SINGLE-SHOT SUB-MICROSECOND SPECTROSCOPY OF THE BACTERIORHODOPSIN PHOTOCYCLE WITH QUANTUM CASCADE LASER FREQUENCY COMBS

MARKUS MANGOLD, *IRsweep AG, IRsweep AG, Stäfa, Switzerland*; TILMAN KOTTKE, JESSICA KLOCKE, *Physical and Biophysical Chemistry, Uni Bielefeld, Bielefeld, Germany*; ANDREAS HUGI, PITT ALLMENDINGER, *IRsweep AG, IRsweep AG, Stäfa, Switzerland*; JEROME FAIST, *Institute for quantum electronics, ETH Zurich, Zurich, Switzerland*.

Time-resolved vibrational spectroscopy is an important tool for understanding biological processes and chemical reaction pathways [1]. Today, all available methods to our knowledge require many repetitions of an experiment to acquire a microsecond time-resolved mid-infrared spectrum.

We present the IRspectrometer, a quantum cascade laser dual frequency comb spectrometer [2-3]. It allows for parallel acquisition of hundreds of mid-infrared wavelengths with microsecond time resolution. The formation of the light-activated L, M and N-states in bacteriorhodopsin – which only have μs to ms lifetimes – has been recorded by analyzing the infrared response of bacteriorhodopsin to 10 ns visible light pulses with sub-microsecond time-resolution. The different wavelengths were all measured in parallel thanks to the dual-comb approach. The spectra as well as the kinetics show good agreement with those from step-scan FT-IR measurements. As a benchmark, the spectral signature of several intermediate states of the bacteriorhodopsin photocycle has been recorded in a single shot measurement. This approach greatly reduces the complexity of time-resolved spectroscopy measurements in the mid-infrared which currently require many repetitions.

References

[1] Ritter, E. et al. “Time-Resolved Infrared Spectroscopic Techniques as Applied to Channelrhodopsin.” Front. Mol. Biosci. 2:38.

[2] Hugi, A. et al. “Mid-Infrared Frequency Comb Based on a Quantum Cascade Laser.” Nature 492: 229–33

[3] Villares, G. et al. “Dual-comb spectroscopy based on quantum-cascade-laser frequency combs.” Nat. Commun. 5:5192