Off-Axis Integrated Cavity Output spectroscopy for trace gas detection

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There is a growing interest to use coherent light (from non-linear generation or lasers) from molecular trace gas detection. As the strongest molecular absorptions are in the mid-infrared wavelength region Quantum Cascade lasers, Interband Cascade lasers, Optical Parametric Oscillators, Difference frequency Generation systems are used for this. On the other hand Semiconductor lasers in the near infrared wavelength region (Telecom lasers) are also successfully used thanks to their mature technology, although the absorption strength in that wavelength region is a factor 100-100 times weaker. Such trace gas detection systems are used in environmental sciences, biology, agriculture and medical sciences. Nowadays, such coherent systems provide relatively high output power, narrow linewidth and emit almost at any desired wavelength within the infrared wavelength. Accurate detection of specific gases becomes into reach thanks to the known infrared fingerprint absorption spectrum of many molecular gases and the exact tuning capabilities of lasers. When the lasers are combined with sensitive spectroscopic techniques, such as photoacoustic spectroscopy and Off-Axis-Integrated Cavity Output Spectroscopy (OA-ICOS), gases can be determined extremely sensitive under atmospheric conditions.
Here, the performance of OPOs and Quantum cascade lasers for trace gas sensing is demonstrated in combination with OA- ICOS, we demonstrate the analysis from breath detecting CH_4, C_2H_6, CO, HCN and NO. The advantages are a rapid, sensitive, multicomponent trace gas detector for gases at sub-second time scale in single exhalations of human breath at the low part per billion levels. We present the real-time HCN production from *P. aeruginosa* strains *in vitro*, using laser-based photoacoustic spectroscopy and compare this with OA-ICOS using a near-infrared semiconductor laser.