Underwater laser texturing of Ti6Al4V

E. Uhlmann[1,2], C. Hein[1], A. Brehmer[1], L. Schweitzer[1]

[1]Fraunhofer Institute for Production Systems and Design Technology IPK, Germany
[2]Institute for Machine Tools and Factory Management, Technische Universität Berlin, Germany
luiz.schweitzer@ipk.fraunhofer.de

Abstract

Annual sales of dental implants, estimated on 33 billion USD in 2019 and the efforts to keep the teeth functionality and aesthetics is continuously growing over the years. However, the loosening of dental implants caused by infection is still a critical and global problem. In this scenario, the development of new implant manufacturing strategies is of major importance.

Any surface exposed to the oral cavity is covered by a layer of salivary proteins called the pellicle. After the initial formation of a saliva layer, which is a cellular, protein-containing film on the surface, bacterial cells are adsorbed onto it. Well-developed biofilms on dental implant surfaces then become the main source of pathogenic microbes that cause Peri-implantitis, which is one of the leading causes of dental implant failure. The surface topography and chemical composition of an implant are key factors for the interface surface / pellicle, which directly affects the formation of biological layers. In this sense, laser surface texturing with ultrashort pulse lasers constitutes a powerful technique to functionalise the surface and improve the biological properties of the implant surface. Laser processing parameters such as feed rate, fluence and number of pulses are essential aspects for this control.

This paper presents promising results on the surface texturing of Ti6Al4V. The functionalisation of the implant by sub-micrometre structures is feasible through the processing of laser induced periodic surface structures (LIPSS). The laser beam wavelength dictates the LIPSS size, which cannot be steered by the processing parameters. The novel application of underwater laser processing for the surface texturing enables reduces the size of LIPSS if compared with processing in atmospheric air. The manufacturing technology and results of the biomedical evaluation are presented in the context of this publication.