OR2004

Antimicrobial Surface Finishing for Medical Implants by means of Metal Plasma Immersion Ion Implantation and Deposition

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Medical implants are widely used in surgery and dentistry, i.e. for total joint replacement or dental implants. Although regenerative medicine is highly sophisticated, an implant remains a foreign material in the human body and therefore its surface properties should meet certain criteria. First and foremost the implanted material has to be biocompatible. In particular no adverse reaction should be provoked and a fast integration into the respective tissue has to be guaranteed. Additionally, implants should exhibit an antimicrobial effect to minimize the implant-associated risk of infection. These infections can persistent against antibiotics and the body´s immune system and are therefore still a huge problem in clinical practice. Hence, titanium implant surfaces should ideally be designed to promote the attachment of target tissue cells and at the same time, they should prevent bacterial adhesion, achievable through specific modification strategies.
In this contribution, we present results of antimicrobial titanium surfaces generated by the insertion of copper. The surface was prepared via copper implantation and deposition into the subsurface and on the titanium surface by means of plasma ion immersion implantation and deposition (Cu-PIII&D) a combined method to dope the subsurface and to coat the metallic implant material in one single step. Compared to conventional coatings a considerably stronger bonded coating can be realized by the PIII&D technique. Depending on the sample mounting and the process parameters, the absolute amount of copper on and in the surface and therefore the copper release from the surface can be adjusted respectively. It was observed, that the kinetic of the copper release in Dulbeccos modified eagle medium (DMEM) can be controlled between some µmol/l up to 3 mmol/l Cu. Furthermore, the longtime release is variable between a full release after 2 days and a remaining release of more than 1 mmol/l even after 7 days. This also affects the antimicrobial properties of the modified surface.

Keywords
antimicrobial medical implants with defined copper release