IN²UB_Proposals

Title of the project: Optoelectronic properties of ZnO-based light-emitting devices
Name of the Group: *Group of Optoelectronics and Photonics (Faculty of Physics)*

Short description of the project: Light emitting devices will be design, fabricated and characterized during the execution of the Master thesis. Oxide semiconductors compatible with silicon technology will be employed as active material, such as SiO2 or ZnO alloyed with nitrogen. The inclusion of rare ions will be also considered as optically active centers. Electroluminescence emission, quantum efficiency and modulation properties of the devices will be studied and modeled. PhD studies are possible after the master thesis.

Contact persons:
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Title of the project: Electrical study of the resistive switching properties of metal oxide (ZnO-based) compounds
Name of the Group: *Group of Optoelectronics and Photonics (Faculty of Physics)*

Short description of the project: Materials based on silicon and transition metal oxides will be employed for fabricating resistive switching devices (memristors), using a simple metal-oxide-semiconductor (MOS) configuration. The electrical I(V) curves of the devices will be studied by applying a voltage on the top electrode while grounding the bottom contact, sweeping it from negative to positive voltages. The charge transport mechanisms will also be analyzed for the different resistance states (pristine, high resistance and low resistance states), with the aim of obtaining information regarding the mechanism that drives the resistive switching process. PhD studies are possible after the master thesis.
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Topic: Preparation and study of multifunctional molecules for spintronics
Name of the Group: *Grup de Magnetisme i Molècules Funcionals (GMMF) (Faculty of Chemistry)*
http://www.gmmf-ub.com/
Contact person: Dr. Guillem Aromí (aromi@ub.edu)

Title of the project: Study of 3D neuronal cultures alteration by Amyloid-magnetite complex for a better understanding of Alzheimer disease
Name of the group: *Unitat Bioelectrònica del Laboratori de Nanobioengenieria (www.ibecbarcelona.eu)*

Description of the project: Abnormal accumulation of iron in the brain has been observed in Alzheimer's disease (AD), Parkinson's disease, Huntington's disease, and multiple sclerosis. In AD, the binding of iron to monomers, oligomers, or fibrils of amyloid β peptide (Aβ), the main component of the characteristic extracellular plaques formed in the brain, has been proposed as a mechanism that stabilizes $Fe2^+$ and $Fe3^+$ ions and favors the formation of free radicals that could provoke the death of neurons by apoptosis.
Our research group has focused some effort in reveling the association of magnetite nanoparticles and Aβ in vitro, the properties and size of the magnetite nanoparticles formed in the presence of Aβ [and the higher toxicity of magnetite-Aβ complex tested in 2D neuronal cultures. But we want to go a step beyond and study neuronal toxicity of this complex in 3D cultures. 3D cultures bring more adequate representations of cell environment and permits cells to grow and interact in all directions, similar to how they would in vivo. This improved cell contacts with their environment let to achieve more realistic cell-cell and cell-matrix interactions, complex transport dynamics, cell migration, differentiation and survival.

Task. 1. Thioflavin test to monitor the Aβ fibrils structure under different concentrations of $Fe2^+$ and $Fe3^+$ ions
Task. 2. 3D-neuronal cultures fabrication in collaboration with a group expert in this field.
Task. 3. Toxicity test of neuronal cells under different concentration/Aβ fibrillation
Task 4. Different type of immune staining to determine the type of cells affected by the magnetite- Aβ complex.

Requirements;
It is recommended that the applicant has a background in biotechnology or biology, good English skills, strong initiative and curiosity, skillful and good team worker

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Title of the project: Therapeutic Applications of Stimulus Triggered Delivery Systems

Name of the group: *Resposta Cel·lular als Xenobiòtics (CEREX) (Faculty of Pharmacy and Food Sciences)*

Description of the project: The procedure by which a drug is administered has a significant effect on its therapeutic efficacy. Some drugs present an optimum concentration range within maximum benefit, and concentrations above or below this range may be toxic or produce no therapeutic benefit.
In order to minimize the degradation of the drug and its loss of efficiency, our research group develops nanoparticle systems for the encapsulation and controlled release of molecules of therapeutic interest. Among other strategies, these systems are designed based on their response to endogenous stimuli to facilitate the controlled release of the drug. Encapsulated molecules include nucleic acids, proteins and antitumor drugs, among others.
During the development of these systems it is essential to increase their stability in the biological environment, transport, directionalization and interaction with biological barriers. The evaluation of the biocompatibility and cytotoxicity of the nanoparticles systems is key in the modulation of pathophysiological processes.

Contact person: Dr. M. Carmen Morán Badenas (mcmoranb@ub.edu)

Title of the project: Iron oxide nanoparticles for targeted cancer therapy

Name of the groups: *Grup de Magnetisme i Molècules Funcionals (Faculty of Pharmacy and Food Sciences)* *http://www.gmmf-ub.com* & *Grup de Terapia anticancerosa, Immunomodulació i Nutrigenòmica (Faculty of Pharmacy and Food Sciences)* *http://www.ub.edu/terapiamol/cancer/*

Description of the project:

Iron oxide nanoparticles (NPs) can be readily prepared by well-known methods as monodisperse, crystalline nanoparticles. By controlling the conditions, the major phase in these nanoparticles is the magnetic oxide magnetite, Fe_3O_4. The properties of iron oxide NPs make them excellent candidates for medical applications: Fe is an essential element and iron oxides can be readily metabolized or assimilated by the organism, thus iron oxide NPs lack the toxicity often related to heavy metals. The fact that they are magnetic can be exploited for targeting specific sites in the organism using a magnetic field that is not harmful.

Cancer therapy with PPRH hairpins. PolyPurine Reverse Hoogsteen hairpins are a new kind of gene silencing molecules developed in our laboratory. They consist of two strands of DNA linked by 5 thymidines. Each strand of that DNA is formed by polypurines and bind to each other by Hoogsteen bonds. These hairpins bind to polypyrimidine tracks present in the genomic DNA inhibiting transcription and splicing thus causing a decrease in gene expression. Therefore, this genomic tool can be used to decrease the expression of genes that are overexpressed in certain diseases, such as cancer.

In this project you will work in a multidisciplinary environment. The main goal is a preliminary study of the functionalization of iron oxide NPs with a PPRH hairpin in order to obtain hybrid nanoobjects suitable for delivering the hairpin to the target. The final aim is to be able to deliver therapeutic molecules such as PPRHs using Iron oxide NPs for efficient targeted cancer therapy.

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Title or schematic description of the project: Exploring the deconstruction and modification of cellulosic materials by enzymatic assisted interactions. The proyect involve the study of cellulases and Lytic polysaccharide monooxygenases in cellulosic materials, to oxidize and functionalize sustainable materials.

Name of the group: Microbial Enzymes for Industrial and Environmental Applications (http://www.ub.edu/enzimsmicrobians/) *(Faculty of Biology)*

Contact persons: Dr. Francisco I. J. Pastor, fpastor@ub.edu; Dr. Susana V. Valenzuela, susanavalenzuela@ub.edu

Title: Water-soluble gold nanoparticles for the efficient delivery of DNA in cancer gene therapy

Name of the group: Supramolecular Systems in Nanobiomedicine *(Faculty of Pharmacy and Food Sciences)*

Description of the project: In this project, small, water-soluble GNP will be synthesized and functionalized with appropriate cationic chemical entities that could work as binders of DNA Polypurine Reverse Hoogsteen hairpins (PPRHs), a novel, effective, and stable approach for gene therapy. The functionalized GNP and their complexes with will be characterized using different techniques (UV-VIS spectroscopy, TEM, SEM, DLS, etc.) and cytotoxicity studies of the suitable GNP and their complexes with PPRH will be performed in various kinds of cancer cells for evaluating their therapeutic efficacy.

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Title of the project: Design and characterization in optical cavities and optomechanical structures

Name of the Group: *Group of Optoelectronics and Photonics (Faculty of Physics)*

Short description of the project: Rare earth-doped glass spherical micro- and nanosphere resonators are structures that show special resonant modes called whispering gallery modes (WGM), which can be used in optical pumping to achieve lasing. On the other hand, optomechanical coupling is taking advantage of the momentum carried by photons to force mechanical motion to an object. In this proposal, optical cavities integrated with silicon technology will be designed, fabricated and tested, in order to understand and exploit the interaction between light in optical cavities and mechanical structures, at the micro- and at the nano-scales.
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Title of the project: Simulation of photonic crystals based on silicon nanopillars

Name of the Group: *MIND - Nanosystems, Dept. of Electronic and Biomedical Engineering (Faculty of Physics)*

Short description of the project: The periodic layouts of dielectric nanostructures can lead to the material behaving as a photonic crystal. Among the possible layout distributions, in this work we propose studying periodic hexagonal structures of silicon nanopillars, simulating the structure by introducing defects and/or other photonic elements (such as resonator rings, wave guides, etc.) and finally , the deformations of the pillars upon the application of external forces.

Contact persons: Elena Lopez-Aymerich, Dr. Albert Romano-Rodriguez (romano@el.ub.es)

Title of the project: Development and test of gas nanosensors of gas based on semiconducting oxides

Name of the Group: *MIND - Nanosystems, Dept. of Electronic and Biomedical Engineering (Faculty of Physics)*

Short description of the project: The actual society generates high gas emissions that can be harmful both to health and environment. This fact fosters the development of gas sensors that allow monitoring these emissions with the aim of their control. In this work, we propose to manufacture and study the response of gas nanosensors based on nanostructured metal oxides. The student will participate in the manufacturing and characterization of both materials and devices, as well as the study of the response to some gases of interest in health and environment, such as CO and NO2.

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