fabricate the samples by the bottom-up growth of different type of superlattices, and the transfer of monolayer thick flakes of the 2D material under investigation on top of the superlattice. The characterization of the structural, electronic, and optical properties of these heterostructures will be carried out by combining scanning tunnelling microscopy (STM), scanning tunnelling luminescence (STML), tip-enhanced photoluminescence (TEPL), with (micro) angle-resolved photoelectron spectroscopy (μ-ARPES), and photoemission electron microscopy (PEEM). Correlative measurements will be carried out in the same heterostructure by the integration of all these techniques in a collaborative project with ALBA synchrotron, where Prof. Mugarza coordinates the SPM platform that will include a state-of art STM equipped with time-resolved photon spectroscopies. The student will be responsible of designing and carrying out experiments, analyzing data and reporting. She/he will also be participating in the common activities of both groups, such as group meetings or journal clubs.

Education:

- Bachelor level background in physics, nanoscience, materials science or engineering.

Experience:

- Background in condensed matter, physics at the nanoscale, low dimensional materials.
- Experience in scanning probe microscopy and spectroscopy, and/or electronic nanodevices is highly valued.

Competences:

- Demonstrated skills in experimental condensed matter physics.
- Proficiency in English and demonstrated skills in oral and written communication.

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