

SPECTROSCOPIC DETECTION OF METHANE AT A PPT SENSITIVITY LEVEL IN MID-IR WITH A LONG-PATH MULTIPASS CELL

HANS A SCHUESSLER, Department of Physics and Astronomy, Texas A&M University, College Station, TX, USA; JINBAO XIA, State Key Laboratory of Crystal Materials, Shandong University, Jinan, China; CARLOS RODRIGUEZ, Department of Physics and Astronomy, Texas A & M University, college station, TX, USA; JAMES R BOUNDS, ALEXANDRE KOLOMENSKII, Department of Physics and Astronomy, Texas A&M University, College Station, TX, USA.

Highly sensitive detection of methane is important for biomedical applications, environmental monitoring, and the detection of leaks in the gas and oil industry. An ultra-high sensitivity sensor employing a mid-IR (MIR) interband cascade laser (center wavelength of 3.37 micron) and a multi-pass cell (MPC) was developed for methane detection. The ultra-high sensitivity is achieved due to the high absorbance in the MIR, a long interaction path length, and the implementation of a wavelet denoising processing algorithm. The long interaction path of 580 m was achieved with a confocal MCP and the distance between the mirrors of 1 m. The performance of the sensor was tested in two measuring modes: direct absorption spectroscopy (DAS) and wavelength modulation spectroscopy (WMS). For the sensor working in the DAS measurement mode the optimal set of sub-wavelet functions was determined and utilized for denoising and the minimum of the Allan deviation of the sensor of 3 ppb was achieved with an averaging time of 200 s. For the WMS measuring mode the sensor detection limit for methane of 560 ppt with 290 s averaging time was determined from the Allan deviation analysis. The developed sensor is suitable for a compact and portable design and has broad applicability in the high-sensitivity measurements of methane and other trace gases. This work was supported by the Robert A Welch Foundation, grant No A1546 and the T3 grant from Texas A and M University and Open Fund of State Key Laboratory of Applied Optics (SKLA02020001A12).

[1] Jinbao Xia et al. A sensitive methane sensor of a ppt detection level using a mid-infrared interband cascade laser and a long-path multipass cell, *Sensors and Actuators B: Chemical*, 334, 129641 (2021). [2] Jinbao Xia: State Key Laboratory of Applied Optics, Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences Changchun, 130033, China