11th International Conference on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

FTIR studies of Fluorapatite coatings produced by opposing magnetron sputtering

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In the present work we describe the preparation and characterization of Fluorapatite (FAP) coatings deposited on silicon substrate by means of opposing magnetron sputtering (OMS). The composition and cristallinity of FAP coatings has been studied by means of Fourier transform infrared spectroscopy (FTIR) and x-ray diffraction (XRD). FAP coatings were produced at different radio frequency powers applied to the cathodes of the OMS system. For all deposited samples, FTIR results showed low crystallinity FAP coatings. Subsequent heat treatment at 400 ^oC, produces no changes on the FTIR spectra of FAP coatings. The results are discussed in terms of the deposition parameters and microstructure.

The increase in average life expectancy of people has lead to an increase in the number of replacement surgeries of deteriorated bones, joints and other parts of the human body. Artificial bone substitutes have been constructed from many sorts of metals, like stainless steel, cobalt chromium alloys, titanium and its alloys. Despite their good mechanical and wear properties, these materials present poor surface bioactivity with living tissues. Hydroxyapatite (HAP) is the main component of mineral bone and is known to be bioactive, thermodynamically stable at physiological pH and actively takes part in bone bonding. Plasma splaying is the most common and commercial method to coat metallic implants. Advantages of this technique include a high deposition rate and low cost. However, careful control of processing parameters is necessary to prevent thermal decomposition of HAP into other soluble calcium phosphates due to the high processing temperatures. An alternative technique to plasma-spraying is magnetron sputtering, which is a suitable technique to deposit homogeneous dense thin films of HAP. In a previous paper on HAP coatings produced by opposing magnetron sputtering (OMS), crystalline HAP coatings were achieved. This sputtering system, which was developed in our laboratory, has an arranging of two sputtering guns back-to-back and setting the substrate and gun axes at right angles [1].

Fluorapatite $Ca(PO_4)_6F$ (FAP) is a biocompatible material, less soluble than HAP and more resistant against micro-organisms and acids. In this work, FAP coatings have been produced by radio frequency OMS. FAP targets were prepared and characterized by XRD and FTIR. FTIR spectrum of FHA target has the typical hydroxyapatite phosphate bands in 1100 - 1039 cm-1 (n3 PO43), 603 - 566 cm-1 (n4 PO43-) and 470 cm-1 (n2 PO43-), Fig 1a. The OH bands at 3570 cm-1 is very weak and band at 630 cm-1 is not detected indicating the HO- substitution for F. FTIR spectrum of FHA coatings have also the typical hydroxyapatite phosphate bands in 1000 cm-1 and 600 cm-1 regions (n3 PO43), Fig 1b. However, important differences in respect to the FTIR spectrum of a crystalline FHA powder can be observed. The phosphate n1 and n3 bands at 962 cm-1 and 1032 cm-1 and 1092 cm-1 were broader than in crystalline FHA. This characterizes a structure with low crystallinity and local disorder at PO43- sites. This modification on the PO43- modes is typical of low phosphate in low symmetry environments, which should probably generate three non equivalent phosphate C1 sites. Bands related to OH- groups at 3570 cm-1 was not observed suggested that OH- groups were substituted for F ions in HAP film structure. Optimization of the deposition process and heat treatment has been developed in order to obtain crystalline FAP coatings.

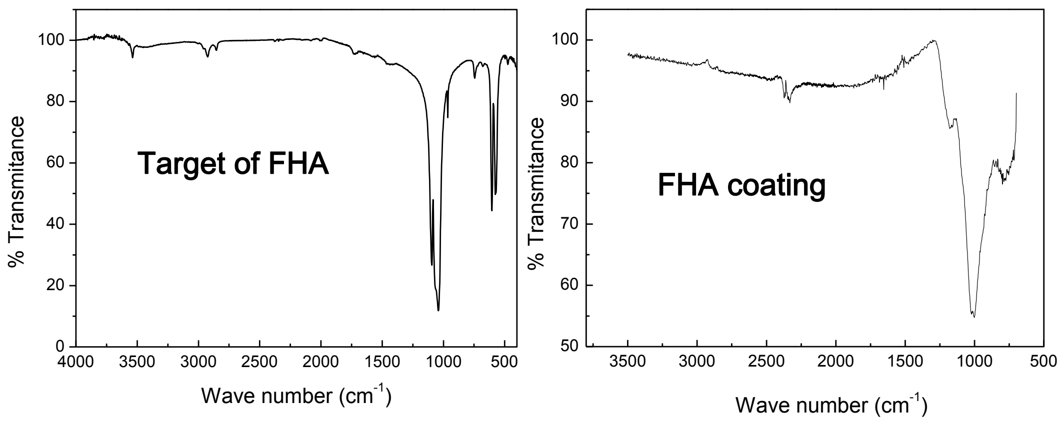

Fig 1. (a) FTIR of FHA target, and (b) FTIR of FHA coating.

[1] A. Mello, Z. Hong, A.M. Rossi, L. Luan, M. Farina, W.Querido, J. Eon, J. Terra, G. Balasundaram, T. Webster, A. Feinerman, D.E. Ellis, J.B. Ketterson and C. L. Ferreira, Biomed. Mater. 2, 67 (2007).