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A novel bacterial sensing platform: Diamond Thin-Film Waveguides based on Quantum Cascade Laser Mid-Infrared Spectroscopy

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Escherichia coli, one of the most widespread anaerobic bacteria, is known to create strong biofilms in the gastrointestinal tract and is used as a model organism to study biofilms [1]. Biofilms are a community of aggregated bacterial cells and grow at a solid-liquid interface. Several strategies have been developed to investigate the formation and development of biofilms. Spectroscopic techniques, such as the attenuated total reflection Fourier transform infrared spectroscopy (ATR-FTIR), has shown their potential to monitor the transition from planktonic to sessile bacteria. Furthermore, mid-infrared spectroscopy (MIR) is a sensitive, selective, and non-destructive technique [2,3], that enables the conformational study of peptides, polypeptides, and proteins in living cells [4]. However, the conventional MIR-based ATR-FTIR spectroscopy shows a lack in sensitivity [5], especially in the analysis of protein, and therefore needs to be improved. One way to improve the intensity of the signal is by the application of quantum cascade lasers (QCL) technologies that can provide a more comprehensive understanding of the formation of biofilms. As the growth of biofilm is dependent on the surface, where the bacteria can attach, diamond is a promising biocompatible platform to study living cells within the MIR spectroscopy, since it is transparent in the MIR range and chemically inert. Diamond thin-film waveguides, a novel sensing platform that can be coupled with QCL spectroscopy is suitable to detect chemical and conformational changes during the growth of bacteria. Further advantages of these thin-film waveguides are the more pronounced vibration features, coupled to a small sample volume.

In this contribution, we present the novel sensing platform based on diamond thin-film waveguides and QCL technologies, which are used to study planktonic and sessile bacteria. Furthermore, a comparison to conventional ATR-FTIR and atomic force microscopy (AFM) studies will be shown.

References

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