

CHEMICAL SENSING WITH QUANTUM CASCADE LASERS

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This talk will focus on the development of compact trace gas sensors based quantum cascade lasers for the detection, quantification, and monitoring of several key trace gas species in ambient air addressing important analytical instrumentation needs in atmospheric chemistry, industrial and medical applications. The use of quantum cascade lasers will permit to target strong fundamental rotational-vibrational transitions in the mid-infrared, which are one to two orders of magnitudes more intense than overtone or combination band transitions in the near infrared.

Novel quantum cascade distributed feedback (QC-DFB) lasers fabricated by band structure engineering and grown by molecular beam epitaxy offer an attractive new radiation source for mid-IR laser absorption spectroscopy in the 3.5 to 80 μm spectral range. The most technologically developed system to date is based on intersubband transitions (type-I QC) in InGaAs/InAlAs heterostructures [1].

The architecture and performance of several sensitive, selective and real-time gas sensors based on mid-infrared cw and pulsed QC-DFB lasers will be described. To date we have detected 11 gases (CH_4 , N_2O , CO_2 , CO , NO , H_2O , NH_3 , C_2H_4 , OCS , C_2H_4 and $\text{C}_2\text{H}_5\text{OH}$) including isotopic signatures of carbon and oxygen at the ppm to the ppt level [2-4]. This requires different sensitivity enhancement schemes such as multipass gas absorption cells, cavity ring down and photo-acoustic absorption spectroscopy which can realize minimum detectable absorbances in the range from 10^{-4} to 10^{-6} in several real world applications. Specific examples of sensors for detecting NH_3 , CO and NO will be reported.

References:

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