PROBIST: BIST POSTDOCTORAL FELLOWSHIP PROGRAMME

PROBIST is a post-doctoral fellowship Programme led by the Barcelona Institute of Science and Technology. Altogether, 61 fellowships will be awarded and implemented in top research in the Barcelona and Tarragona area (Spain).

BIST brings closer together seven independent Catalan internationally recognized research centres.

PROBIST applicants will have complete research freedom. Applicants may subscribe to one or several generic research topics published with the calls. Once pre-selected they may design their research project proposal with a research group of their choice in the participating BIST centres. Successful candidates will be hosted by the selected research group. They will have full access to facilities, seminars and training programmes of the BIST centres. Networking activities shall facilitate inter-centre and inter-disciplinary exchange and collaborations. PROBIST will offer fellows the opportunity to opt for secondments from a pool of international institutions with which BIST centres have institutional agreements or collaborations.

ICN2 has 6 topics in this PROBIST Call:

ICN2_C3_01: Phononic and Photonic Nanostructures

Group Leader: Clivia Sotomayor
Keywords: Optomechanics, Topology, Emitters, Disorder

Description: The coupling of electromagnetic radiation (photons) to mechanical waves (phonons) is at the heart of solid-state quantum photonics while phonon transport at different frequencies governs crucial physical phenomena ranging from thermal conductivity to the sensitivity of nano-electromechanical resonators. To engineer and control the overlap of light management with the mechanical vibrations of matter efficiently, we make use of very precisely fabricated nanometer-scale devices. The standard way of achieving this control is to use engineered defects in periodic structures - optomechanical crystals - where the electromagnetic field and the mechanical displacement can be confined simultaneously thus enhancing their interaction.

During this project, we will explore novel designs for optomechanical nanostructures and we will measure their mechanical and photonic properties in the lab. We will make use of ultrafast pump and probe techniques to explore the mechanical vibrations. In addition, the structures will contain active light-emitting materials which will allow us to get access to the photonic properties of the system. Our goals are:

1. Explore novel designs for optomechanical structures.
2. Measure the effect of the mechanical modes in the light-emission properties of these materials.
3. Measure the effect of the photonic modes in the lifetimes of the mechanical resonances.
4. Explore designs to obtain topological protection based on these novel structures. topological effects of these novel designs.
5. Measure topologically protected phononic and photonic modes in these structures

ICN2_C3_02: Nanobioelectronic and bioanalytical applications and Supramolecular NanoChemistry and Materials

Group Leaders: Laura M. Lechuga and Daniel Maspoch
Keywords: Photonic sensors, MOFs, gas/pollutant sensing, multiplexing sensing

Description: Development of photonic sensors using Metal-Organic Frameworks for Environmental monitoring.

This project proposes a complete new direction for solving the unmet need of high sensitivity synthetic sensors. The new sensor will combine MOFs synthetized with the right functionality and morphology to act as specific receptor and photonic transducers specially designed to include the MOFs receptor while affording a high level of sensitivity. This novel phenomena combination will allow detecting small molecules for environmental monitoring. The first application will be in the environmental field for in-situ detection of air and water pollutants.

ICN2_C3_03: Theory and Simulation Group

Group Leader: Pablo Ordejon
Keywords: First-principles simulations, quantum transport, spintronics, nanoelectronics, magnetism, thermal properties, topological materials, heterostructures, interfaces, nanomaterials, computational material design.

Description: Developments and applications of First-Principles methodologies for the investigation of electronic, magnetic, thermal and transport properties of materials at the nanoscale. Deployment of automatization and high-throughput protocols based on the SIESTA package. Development of analysis tools and workflows for computational materials design.

ICN2_C3_04: Physics and Engineering of Nanodevices (PEND)

Group Leader: Sergio O. Valenzuela
Keywords: Topological Insulators, Spintronics, Quantum Anomalous Hall effect, Two-dimensional materials and heterostructures, MBE growth, graphene, transition metal dichalcogenides

Description: Two-dimensional materials (2DM), such as graphene, are gaining relevance in the field of spintronics and metrology. In particular, they are emerging as viable alternatives to achieve the quantum anomalous Hall effect (QAHE) at higher temperatures than those observed with magnetically-doped three-dimensional topological insulators (Tis), and bring the concepts closer to applications. For this to be possible, large spin-orbit interaction (SOI) and magnetic correlations are necessary. These properties, which are absent in pristine graphene, can be imprinted onto it by close interaction with suitable materials. At PEND, we aim at establishing novel approaches for the implementation of nanodevices based on graphene, TIs and other 2DMs, from material deposition e.g. by MBE), to device design and fabrication. Spin-orbit and magnetic proximity effects will be investigated using insulating materials (possibly 2DMs) and deposition of metal atoms/clusters. The developed technology will have significant impact in metrology. The control of spin-orbit interaction and magnetism in graphene will also impact the field of spintronics, by enabling new routes for spin manipulation with great potential in low power electronics.

ICN2_C3_05: Theoretical and Computational Nanoscience Group

Group Leader: Stephan Roche
Keywords: Spin torque physics, advanced memory MRAM generation simulation, topological insulators, theory, quantum simulation, ab-initio and tight binding modelling

Description: The theoretical project will be focused on the modelling design of the next generation enhanced Spin-Orbit Torque (SOT) memory devices, including the search for suitable materials (topological insulators) with higher spin charge conversion efficiency and the analysis of the dominating mechanism to trigger the magnetisation switching. An accurate description of the material will be performed using density functional theory while the study of spin dynamics will be achieved with a non-equilibrium Green's function formalism. The main objective of the project is to create a bridge between these two branches and produce a very powerful tool to study the crucial as well as subtle transport features of real materials and thus will be instrumental to reveal underlying interactions. One main advantage of this approach is here we can study the intrinsic contribution of SOT which plays a major role in the spin Hall effect (SHE) driven torque. Recently it has been found that sputtered Bi2Se3 7 can be an efficient source of SOT, however there is not theoretical model available to study such structural nonuniformity. Here the work will provide a perfect platform to study such systems.

ICN2_C3_06: Nanobioelectronics & Biosensors Group

Group Leader: Arben Merkoçi
Keywords: Nanobiosensors; nanomaterials; nanoparticles; 2D materials; diagnostics; paper-based sensors

Description: Nanobiosensors area has increased significantly, especially in diagnostics, since it has been shown that an early diagnosis can change dramatically the development of a disease. In particular, in the third world the availability of biosensors for the most common diseases could save many lives. Unfortunately, the cost of biosensors and the lack of equipped centers and trained people are probably the hardest obstacles to the diffusion of adequate biosensors in these regions. Nanomaterials (ex. nanoparticles, 2D materials) are bringing important advantages in the design of novel biosensing systems or improvements of the existing devices. Nanomaterial application for DNA, proteins and even cells are showing a great potential in enhancing biosensor sensitivity, stability and in general improvement of such devices. Coupling of nanomaterials-based detection technologies with paper/plastic-based microfluidics is of great interest to develop cost-effective diagnostics devices.

APPLICATIONS PROCEDURE:

All the applications have to be done via the PROBIST website: http://bist.eu/probist/