Master Nanochemistry

Internship subject

Design of antibacterial substituted hydroxyapatite coatings for biomedical applications using the electrostatic spray deposition technique

Confidential subject: No

Subject open to M2: Yes **to M1-RIT:** No **to M1-RIT:** No **Subject adapted to LabTraining:** No

Summary

Replacement of missing or diseased hard tissues has become a common procedure in medicine and dentistry. In this field, coatings are frequently applied onto the surface of metallic implants, such as titanium and titanium alloys in order to improve their biological performance. Calcium phosphate (CaP) family, has been chosen as a synthetic material for this purpose due to its bioactivity and osteoconductivity properties [1]. In addition, one of the major constituents of bone is a CaP whose structure closely resembles hydroxyapatite (HAp), $Ca_{10}(PO_4)_6(OH)_2$. This biological apatite is poorly crystallized, non-stoichiometric with multiple cationic and anionic substitutions [2].

Although using HAp improves the biological response to the implant there are still several limitations to use pure HAp as a coating material, including a lack of antibacterial activity and of long term stability, that may and cause implant failures. There is a significant need for solutions that can fight infection locally and over time. An approach could be the use of multifunctional biomaterials associating inherent therapeutic and anti-microbial abilities. In recent years, the incorporation of inorganic antibacterial cations into HAp structure, has been proposed [3]. This strategy may represent a smart tool to improve clinical outcomes while providing locally-targeted inhibition of infectious processes.

In this respect, this project aims to develop and characterize doped hydroxyapatite coatings of optimized architectures, compositions, and structures by using the Electrostatic Spray Deposition technique (ESD) on biomedical grade titanium substrate.

The Master student will work in two laboratories, LEPMI (Grenoble INP) and MATEIS (INSA Lyon) through an ANR project related to DEFI 4 (Life, Health and Welfare). He or she will have to closely collaborate with a large team, and especially with a Ph.D. student currently working on the project. This is a 6-months internship mainly localised in Grenoble (St Martin d'Hères Campus), the biological assessments will be conducted in Lyon.

Related Publications

[1] De Groot, K., Wolke, J. G. C., & Jansen, J. A. (1998). Calcium phosphate coatings for medical implants. *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine*, *212*(2), 137-147.
[2] Oonishi, H. (1991). Orthopaedic applications of hydroxyapatite. *Biomaterials*, *12*(2), 171-178.
[3] Heidenau, F., Mittelmeier, W., Detsch, R., Haenle, M., Stenzel, F., Ziegler, G., & Gollwitzer, H. (2005). A novel antibacterial titania coating: metal ion toxicity and in vitro surface colonization. *Journal of Materials Science: Materials in Medicine*, *16*(10), 883-888.

Background and skills expected

Knowledge in Biomaterials or inorganic chemistry is a plus, as well as a strong taste for teamwork in a multidisciplinary subject.

Competences that will be acquired during the internship

The Coatings will be characterized by scanning electron microscopy (SEM) associated with energy dispersive X-ray spectroscopy (EDX). Structural properties will be determined by using X-ray diffraction (XRD), Raman spectroscopy and Fourier-transformed infrared spectroscopy (FTIR). The best finding will be chosen to carry on biological tests

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This Master internship could be followed into a PhD within the same research area: not yet