Trace Gas Detection with Quantum Cascade Lasers

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Infrared laser absorption spectroscopy is an extremely effective tool for detecting trace gases. The demonstrated sensitivity of this technique is at the parts per billion (ppb) level. The usefulness of the laser spectroscopy approach is limited by the availability of convenient tunable sources in the spectroscopically important "fingerprint" region from 3 to 20 μm. The recent development of quantum cascade lasers with distributed feedback (QC-DFB) fabricated by band structure engineering offers an attractive option for IR absorption spectroscopy. Pulsed QC-DFB is the only kind of semiconductor laser capable of near-room temperature mid-IR operation. We shall report the design and performance of cw and pulsed QC-DFB laser based gas sensors for the detection and quantification of trace gases in ambient air by means of sensitive absorption spectroscopy. N_2O, $^{12}CH_4$, $^{13}CH_4$, and different isotopic species of H_2O were detected.