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Sub-ppm multi-gas photoacoustic sensor

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The control of industrial processes represents an important field of application for infrared laser spectroscopy. The main requirements of gas sensing instruments for this kind of applications are a good selectivity, a sensitivity at ppm level or even better and continuous on-line monitoring. The capability of measuring simultaneously several species is sometimes also necessary in order to detect various potential contaminants for the process.

In this work we present the design of a new photoacoustic sensor that makes possible the simultaneous measurement of three different gases using tunable laser diodes in the NIR range. The photoacoustic cell is designed to operate in its first longitudinal acoustic mode at about 1 kHz. The sensor was developed for the control of the manufacturing process of novel low-water-content fibres used in optical telecommunications. It aims at monitoring traces of hydrogenated compounds such as H_2O, CH_4 and HCl at sub-ppm level, as the presence of these contaminants during the fabrication of the optical fibre preform results in a large attenuation of the fibre in the 1.39 μm range due to OH^- absorption.

A detection limit (*SNR* = 3) of 0.15 ppm at 1651.0 nm for CH_4, 0.2 ppm at 1742.4 nm for HCl and 24 ppb at 1368.6 nm for H_2O was achieved. The power of each laser was respectively 10 mW, 2 mW and 22 mW.

In addition, the buffer gas used in optical fibre manufacturing plays a crucial role in the photoacoustic response and needs to be included for the evaluation of the gas concentration. Therefore a proper calibration of the system must be performed taking into account the buffer gas composition. Two different buffer gases were used to compare the effect on the photoacoustic signal.