TIME-LAPSED THREE-DIMENSIONAL BIOfILM DEfORMATION IN SITU AND NONINvASIvELY vISUALIzED AND QUANTIfIED BY MEANS Of OPTICAL COHERENCE TOMOGRAPHY

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Interaction of shear stress with bioflm structures leads to dynamic deformation processes, which are related to the structural and material characteristics of bioflms. Bioflm deformation processes play a crucial role in understanding and controlling bioflm development. In an environment of high shear stress, bioflms withstand a certain amount of these stresses before the bioflm structure fails and detachment occurs. Detachment is especially unwanted if pathogenes are involved. This rises the risk of spreading deseases and contaminating clean environments. Therefore it is crucial to understand the bioflm structure and dynamic structural changes during changing stresses. For this purpose optical coherence tomography (OCT) was used as a fast, noninvasive, in situ method which allows to image bioflm strucutres on the mm-scale with a high resolution in the µm-range. We developed a method to estimate rheological properties in situ and non-invasively using OCT (Blauert et al. 2015, DOI: 10.1002/bit.25590). Implementation of OCT allows to investigate 'real' time deformation in 2D as well as time-lapsed deformation in 3D. For this purpose hererotrophic bioflms were grown in a flow cell under defned hydrodynamic conditions. Bioflms were grown under low shear conditions (T_w = 0.01 Pa,Re = 3) and exposed to a set of incrementally increasing (load cycle) and decreasing (unload cycle) shear stresses in stressstrain experiments to investigate the effects of shear stress onto the 3D bioflm structure. OCT allows to not only to follow changes within the bioflm structure, such as changes of porosity P_B, mean bioflm thickness L_F, and surface roughness coeffcient R^*_a, but furthermore make estimations of rheological properties such as the Young's Modulus E or the Shear Modulus G to quantify material properties of bioflms. From stress-strain experiments we found irreversible deformation of the viscoelastic bioflm and we correlated these fndings to the changes of P_B, L_F , and R^*_a. The stress-strain diagram provided an estimation of Young's modulus, assuming an ideal wall shear stress calculation, for the heterotrophic bioflm, which was calculated to be E = 36.0 +/- 2.6 Pa. The experiments are in good agreement with the fndings in literature and show dynamics which could only be estimated by other techniques, such as the change in porosity which was correlated to extrusion of water. Future implementation of OCT datasets in modelling tools will help to understand the remaining questions regarding dynamic processes