Novel biomimetic approach for titanium surface treatment by calcium phosphate: towards the production of implants with improved bioactivity

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INTRODUCTION: The interface between implant and bone is one of the critical factors to achieve short healing time and long term stability. We applied a wet, biomimetic, cost-effective route to activate the surface of titanium implants with a thin calcium phosphate phase. A ceramic micro- and nanostructured surface, strongly joined to the metal, is obtained.

METHODS: The method developed was applied to titanium grade 4 discs with different micro-topography such as polished, sandblasted, sandblasted and acid etched, similarly to what is commercially available [1]. The calcium phosphate (CaP) treatment is done under a novel controlled biomimetic approach [2, 3], promoting the heterogeneous nucleation and growth of the ceramic phase on the metal. The treatment is done by in-situ and on-line monitoring of the deposition. As a consequence, the control over thickness, chemical phases and morphology of the ceramic layer is obtained (Fig. 1). The CaP treatment is carried out after an alkaline-thermal step (a modified version of the Kokubo method [4]). The Ti surface is transformed into a highly porous layer of hydrogen sodium titanate ceramics of few microns (grafting layer, GL), which is chemically bonded to the metal.

RESULTS: A thin layer of CaP nucleates and growths under biomimetic condition within the GL. The nanostructured deposited material has a solubility higher than that of mature hydroxyapatite and, should be resorbed and promote the formation of natural bone in-vivo. Moreover, the experimental conditions for CaP formation can be tuned to stimulate the formation of octacalcium phosphate (OCP), which is considered the precursor of natural bone. Both GL and CaP modifications generate a nanostructured morphology, which also enhances wettability. Concurrently, the microroughness induced by blasting or etching is preserved. The synergistic effect of micro- and nanostructure is expected to shorten healing time and promote osseointegration [5].

DISCUSSION & CONCLUSIONS: A thin synthetic bone layer is deposited in a controlled manner on Ti substrate being firmly grafted to it. The GL ensures that CaP does not delaminate after mechanical stress. The modified surface is expected to improve the implant bioactivity.

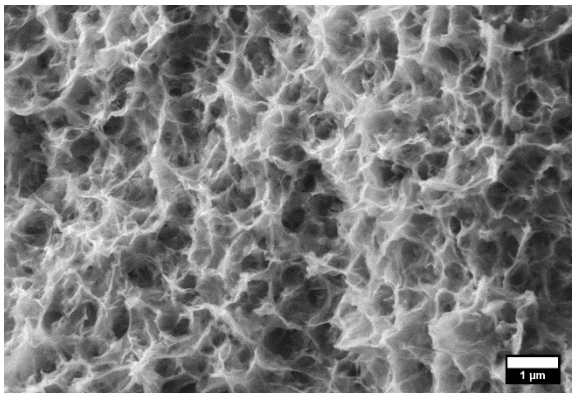

Fig. 1: Micrograph of the nanostructured Ti surface after modification with CaP.

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