Single-Cell Force Spectroscopy to Study Bacterial Adhesion: Fundamental Mechanisms and Effect of Substrate Nano-Topography

Christian Spengler[1], Friederike Nolle[1], Johannes Mischo[1], Markus Bischoff[2] and Karin Jacobs[1]

[1]Experimental Physics, Saarland University, 66123 Saarbrücken, Germany, [2]Institute for Medical Microbiology and Hygiene, Saarland University, 66421 Homburg, Germany

Biofilms formed by pathogenic bacteria at solid surfaces are a nuisance in a wide area of healthcare applications. We present single cell force spectroscopy [1] experiments to reveal fundamental mechanisms of bacterial adhesion to various materials.
Since bacterial adhesion is mediated by thermally fluctuating cell wall molecules [2], comparing the shapes of force-distance curves on different surfaces provides information on the physical/chemical interactions between the bacterial cell wall molecules and the underlying material. In addition, the number of molecules involved and their average lengths during fluctuations can be determined.
With this knowledge the adhesion of *S. aureus* to nanostructured surfaces can be quantified [3]: Thereto, etched silicon substrates with nanostructures in the same size range as the bacterial cell wall molecules (7 nm < RMS < 35 nm) were used for adhesion measurements. Their surface morphology was analyzed in great detail by Minkowski functionals showing that all surfaces are morphologically equivalent with only differences in their physical dimensions. It shows that as the surface nanostructures increase in size, adhesion forces decrease in a way that is directly correlated with the proportion of the surface area available for tethering cell wall molecules.

[1] N. Thewes et al. Eur.Phys. J. E 38, 140 (2015).
[2] N. Thewes et al., Soft Matter 11, 8913 (2015).
[3] C. Spengler et al., Nanoscale *in print*