QEPAS based sensor for detection of sulfur dioxide using a CW-DFB-QCL

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A sensitive, selective and compact gas sensor based on quartz-enhanced photoacoustic spectroscopy (QEPAS) employing a CW-DFB-QCL operating at 7.25 µm as excitation source was developed for detecting SO_2 at ppbv concentration levels, suitable for environmental and industrial monitoring.

QEPAS is a sensitive technique that allows measurements of trace gases in an ultra-small absorption detection module with a total sample volume of a few mm^3 [1]. A 32.768 kHz quartz tuning fork (QTF) is used as a sharply resonant transducer for acoustic waves, which are induced in an absorbing gas by modulated optical radiation. The QTF is a piezo-electric element which converts its deformation by pressure waves into separation of electrical charges that can be measured as a voltage. A QEPAS signal enhancement can be obtained by adding tubes to the sensor architecture acting as a micro-resonator and furthermore by blending the gas mixture with water vapor, which is an efficient catalyst for V-T relaxation processes in the gas phase [2].

Using 2*f* wavelength modulation spectroscopy (WMS) the DFB-QCL emission wavelength was tuned across an SO_2 absorption line centered at 1380.94 cm^{-1} (Fig. 1 left). The generated acoustic waves were detected by the QTF. The sensitivity and linear response of the QEPAS based SO_2 sensor were investigated at different SO_2 concentration levels (Fig. 1 right). For a certified mixture of 10 ppm SO_2 in N_2, the determined QEPAS SNR was 100, which yielded a minimum detection limit (1σ) of 100 ppbv.

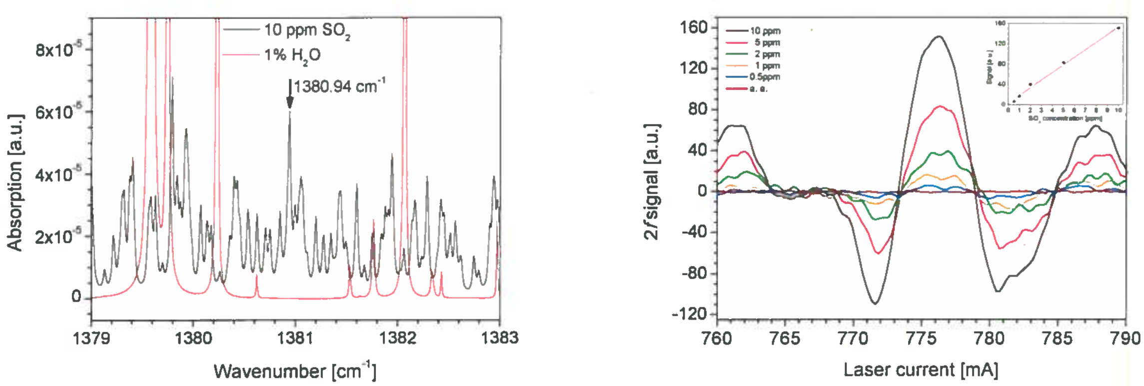

Fig. 1: (left) HITRAN simulated absorption spectrum of 10 ppm SO_2 and 1% water vapor (p=100 torr, l=1 cm); (right) 2*f* wavelength modulation QEPAS signals acquired at different SO_2 concentration levels (a.a.: ambient air). The inset shows the linear dependence of measured 2*f* signals as a function of SO_2 concentrations.

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