Title of the project Inorganic nanomaterials for biotechnology and medicine

Description of the project My laboratory (inLAB – inorganic nanochemistry laboratory) at the Department of Chemistry has a 20 years experience in the synthesis, characterization and application of inorganic nanoparticles, ranging from noble metals (gold, silver), to inorganic oxides (iron oxides, silica oxides), to coordination polymers (Prussian Blue), with a particular focus on tuning the dimensions, the shape and the coating of the studied NPs. As regards the bio and nanomedicine area, we worked on antibacterial inorganic nanoparticles and inorganic nanostructured materials, on photothermal inorganic nanoparticles, on inorganic nanoparticles for the delivery of drugs, and on the interactions of inorganic nanoparticles with in-vivo-like environments, with a particular attention to their stability as a function of a protein-corona formation. In this context, traineeship projects are available on:
1) protein corona formation on Prussian Blue NPs (with particular reference to the iron-containing proteins ferritin and transferrin), study of the stability in in-vivo-like conditions of the protein-coated PB-NPs (eg agglomeration, decomposition, protein exchange with albumin), loading of the protein-coated PB-NPs with hydrophobic antitumoral drugs
2) SiO_2 (silica) monoliths with embedded silver nanoparticles; these are macroscopic objects (1-2 cm) that contain AgNPs that are sealed inside the SiO_2 matrix. While this avoids the AgNPs release to the environment, the embedded AgNPs slowly oxidize and release the antimicrobial Ag^+ cations from the SiO_2 pores, working as a disinfectant for surface waters, active against a wide range of bacteria, viruses, fungi.
3) calcium phospate, i.e. $Ca_3(PO_4)_2$, nanoparticles (CP-nps) doped with silver. The preparative conditions will be tuned so to tune the CP-nps dimensions and the quantity of Ag contained; their stability and Ag^+ release capacity will be studied in in-vivo-like contitions.
For all projects the training student will use and learn a full set of synthetic and characterization techniques that are fundamental in nanotechnology, such as dimensionally controlled synthesis, seed-growth processes, SEM and TEM imaging, Dynamic Light Scattering, zeta-potential determination, UV-Vis-NIR absorption spectroscopy, ThermoGravimetric Analysis, Inductively Coupled Plasma analysis for trace elements, XRD, SEM-EDX.

Aim of the project. Project 1: obtain stable, protein coated PB-NPs, that can be used for a coupled photothermal and chemical antitumoral or antibacterial activity. Project 2: prepare materials that can be actually used in real life as on-demand disinfectant for emergency surface water disinfection. Project 3: obtain bone-substitute materials that are also self-disinfectant, that can be used eg in dental reparation.

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