ACULIGHT®

Argos™

Application Note:
Photoacoustic Spectroscopy / Trace Gas Sensing

Dr. Anatoliy Kosterev and Dr. Frank Tittel at Rice University (Houston, Texas) are leading researchers in developing advanced trace gas sensors for applications such as monitoring pollutant gases and analyzing breath for early and non-invasive detection of diseases. In these applications, the high power and spectral characteristics of a continuous wave (CW) optical parametric oscillator (OPO) enable high-sensitivity detection using a photo-acoustic technique called Quartz-Enhanced Photo-Acoustic Spectroscopy (QEPAS). In 2005, Dr. Kosterev performed QEPAS feasibility tests using a prototype Aculight® CW OPO.

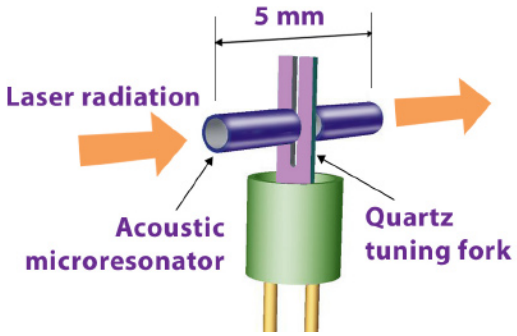

Figure 1: The QEPAS tuning-fork sensor.

With QEPAS, researchers measure the amplitude of the sound wave that is generated when gas molecules absorb modulated light. The detection module is a low-cost, compact, quartz tuning fork, such as those commonly found in digital watches. The QEPAS sensor has a resonant frequency of ~32 kHz, so the OPO source must be frequency modulated at half this frequency over a range corresponding to the width of an absorption feature of the gas. To allow the high frequency modulation rate, the prototype OPO used a 1080-nm distributed Bragg reflector (DBR) diode laser as the seed for its pump fiber laser. (In Aculight Argos™ CW OPO systems, a fiber-coupled diode laser can be simply exchanged for the standard fiber laser seed to enable high modulation frequencies.)

By applying a slow current sweep to the diode in addition to the modulation signal, Kosterev's team recorded 2f wavelength modulation spectra of ammonia and water vapor at 2.8 µm.

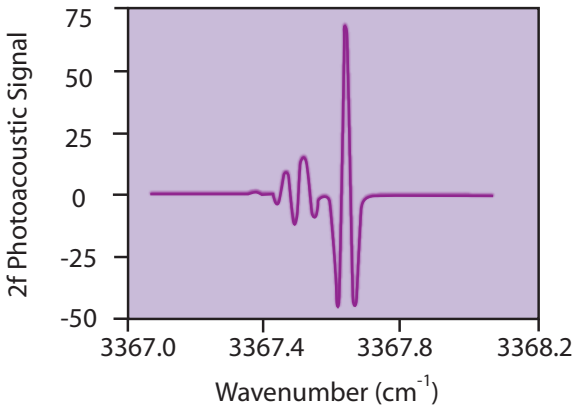

Figure 2: The spectrum recorded using the output of an Aculight CW OPO shows absorption features for water vapor and ammonia.

The Rice group, in cooperation with a team at Nijmegen University in the Netherlands, has also applied QEPAS to trace ethane detection. They used a CW OPO producing 300 mW at 3µm to detect ethane to a concentration level of 13 parts-per-billion. The Rice researchers now have an Aculight Argos system that produces 3 W and with it they expect to improve detection sensitivity by a factor of 10.

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