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ABSTRACT BOOK

Mid-infrared lab-on-a-chip for highly-sensitive plasmonic sensing of proteins

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The recent advances in high-performance mid-IR quantum cascade devices [1], i.e. quantum cascade laser (QCLs) and detectors (QCDs), enabled a whole new field of liquid spectroscopy by realizing the so-called QCLDs which monolithically integrate both: a coherent light source (QCL) and a high-performance detector (QCD) on the same chip. Connecting them with a dielectric-loaded plasmonic waveguide [1], opens the pathway to highly-sensitive on-chip measurements of liquids, because the optical mode mainly travels outside in the surrounding medium (>> 90%). This combines two important features for liquid spectroscopy: 1.) the high power of mid-IR QCLs allows to penetrate 10s – 100s of micrometers of liquid films, e.g. in H2O, as compared to a few micrometers only with a globar, and 2.) fully monolithically integrated lab-on-a-chip QCLD configurations, which emit and detect mid-IR light at the identical wavelength. In this work we realize such a mid-IR QCLD device. As a proof-of-concept and to show its performance we analyze two different scenarios: 1.) determination of the water content in the solvent isopropyl alcohol (IPA) at l ~ 1630 – 1660 cm-1 up to ~30% (Fig. 1b.) of H2O and measured in a custom made 60-µl microfluidic cell (Fig. 1a.) and 2.) measurement of the absorbance vs concentration curve of the protein bovine serum albumin (BSA) in D2O at 1597 cm-1, for concentrations between ~4 mg/ml up to ~86.5 mg/ml (Fig. 1c.). In this experiment, the entire sensor chip is submerged into the solution. Next, we want to monitor the change of secondary structure of BSA when exposed to increasing temperatures, monitored with our QCLD sensor and compared to similar experiments with other configurations [2].

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[1] B. Schwarz et al., "Monolithically integrated mid-infrared lab-on-a-chip using plasmonics and quantum cascade structures", Nat. Commun. 5, 4085 (2014). [2] A. Schwaighofer, et al. External cavity-quantum cascade laser infrared spectroscopy for secondary structure analysis of proteins at low concentrations. Sci. Rep. 6, 33556, (2016).

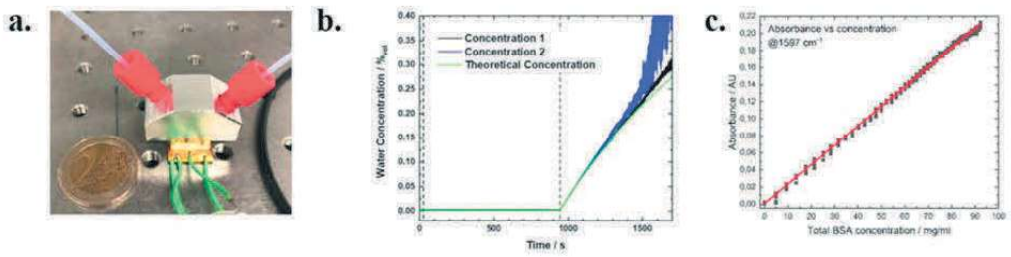

Figure 1: a. Custom made Al fluid-cell (~60 µl) b. Time-dependent water concentration measured in the microfluidic cell. c. Absorbance vs conc. measurement of BSA in D2O, submerging the whole sensor.