Anodization/anaphoretic deposition of composite zein/hydroxyapatite coatings on titanium substrate

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INTRODUCTION: Hydroxyapatite, the main inorganic component of human bone, is a widely used bioceramic for bone implant coatings due to its chemical and structural similarity with bone minerals and approved biocompatibility. Nowadays, the surface properties of implants are also modified by the addition of different biopolymers. Features such as biocompatibility, tuned biodegradability, and non-cytotoxicity make these materials excellent candidates for these applications. Zein is one of the natural polymers that has gained great interest for biomedical applications due to its natural renewable resource, biodegradability, biocompatibility and potential antibacterial activity.

EXPERIMENTAL: In this study, zein/titanium dioxide (zein/TiO_2), hydroxyapatite/zein/titanium dioxide (HAp/zein/TiO_2) and strontium-doped hydroxyapatite/zein/titanium dioxide (Sr-HAp/zein/TiO_2) coatings were obtained on a titanium substrate by *in situ* anodization/anaphoretic deposition method at a constant voltage of 60 V and deposition time of 1 min. For the fabrication of HAp/zein/TiO_2 and Sr-HAp/zein/TiO_2 composite coatings, HAp and Sr-HAp nano-sized powders obtained by a modified chemical precipitation method were used. The microstructure and morphology of all coatings were characterized by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FT-IR) and scanning electron microscopy (SEM). Adhesion strength was measured according to the ASTM D3359-02 standard. Morphology and cell adhesion were analyzed by SEM.

RESULTS AND DISCUSSION: The advantage of this methodological approach compared to cataphoretic deposition is reflected in the simultaneous performance of several processes. The first is the anodization of the substrate surface, whereby a passive oxide layer (TiO_2) is formed on the surface, which changes the structure and increases the surface roughness in a controlled manner. Another parallel process is the deposition of the HAp based coatings on the substrate. This way of coating formation shows better results than cataphoretic deposition in terms of better coating adhesion to the substrate. Adhesion strength was significantly improved compared to coatings obtained by cataphoretic processes, without the need for subsequent treatment. Cytotoxicity tests showed that there was no significant decrease in the survival of healthy human lung fibroblasts (MRC-5) cells exposed to the obtained coatings.

CONCLUSIONS: Altogether, zein/TiO_2, HAp/zein/TiO_2 and Sr-HAp/zein/TiO_2 could be promising non-toxic biomaterials for orthopedic and dental applications.

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