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Micro-arc oxidation as a tool to develop multifunctional calcium-rich surfaces for dental implants applications

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Titanium (Ti) is commonly used in dental implants applications. Surface modification strategies are being followed in last years to build Ti oxide-based surfaces that can fulfill simultaneously, the following requirements: induce cell attachment and adhesion, while providing a superior corrosion and tribocorrosion performance. In this work, micro-arc oxidation (MAO) was used as a tool for the growth of a nanostructured bioactive titanium oxide layer aimed to enhance cell attachment and adhesion for dental implant applications. Characterization of the surfaces was performed, in terms of morphology, topography, chemical composition and crystalline structure. Primary human osteoblast adhesion on the developed surfaces was investigated in detail by electronic and atomic force microscopy as well as immunocytochemistry. Also, an investigation on the early cytokine production was performed. Results showed that a relatively thick hybrid and graded oxide layer was produced on the Ti surface, being constituted by a mixture of anatase, rutile and amorphous phases where calcium (Ca) and phosphorous (P) were incorporated. An outermost nanometric-thick amorphous oxide layer rich in Ca was present in the film. This amorphous layer, rich in Ca, improved fibroblasts viability and metabolic activity as well as osteoblasts adhesion. High-resolution techniques allowed to understand osteoblasts adhered less in the crystalline-rich regions while they preferentially adhere and spread over the Ca-rich amorphous oxide layer. Also, these surfaces induce higher amounts of IFN-γ cytokine secretion which is known to regulate inflammatory responses, bone microarchitecture as well as cytoskeleton reorganization and cellular spreading. These surfaces are promising in the context of dental implants, since they might lead to faster osseointegration.