Adhesion in soft matter systems:
About proteins, bacteria and an effective way of tooth brushing

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Why are we brushing our teeth? To remove the formed biofilm and to prevent tooth decay. But why is the biofilm so sticky, which forces are involved? To answer these and other questions, we teamed up with colleagues in microbiology and clinical dentistry to identify suitable model systems for the investigation and quantification of the forces involved. Our main experimental tool is force spectroscopy using an atomic force microscope (AFM). By mounting a single, living bacterium on the AFM cantilever, we can record force-distance-curves and study the adhesive force on a variety of surfaces under different conditions [1]. Force-distance-curves not only provide information about adhesive force and energy, but also about the length and stiffness of the proteins involved. Monte Carlo simulations guide the interpretation of the experimental force-distance curves and allow further insight in the type of involved forces [1,2].

The biofilm on our teeth not only consists of bacteria, but also of proteins. Further experiments probe the intermolecular forces between proteins as well as between proteins and surfaces. Certain properties of amphiphilic proteins lead to strong cohesion forces, allowing for the building of membranes and even vesicles [3,4]. How far can we go towards a pure-proteinaceous cell membrane? Can ion channels be inserted?

[1] N. Thewes et al, *Stochastic binding of Staphylococcus aureus to hydrophobic surfaces*, Soft Matter **11** (2015) 8913
[2] C. Spengler et al., *Determination of the nano-scaled contact area of Staphylococcal cells,* Nanoscale **9** (2017) 10084
[3] H. Hähl et al., *Pure Protein Bilayers and Vesicles from Native Fungal Hydrophobins, Adv. Mat.* **29** (2017) 1602888
[4] H. Hähl et al, *Adhesion Properties of Freestanding Hydrophobin Bilayers, L*angmuir **34** (2018) 8542