Electrospinning of PVP-calcium phosphates sol precursors for the production of hydroxyapatite nanofibres

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Natural bone consists of nanometer-sized needlelike crystals of hydroxyapatite (HA) growing in intimate contact with collagen. These hydroxyapatite nanofibres are about 5–20 nm wide and 60 nm long and act as tiny reinforcements to enhance the hardness and strength by many orders of magnitude. In this work, we investigated the production of HA nanofibres by the combination of sol-gel, a versatile technique frequently used to produce ceramic nanoparticles [1], and electrospinning, a technique that permits the fabrication of nanometer-sized fibres from polymeric solutions in an electric field-assisted spinning process [2].

A new method of producing HA fibres combining electrospinning and a non-alcoxide sol-gel system, using cheap precursors, was used. Phosphorus pentoxide (P_2O_5) and calcium nitrate tetrahydrate ($Ca(NO_3)_2.4H_2O$) were used as precursors of phosphorus and calcium, respectively. Fibrous membranes were electrospun from a mixture of the gel obtained from the system $Ca(NO_3)_2.4H_2O/P_2O_5$ with polymeric solutions of polyvinylpyrrolidone (PVP) in water and ethanol/water mixtures. Polymeric solutions were prepared with 15 % (w/w) and 18 % (w/w) of PVP. After sintering the as-spun membranes, at 500 ºC, 600 ºC and 700 ºC, nano and microfibres were obtained. The fibres were analyzed for their morphology (Scanning Electron Microscopy, SEM), chemical composition (Fourier Transform Infrared Spectroscopy, FTIR) and structure (X-ray diffraction, XRD). XRD analysis revealed that the fibres were composed mainly by type B carbonated HA with traces of calcium oxide (CaO) and β-tricalcium phosphate (β-TCP). Figures 1 and 2 present the typical morphology of the HA sintered fibres and the XRD pattern of the fibres after sintering at 700 ºC, respectively. From SEM analysis it was found that higher concentration of PVP in the electrospinning solutions leads to the formation of cylindrical fibres and that a larger amount of water allows for smaller diameter fibres and narrow diameters' distribution.

These HA nanofibres can have important applications in the field of bone tissue engineering.

References:

[1] Wang F, Li MS, Lu YP, Qi YX *Materials Letters* (2005), 48, 5742
[2] Li D, Xia Y., *Advanced Materials* (2004), 16, 1151-1170

Figures:

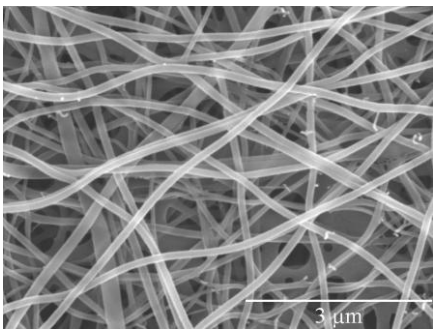

Figure 1. HAp fibres obtained after sintering, at 700 ºC, precursor electrospun nanofibres (from a mixture of sol and 18% water solution of PVP).

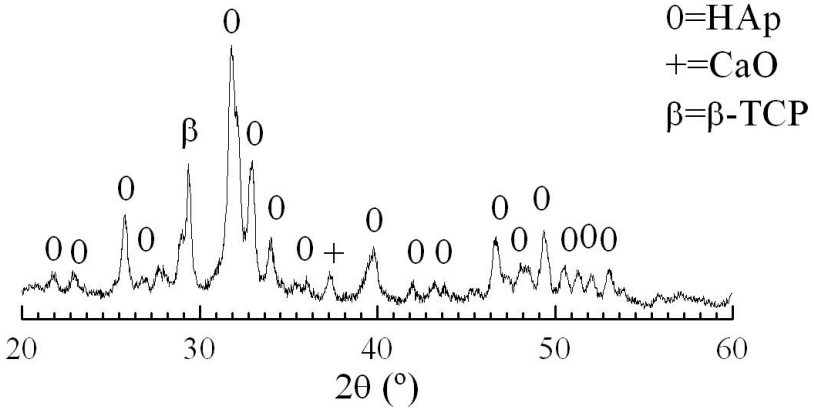

Figure 2. XRD pattern of the fibres sintered at 700 ºC.