Bacterial adhesion on ultrashort pulse laser processed surfaces — more than size matters!

Elisa Garcia de Eulate Perez[1], Dorothea Thiele[1], Heike Voss[1], Jörn Bonse[1], and Karin Schwibbert[1*]

[1] Bundesanstalt für Materialforschung und -prüfung (BAM), Unter den Eichen 87, 12205 Berlin, Germany
[*]Corresponding author email: karin.schwibbert@bam.de

Bacterial biofilms are aggregates of bacterial cells, often attached to a surface and enclosed by a self-produced extracellular matrix which confers increased stress tolerance and resistance to cleaning. Biofilm formation leads to biofouling which gives rise to high costs in numerous technical settings due to biocorrosion and biodegradation. However, biofilms can also be attractive for industrial settings such as wastewater treatment systems or for soil bioremediation processes. Hence, the control of bacterial adhesion to a surface is of major concern. Surface topography strongly influences bacterial adhesion. Therefore, one promising way to achieve bacteria-guiding surfaces lies in the contactless and aseptic large-area laser processing of technical surfaces [1]. We used short and ultrashort pulsed laser systems to generate different surface textures, mainly high-spatial-frequency and low-spatial-frequency laser-induced periodic surface structures, LIPSS (HFSL and LFSL), on Ti, Ti-alloy, steel, and polymers (PET and PE). Pristine (polished) and laser processed samples were subjected to bacterial adhesion experiments with two different *Escherichia coli* strains and *Staphylococcus aureus* as test organisms. The bacterial strains differed in their cell wall structure (grampositive vs. gramnegative strains), in size, shape, the occurrence of cell appendages, and in their biofilm forming capabilities. Adhesion patterns were analyzed microscopically and compared regarding the respective test strain and surface topography. Our results revealed that adhesion behavior strongly depends not only on the material's topography and chemistry, but also on the specific bacterial strain, the presence of cell appendages, and ambient growth conditions.

References:

[1] K. Schwibbert, A.M. Richter, J. Krüger, J. Bonse, Laser-Textured Surfaces: A Way to Control Biofilm Formation?, Laser & Photonics Reviews, 18, 2300753 (2024)