Quantum cascade laser-based infrared spectrometer combined with small angle neutron scattering for life science applications.

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Using the amide I band, infrared spectroscopy can give information on the fold of the protein and also allows to follow aggregation phenomena. Small angle neutron scattering also reports on the global structure of proteins in solution and can give information on the shape of growing aggregates or folded proteins in solution.

In the framework of the BMBF-funded project "Neut-IR", we would like to explore the capabilities of quantum cascade lasers (QCLs) for the combination of small angle neutron scattering with infrared spectroscopy. Their advantages are superior Gaussian beam characteristics and a higher spectral density as compared to the glow bar infrared light sources of the Fourier-transform infrared spectrometer (FTIR). Their disadvantage is the more complicated pulsed mode of operation and the limited spectral width they can cover.

As a first scientific sample, the effect of a pH drop on protein aggregation and amyloid like structure formation in insulin is investigated. Insulin is a peptide hormone, secreted in ß-cells of the pancreatic islets. Insulin was dissolved in a phosphate buffer, where the pH was adjusted to 2. At room temperature the sample was pumped through varying combinations of flow through cells of the FTIR spectrometer, the QCL, the UV-Visible spectrophotometer and the static light scattering device. Thereby we could follow the amyloid like structure formation on the very same sample using many different techniques in parallel. The initial result related to the amyloid like structure formation, obtained by FTIR measurements is shown in Figure 1. As seen, the amyloid formation peak can be observed at 1627 cm^{-1}. Furthermore, a peak near 1650 cm^{-1} is due to the amide I vibration.

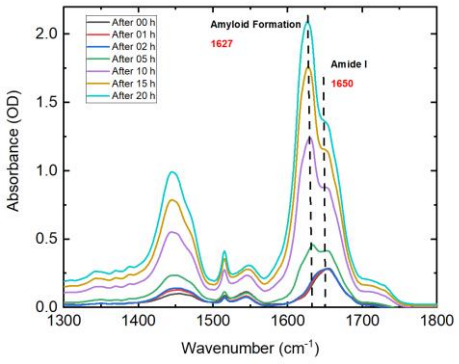

Figure 1: FTIR measurement for human insulin at pH = 2 with a phosphate buffer of 200 mM.