Antimicrobial Porous Surfaces for Ti implants

W. Hoffmann[1,3], J. Köser[1], M. de Wild[1], I.Martin[3], F.Schlottig[4], C. Jung[2], U. Pieles[1]
[1]*University of Applied Sciences Northwestern Switzerland, Basel*
[2]*KKS Ultraschall AG Medical Surface Center, Steinen, Switzerland.*
[3]*Department of Biomedicine, Basel, Switzerland*
[4]*Thommen Medical AG, Waldenburg, Switzerland*

INTRODUCTION: Over the last two decades the use of dental implant has been steadily increased with annual growth rates of up to 15%. This has drawn the attention to periimplantitis and poor implant ingrowth as the major causes for implant failure which occurs at a rate of up to 5% [1]. Since the main cause for periimplantitis is the affection of implants with bacteria. Implant surfaces are designed to show antimicrobial activity concurrently to osseoconductive properties.
Here we present results from a multidisciplinary approach to develop new antimicrobial active porous surfaces of titanium implants by spark assisted anodizing. Anodisation offers the unique property to micro- and nanostructure titanium implant surfaces to provide optimal osseo-integration of implants [2] and at the same time to incorporate antimicrobial active metal ions.

METHODS: The surface treatments applied in the course of this project include pre-cleaning, spark-assisted anodizing in proprietary electrolytes and with proprietary anodizing parameters and final cleaning. The spark-assisted anodizing process [3] produces different layers, which can be affected by different post-anodisation treatments. Dilution series of non-adhering bacteria and live/dead staining are performed to assess the antimicrobial activity of the modified surfaces.

RESULTS: It has been discovered that the surface roughness of the anodized layers is very similar for different mechanical pretreatments, as well as the elemental composition of the anodized layers. This demonstrated that the mechanical pretreatment for deburring has no significant effect on the overall anodisation process. Although similar in chemical composition and morphological appearance, the thickness of the porous layer can be tuned, by modifications of the sample preparation protocol under the conditions tested, to 1.5 to 3.5 µm (Fig. 1).

Fig. 1: Scanning electron micrographs of differently modified samples.

The antimicrobial activity of the prepared titanium surfaces has been evaluated a) in extracts obtained after different incubation times of the samples in simulated body fluid as well as b) on the modified titanium samples in direct contact with bacteria.

Next we will establish dedicated live/dead staining protocols to assess the antimicrobial activity of modified titanium surfaces towards biofilm forming bacteria via fluorescent microscopy.

Additionally the biocompatibility of the modified titanium samples was assessed using human bone marrow derived stem cells (Fig. 2).

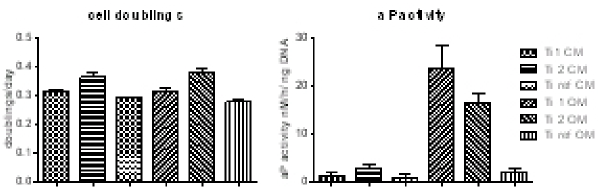

Fig. 2: Stem cell proliferation and alkaline phosphatase activity on various Ti samples in either control medium (CM) or differentiation medium (OM).

DISCUSSION & CONCLUSIONS: Titanium samples were subjected to the electrochemical spark-assisted anodizing process and the layers formed were analyzed with regard to their structural and chemical composition. In initial experiments antimicrobial activity was observed with concurrent biocompatibility and osteoblastic differentiation supporting properties.

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ACKNOWLEDGEMENTS: This research activity belongs to the project "NAPTIS", funded by the Swiss Nanoscience Institute.