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COLLIMATION OF A SPUTTERED FLUX DURING THE GLANCING ANGLE DEPOSITION OF CALCIUM PHOSPHATES

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Physical vapor deposition of calcium phosphates is a growing area of research. It is due to the possibility of sculpturing the morphology and tailoring the properties of deposited films. In the field of biomedical engineering, the formation of nanostructures is believed to be an alternative route for improving the osteointegration and osteoinduction properties of the implants' surface. One of the promising approaches for sculpturing thin film morphology is glancing angle deposition. When the substrate is tilted to glancing angle nuclei that condense on it prevent incoming vapor from condensing into the region behind the nuclei, causing the nuclei to develop into columns that tilt towards the vapor source [1]. At high tilting angles ($>85^\circ$), the film microstructure is usually open and composed of distinct columns separated by distances on the order of the column diameter. The glancing angle deposition provides the opportunity to form various types of structures such as zigzag, helical, vertical columns and other types of structures [2]. This approach can be used for multiple different materials. However, for this to happen, a ballistic (line-of-sight) deposition regime should be used. It involves source geometry, decreased working gas pressure, and collimated flux of sputtered material. When the sputter source is relatively large in comparison to the available throw distance, the particle collimation is needed.

In our work, we show the influence of collimation conditions to the structure and morphology of calcium phosphate films deposited by RF magnetron sputtering using glancing angle geometry.

The Ti samples and Si wafers were cut in the shape of plates with a size (dimensions) of the $10 \times 10 \times 1$ mm³. The Ti samples were polished in series using silicon-carbide paper up to 1200 grit. Prior to deposition, the samples were sonicated for 10 min consecutively in acetone, ethanol, and distilled deionized water. The samples were tilted to an oblique angle of 80° relative to the surface of the sample holder. The samples were put inside the collimation tube with an opening of 10 mm in diameter. A vacuum installation, with a planar magnetron, was operated at 13.56 MHz, in order to deposit the calcium phosphate coatings on the Ti and Si substrates. The coatings were formed on the surface of substrates by magnetron sputtering at an RF-power level of 250 W in the Ar atmosphere. During the coating deposition, the working pressure in the vacuum chamber was controlled through the process and was set at 0.1 Pa.

The morphology of the thin films deposited with and without a collimation system significantly differ. The directionality of the coating surface features improved when the collimator was used. However, the deposition rate significantly decreased when the collimator was used. The thickness inhomogeneity of films was noted in both cases of deposition. The Refractive index varied from 1.5 to 1.9 for deposited calcium phosphate films.

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