NOVAFLOW – NOVEL APPLICATIONS OF A STATE-OF-THE-ART OSCILLATORY FLOW PLATFORM: HYDROXYAPATITE PRODUCTION AND ITS USE IN BONE EXTRACELLULAR MATRIX GROWTH

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Introduction

Hydroxyapatite (HAp) $Ca_{10}(PO_4)_6(OH)_2$ characteristics relevant to bone replacement application, like bioactivity, biocompatibility and solubility, are directly influenced by particles properties

Several methods have been used to synthesize HAp. Among them, precipitation is of significant interest because of its simplicity, low cost, and easy application in industrial production

Difficulties have been encountered in producing stoichiometric HAp at physiological conditions due to the complexity of the calcium phosphate system (Fig1), the structure of HAp particularly prone to ion substitution and the role of the kinetic factors

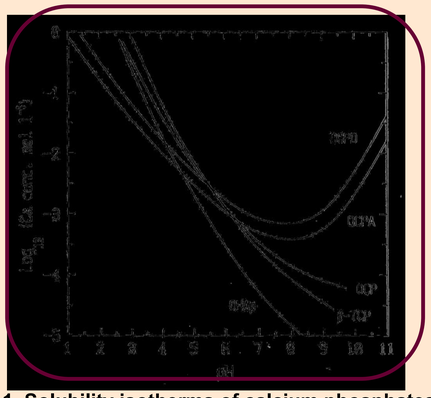


Figure 1. Solubility isotherms of calcium phosphates in the system $Ca(OH)_2$-H_3PO_4-H_2O at 37ºC (Elliot, 1994).

At the moment, the systems available for HAp production do not guarantee the stoichiometrical equilibrium, mainly due to the way reagents are mixed. This calls for the development of a system that provides an efficient and intense mixing. In that way, the oscillatory flow reactor (OFR) appears as a good candidate to promote ideal conditions for the controllability of HAp particles properties

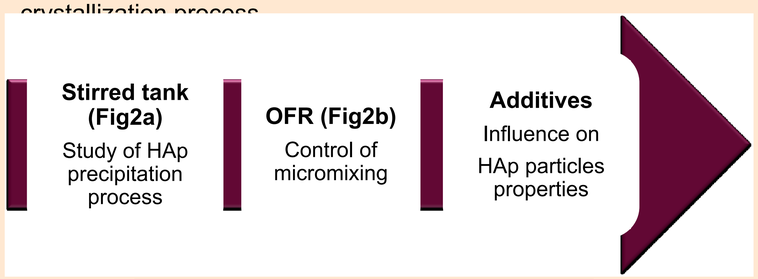
Objectives

The present project aims at precipitating HAp crystals at 37ºC with a carefully controlled size, with a controlled and narrow size distribution and with a high purity, making them suitable for application in bone substitution

Work plan

❑ HAp precipitation process:

Optimization of the operation conditions and modelling of the HAp crystallization process



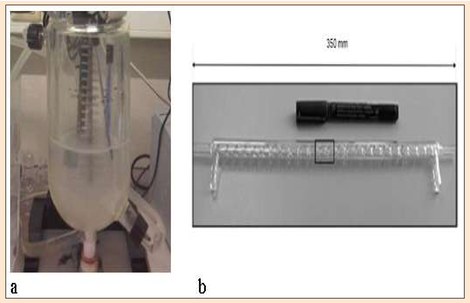
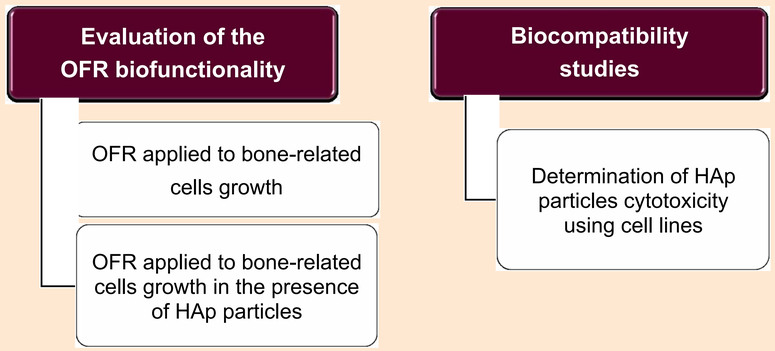


Figure 2. a) Experimental crystallization apparatus, b) OFR developed by CEB-UMinho (Reis *et al.*, 2005).

❑ Bone extracellular matrix growth:

Biological validation of the processes and the products developed



Results

HAp precipitation was carried out in a 1L stirred tank reactor (Fig2a) mixing a calcium aqueous solution and a phosphate aqueous solution

During HAp precipitation, pH was continuously measured revealing the occurrence of three stages (Fig3). In those stages the product was characterized through SEM analysis

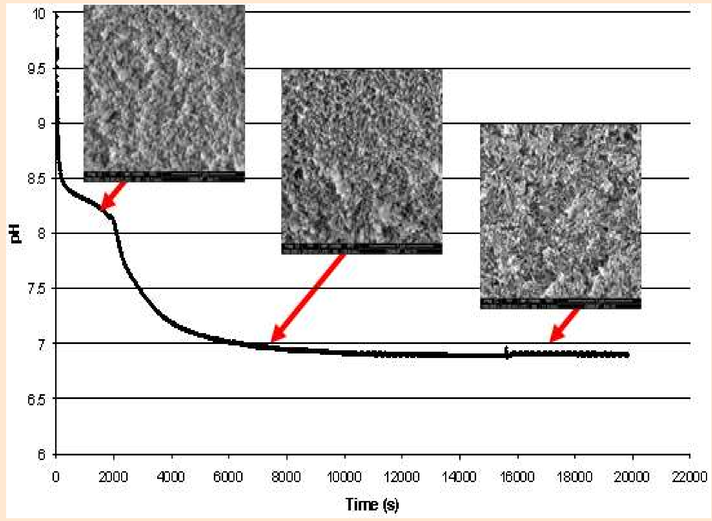


Figure 3. pH evolution during HAp precipitation and SEM images of the product developed at the different pH stages.

The final product was analyzed by X-ray diffraction which confirmed it to be HAp (Fig4)

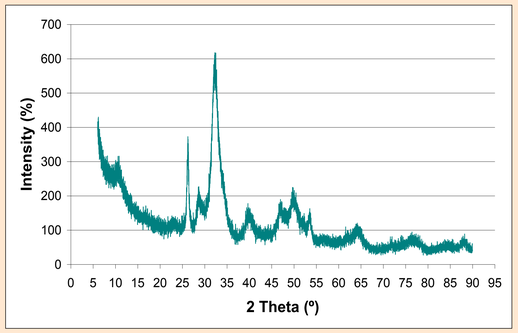


Figure 4. X-ray diffraction diagram corresponding to the final product of HAp precipitation.

References:

Elliot, J.C.. 1994. "Structure and chemistry of the apatites and other calcium orthophosphates". Elsevier, Amsterdam.

Reis, N., Harvey, A.P., Vicente, A.A., Teixeira, J.A., Mackley, M.R.. 2005. "Fluid Mechanics and Design Aspects of a Novel Oscillatory Flow Meso-Reactor". *Chemical Engineering Research & Design*, 83, 357-371.

Aknowledgment:

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