Iron as a biofilm control agent: manipulation of biofilm development and differentiation

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In order to optimize operative parameters in wastewater treatment plants, drip irrigation systems as well as in biofilm reactors, it is necessary to understand biofilm development and proliferation under certain conditions. Additionally, the physical structure of biofilms is of great interest since it determines the interaction with its microenvironment, while knowledge about the mechanical behavior of biofilms is important for applying e.g., cleaning procedures.

In the past two years we refined a fully automated monitoring and cultivation setup that enabled replicate biofilm cultivations and investigation by means of optical coherence tomography (OCT). OCT as an imaging modality is ideal for biofilms since it allows for the monitoring of structure and deformation in real-time and noninvasively.

With this setup it was possible to analyze the effect of iron on biofilm growth and behavior with a minimum of $N = 10$ biofilm replicates including a statistical treatment. At least eight structural parameters of biofilms grown in flow cells could be analyzed and statistically quantified, providing insights into the structural integrity of biofilms and to their interface. Thereby, the results clearly show the positive effect of iron on Bacillus subtilis biofilms regarding biomass production and differentiation to mature biofilms. Further gravimetric and optical analyses prove the incorporation of iron as iron oxide-hydroxides and explain the positive effect on the biofilm's matrix. Initial experiments under mechanical stress confirm the withstanding of high flow rates as well as a high compressibility of the biofilms.