

## Session: Tools & modelling

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### **Biofilm imaging and its changes within the last decades**

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Achieving a better understanding of biofilm systems is strongly coupled to the visualization of the biofilm structure. Starting with rather simple microscopes developed hundreds of years ago to study bacteria, today's biofilm researchers have access to various visualization modalities. Available techniques provide access to different information at different scales. Information about the physical distribution of biomass and its chemical characteristics are provided. At smaller scales (microscale) microscopic tools reveal the biofilm composition with respect to microorganisms, extracellular polymeric substances (EPS) and additional matrix components (e.g., inert materials). As EPS are the backbone of biofilms, the approach of a lectin binding analysis was and still is key to successful analysis of biofilm structure using fluorescence microscopy. Nowadays it is even possible to visualize processes occurring at cell level as well as to optically cut through the entire sample for tracing interactions. In addition to the fundamental understanding of microscopic structural properties, biofilm research meanwhile focuses also on capturing the overall picture of a biofilm. Thus, the mesoscale (mm-range) of biofilms is investigated/visualized in order to understand the interaction between the biofilm and the surrounding (moving) fluid (bulk-biofilm interaction). Tools such as magnetic resonance imaging (MRI) and optical coherence tomography (OCT) have thus become popular. Both tools provide non-destructively and in situ three-dimensional information about the distribution of biomass even within complex cultivation settings.

However, there are many other approaches such as Raman microspectroscopy, ionization mass spectrometry and photoacoustic spectroscopy available, which can be used to „image“ certain biofilm properties.

As we can see, biofilm research has a great variety of tools at hand in order to understand biofilm structure, properties and functions in more detail. The lecture will point on the highlights and their impact on the assessment of biofilm characteristics.