Enhancing the antibacterial performance of orthopaedic implant materials by fibre laser surface engineering - DTU Orbit (22/04/2019)

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Implant failure caused by bacterial infection is extremely difficult to treat and usually requires the removal of the infected components. Despite the severe consequence of bacterial infection, research into bacterial infection of orthopaedic implants is still at an early stage compared to the effort on enhancing osseointegration, wear and corrosion resistance of implant materials. In this study, the effects of laser surface treatment on enhancing the antibacterial properties of commercially pure (CP) Ti (Grade 2), Ti6Al4V (Grade 5) and CoCrMo alloy implant materials were studied and compared for the first time. Laser surface treatment was performed by a continuous wave (CW) fibre laser with a near-infrared wavelength of 1064 nm in a nitrogen-containing environment. Staphylococcus aureus, commonly implicated in infection associated with orthopaedic implants, was used to investigate the antibacterial properties of the laser-treated surfaces. The surface roughness and topography of the laser-treated materials were analysed by a 2D roughness testing and by AFM. The surface morphologies before and after 24 h of bacterial cell culture were captured by SEM, and bacterial viability was determined using live/dead staining. Surface chemistry was analysed by XPS and surface wettability was measured using the sessile drop method. The findings of this study indicated that the laser-treated CP Ti and Ti6Al4V surfaces exhibited a noticeable reduction in bacterial adhesion and possessed a bactericidal effect. Such properties were attributable to the combined effects of reduced hydrophobicity, thicker and stable oxide films and presence of laser-induced nano-features. No similar antibacterial effect was observed in the laser-treated CoCrMo.

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