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Recent Advances and Applications of Mid-infrared Cavity and Quartz Enhanced Photoacoustic Spectroscopy

F.K. Tittel [1], V. Spagnolo [1,2], P. Patimisco [1,2], M. Giglio[1,2], A. Sampaolo[1,2], W. Ye[1], Q. He[1], H. Zheng[1,3], M. Lou[1]

[1] *Department of Electrical and Computer Engineering, Rice University, 6100 Main Street, Houston, TX 77005, USA*
[2] *Dipartimento Interateneo di Fisica, Università e Politecnico di Bari, CNR-IFN BARI, Via Amendola 173, Bari, Italy*
[3] *State Key Laboratory of Quantum Optics and Quantum Optics Devices, Institute of Laser Spectroscopy, Shanxi University, Taiyuan 030006, China*

The recent development of compact interband cascade lasers (ICLs) and quantum cascade lasers (QCLs) capable of targeting strong fundamental rotational-vibrational transitions in the mid-infrared has led to the design and fabrication of mid-infrared compact, field deployable sensors based on cavity absorption and enhanced photoacoustic spectroscopy. These sensors have found use in the petrochemical industry, environmental monitoring, monitoring, atmospheric chemistry, life sciences, medical diagnostics, defense and security applications. Specifically, the spectroscopic detection and monitoring of four molecular species, methane (CH_4), ethane (C_2H_6), formaldehyde (H_2CO) and hydrogen sulphide (H2S) will be described.

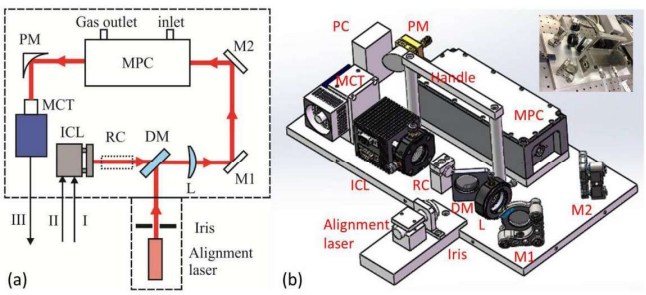

Fig. 1. Schematic of the mid infrared cavity sensor, CAD image of sensor reduced dimensions of length (35.5 cm), width (18 cm), and height (8 cm). Inserted image: photograph of sensor core. ICL: interband cascade laser; DM: dichroic mirror; L: lens; M: plane mirror; MCT: mercury-cadmium-telluride detector; MPC: multi-pass gas cell; PM: parabolic mirror; RC: reference cell.

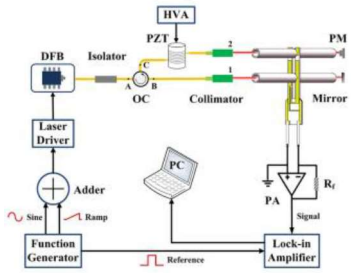

Fig. 2. Schematic of a double antinode excited quartz-enhanced photoacoustic spectroscopy apparatus. DFB: distributed feedback diode laser; OC: optical circulator; PZT: piezoelectric transducer; HVA: high voltage amplifier; PM: power meter; PA: pre-amplifier; and PC: personal computer.

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[2] H. Zheng, L. Dong, P. Patimisco, H. Wu., A. Sampaolo, X. Yin, S. Li, W. Ma, L. Zhang, W Yin, L. Xiao, V. Spagnolo, S. Jia, and F. K. Tittel, *App. Phys. Letters,* **110**, 02110 (2017).

F.K. Tittel acknowledges the support from the Robert Welch Foundation (Grant C-0586), NSF ERC MIRTHE award, DOE ARPA-E, (DE-0000545, DE-0000547)