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FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

Department of Materials Science – CENIMAT / I3N

Influence of HA's Electrical Polarisation on Its Bioactivity

Dielectric Structures and Materials Group
&
Polymeric and Mesomorphic Materials Group
at DCM/FCT-UNL and Cenimat / I3N

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PhD Student

- **Supervisors:** Prof. Dra. Maria do Carmo Lança, Prof. Dr. João Paulo Borges and Prof. Dr. Jorge Carvalho Silva
- MSc in Biomedical Engineering, FCT-UNL, 2011
- Main Research Interests: biomaterials with application in hard tissues regeneration

Objectives

Over the last decade, interest in the application of biomaterials for replacement and regeneration of hard tissues has increased. Synthetic hydroxyapatite (HA) is considered one of the most promising biomaterials due to its biocompatibility, bioactivity and osteoconductivity. However, it has a weak osteogenic capacity compared to that presented by the bone tissue, leading to a slow process of mineralization. Because of the piezoelectric character of bone, electrical polarization can enhance bone growth and, consequently, polarized HA can have a higher bioactivity than non-polarized. So, this PhD work is focus on the influence of electrical polarization on HA's bioactivity, aiming the reduction of the required healing time between implant (HA) and the host bone (i.e. improving HA's biointegration).

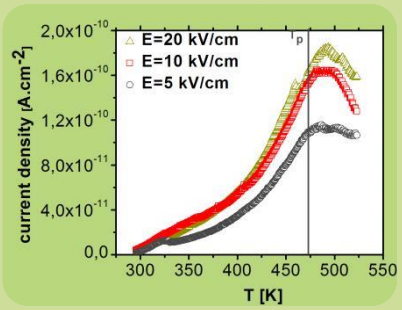
Methodology

To accomplish the objectives proposed, this project comprises:

- **Synthesis and characterisation of HA** (which involves the production of HA nanopowders by sol-gel method, the coating of titanium substrates with HA by the spin-coating method and the production of porous HA ceramics)
- **HA polarisation** (by two different methods: *electro-thermal polarisation* or *Corona discharge*, evaluation of the amount of charge stored and its stability achieved by each method as well as their viability for commercial use)
- **Sterilisation techniques versus polarisation stability** (the sterilisation will be performed by thermal methods and gamma-ray irradiation)
- **Bioactivity** (in SBF) **and cell culture tests** (to assess the bioactivity improvement induced by polarisation)

Expected Results

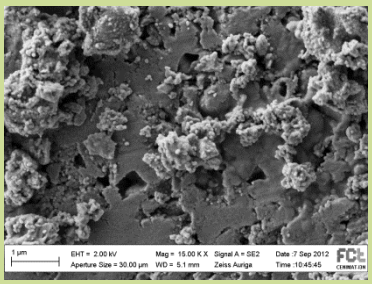
In vitro tests, e.g. bioactivity and cell culture tests, to polarised and non-polarised HA samples can represent a vital step to improve successfully medical applications with HA based materials. Moreover, it is essential to have tailored materials that can speed up the implant/host bone biointegration. Studying in a systematic way the dielectric and electrical properties of materials containing HA can contribute to improve the knowledge and understanding of bone growth mechanisms and also to produce more suitable materials for biomedical applications.



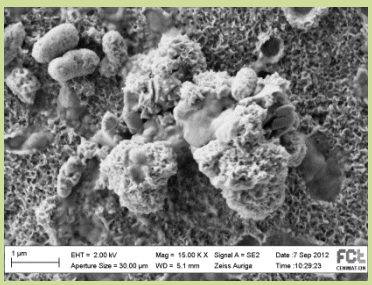
TSDC spectra obtained for a HA sample electrically polarized under different DC electric fields.

Effect of the different DC electric fields intensity in the depolarization parameters.

E_p [kV.cm^{-1}]	J_{max} [A.cm^{-2}]	Q_p [C.cm^{-2}]	E_a [eV]
5	1.15x10^{-10}	3.84x10^{-5}	0.32±0.01
10	1.65x10^{-10}	5.63x10^{-5}	0.30±0.01
20	1.85x10^{-10}	6.19x10^{-5}	0.35±0.01



SEM image of a HA sample immersed in SBF for 1 week.



SEM image of a polarised HA sample immersed in SBF for 1 week.

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