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Characterization of a pulsed laser deposition Hydroxyapatite thin films grown, using a grazing incidence x-ray diffraction from synchrotron radiation.

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Abstract – Hydroxyapatite (HAP) thin-coatings for applications in the biomedical field were grown by pulsed laser deposition (PLD) using an *in situ* film annealing technique. The crystalline structural information of these biocompatible coatings, the HAP and other phases formation were systematically studied as a function of the deposition condition, such as the substrate temperature, laser irradiance and buffer gas pressure. A grazing-incidence X-ray diffraction (GIXRD) with synchrotron radiation was used for the film structural profile analyses. GIXRD spectra were obtained by fixed incidence angle of 0.5 degree, reducing the substrate interference.

Hydroxyapatite (HAP) is a biocompatible material, which represents the main chemical constituent of the bone tissue. Today there are three coating techniques that are widely employed, namely, plasma spray, plasma sputtering [1] and laser assisted techniques, such as the PLD [2].

In this work we present a detailed study of the thin film crystalline structure, grown under different deposition condition. The PLD experimental set-up is composed by a stainless steel deposition chamber initially pumped down to a residual pressure of 10^{-6} mbar. A Q-Switched Nd:YAG laser beam with energy of 250 mJ and 532nm of wavelength, is focused (500μm) onto a pure crystalline HAP ceramic target, producing a plasma plume that expands into a reactive atmosphere. The plume is subsequently deposited on a heated silicon substrate.

The deposition conditions were varied used in this work, such as the substrate temperature which was changed from 200 to 600 C, and the gas pressure and composition (O_2, a mixture of O_2/H_2O and H_2O). The crystalline structural of the film was analysed using a grazing-incidence X-ray diffraction (GIXRD) with synchrotron radiation for a fixed incidence angle of 0.5 degree. In figure 1 we have a GIXRD spectrum for a substrate with 500 C of temperature and a working pressure of 10^{-4} mbar of O_2. Our preliminary results have shown a film with a highly crystalline HAP phase with an amorphous phase always present for temperatures above 500 C. For a temperature of 300 C a TCP phase was also present.

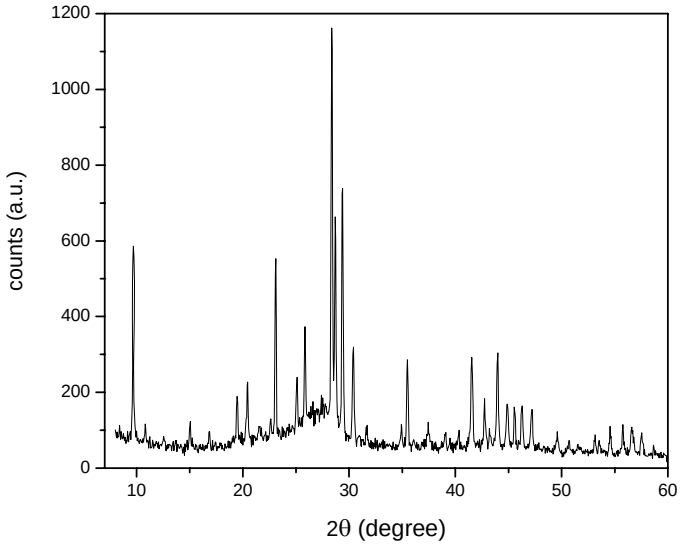

figure 1: GIXRD diffraction pattern a PLD hydroxyapatite coating on Si(001) substrate at 500 C temperature and 10^{-4} mbar of O_2.

[1] A. Mello, et al. Biomedical Materials. 2, (2007), 67–77.
[2] V. Nelea et al. Applied Surface Science 228 (2004) 346–356