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First insights of a novel antibacterial and cytocompatible porous Ta2O5 surface doped with zinc oxide nanoparticles

Luísa Fialho[1], L. Grenho[2], M. H. Fernandes[2], S. Calderon V.[3], S. Carvalho[1]

[1]University of Minho, Guimarães, Portugal [2]University of Porto, Porto, Portugal [3] INL, Braga, Portugal

luisa.gfialho@gmail.com

This work is focused on the development of a novel surface with graded functional treatments that will give a solution for the main problems of dental implants used nowadays: poor bioactivity that delays osseointegration and periimplantitis, an inflammatory disease caused by bacterial infection. In a first step, it was developed a porous tantalum oxide (Ta_2O_5) surface with incorporation of osteoconductive agents, calcium (Ca) and phosphorous (P) by plasma electrolytic oxidation (PEO). The anodizing parameters were optimized in order to achieve a Ca/P ratio near to 1.67 (theoretical value of hydroxyapatite) and thus mimic the bone morphology and chemistry enhancing the surface bioactivity. As second step, Zn nanoparticles (NPs) were deposited onto the bioactive surfaces by DC magnetron sputtering in order provide the surface of antibacterial activity. Moreover, an additional thin carbon (C) layer covered the Zn NPs in order to control the NPs release.The morphologic analysis by SEM reveled the formation of a micro/nano-porous structure on the oxide layer with a non-uniform and non-homogeneous porosity. The deposition of Zn NPs did not affect the surface morphology and the NPs were around and inside the pores increasing consequently the surface roughness. The additional presence of the C layer slightly covered the nano-pores and reduced the roughness. Additionally, BF-STEM was performed to characterize the samples with the Zn NPs, and the morphology indicates that the nanoparticles had irregular shapes and a core-shell structure with two crystalline phases: HCP Zn and ZnO. *In vitro* results demonstrated that after a maximum of 4h leaching the surfaces, an initial osteoblasts adhesion was ensured with a significant proliferation on the surface with Zn NPs. The surfaces with Zn NPs substantially reduced the planktonic bacterial with a greater sessile bacteria inhibition on the surfaces. Thereby, these findings are promising for biomedical applications.

Keywords
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