Single-shot microsecond-res spectroscopy of the bacteriorhodopsin photocycle with quantum cascade laser frequency combs

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High-speed vibrational spectroscopy is an important tool for understanding biological processes, chemical reaction pathways and process analysis in general. Speed combined with high selectivity and sensitivity are key drivers for next generation process analysis tools.
We present the IRis-F1, a quantum cascade laser dual frequency comb spectrometer. It allows for parallel acquisition of hundreds of mid-infrared wavelengths at microsecond time resolution. Here, we validate the method by studying the kinetics of the light-activated protein Bacteriorhodopsin [1]. The reaction has been recorded with the instrument shown in Figure 1 a). Figure 1 b) illustrates the infrared response of bacteriorhodopsin to 10 ns visible light pulses with microsecond time-resolution. The different wavelengths were all measured in parallel thanks to the dual-comb approach.
This time-resolved measurement proofs the extremely high sensitivity and selectivity at high speed of the IRis-F1. Enzyme kinetics can be measured and fast screening processes, where speed and reliable identification of substances is key, will be revolutionized.

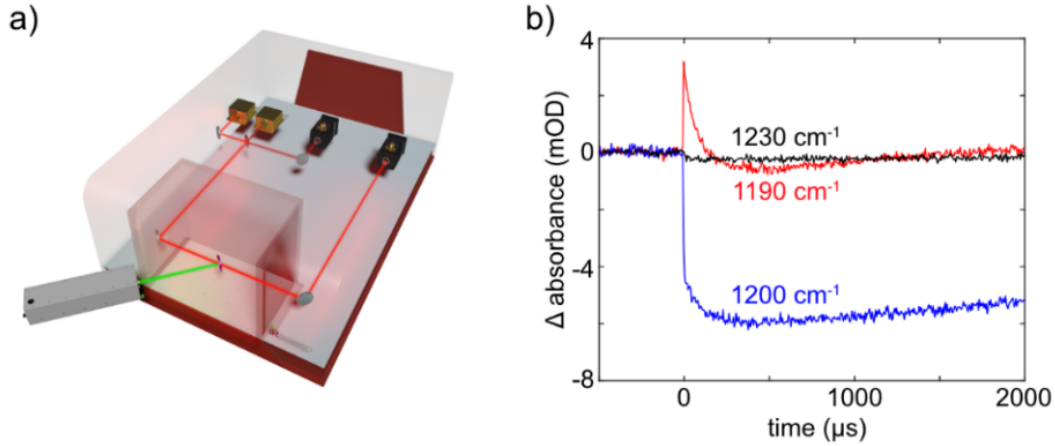

Figure 1 a) Setup illustration of the dual-comb QCL spectrometer including a pulsed Nd:YAG laser for activation of bacteriorhodopsin. b) Absorption changes with microsecond time resolution at 3 different wavelengths.

[1] Klocke et al., ACS Anal. Chem. 90, 17, 10494-10500, 2018