Prof. Gerald Fuller
Stanford University, Chemical Engineering

Rheology to the Rescue: Problems in Bio-adhesion and Bio-friction

Date: Dec 01 2020, 17.00 h Hamburg time

Abstract

Certain problems in human health involve the adherence and friction of cells to surfaces. In this lecture, two such problems are considered: the strength of attachment of *E coli* bacteria onto bladder cells and the sliding friction of corneal epithelial cells against conjunctival cells (blinking friction). The first problem is connected to urinary tract infections and investigates the role of biofilms produced by the bacteria in facilitating their strength of attachment to badder cells. The second area of investigation concerns the problem of mucin-deficient dry-eye phenomenon where the lack of this heavily glycosylated protein leads to a lack of tear film stability, corneal discomfort, and increased risk of infection.

Rheology is the science of flow and deformation of complex matter and the principles of this line of research are well suited to study the mechanical response of soft biological materials. To enable rheometric methods to study the two problems outlined above, a new instrument, the live cell monolayer rheometer (LCMR), was developed. This apparatus allows one to apply well-defined shearing deformations to layers of living cells while simultaneously measuring the associated stresses and imaging the morphologies of the deforming cells. It is demonstrated that measurements of the resulting stress-strain relationships allow for a direct determinations of the strength of bacterial adhesion against bladder cells and the magnitude of the sliding friction during blink cycles using an *in vitro* mucin-deficient dry-eye model. It is further demonstrated that biofilm components generated by *E coli* greatly facilitate bacterial attachment. In the second example, lubricin, a proposed replacement for mucin, is shown to successfully reduce corneal frictional resistance.