Development of a beam polarization control for automated alignment of submicrometric structures

E. Uhlmann[12], Peter Schneider[3], L. Schweitzer[14]

[1] Fraunhofer Institute for Production Systems and Design Technology, Berlin, Germany

[2] Institute for Machine Tools and Factory Management, Technische Universität Berlin, Germany

[3] Laser Mikrotechnologie D. Kieburg GmbH, James-Franck-Straße 15, 12489 Berlin

[4] Department of Orthopedics and Orthopedic Surgery, University Medicine Greifswald, Germany

luiz.schweitzer@ipk.fraunhofer.de

Abstract

The initial attachment of microorganisms is only possible by pioneer bacteria, such as the gram-positive streptococci. Since the pathogenic cannot form a biofilm unless attached to a surface, the attachment of the pioneer bacteria is crucial for the onset of peri-implantitis. Due to the flexibility and contact free process, laser material processing is used for the surface structuring of several materials. In this context, is important to both reduce biofilm formation and ensure adhesion of gingival tissue. Automated polarization variation in laser-induced periodic surface texturing (LIPSS) involves a new technique for changing the orientation of LIPSS. This makes it possible to achieve laser texturing with differentiated orientation for better adhesion of fibroblasts (fibronectin) to the titanium surface. Figure 1 shows the size ratios of a bacterium compared to collagen fibres and LIPSS laser texturing. On the one hand, the patterning of LIPSS is smaller than the bacteria themselves, which reduces the useful area for bacterial attachment and biofilm formation. On the other hand, the LIPSS are large enough for the collagen fibres, which are used for human cell attachment. Thus, the usable area for cell attachment is increased and provides an advantage to wound closure. The results comprise the evaluation of the biofilm formation on surfaces with LIPSS in different orientations. The implant material undergoes an in vitro culture of the microorganism Streptococcus salivarius. The analysis was realized by fluorescence microscopy with the application of 4',6-diamidino-2-phenylindole (DAPI) on the adhered biofilm. Results show that the surface modification plays a major role in the inhibition of biofilm formation.

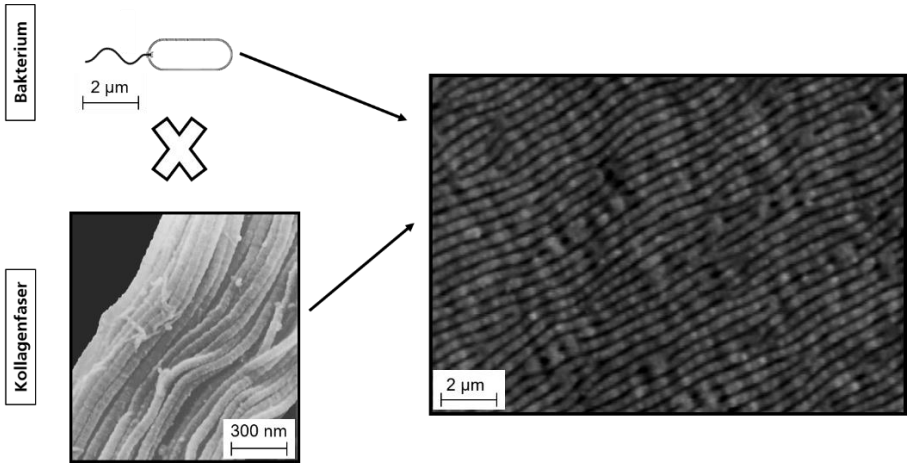

Figure 1: Collagen fiber physical size as an advantage for fibroblast adhesion to the LIPSS surface.