

Laser based Chemical Sensor Technology: Recent Advances and Applications

Frank K. Tittel

Rice Quantum Institute, Rice University, Houston, TX, USA

This talk will focus on recent advances in the development of sensors based on infrared semiconductor lasers for the detection, quantification and monitoring of trace gas species and their application to environmental monitoring, medical diagnostics and industrial process control. The development of compact trace gas sensors based on the use of both diode lasers as well as quantum cascade (QC) and interband cascade (IC) lasers will be described. QC and IC lasers permit the targeting strong fundamental rotational-vibrational transitions in the mid-infrared.

The architecture and performance of several sensitive, selective and real-time gas sensors based on near and mid-infrared semiconductor lasers will be discussed. To date we have detected 14 gases (CH_4 , N_2O , CO_2 , CO , NO , H_2O , SO_2 , NH_3 , C_2H_4 , OCS , C_2H_2 , H_2CO , $\text{C}_2\text{H}_5\text{OH}$ and C_2HF_5) at the ppm to ppt level. In several cases, isotopic signatures of carbon and oxygen have also been observed. High sensitivity requires sensitivity enhancement schemes such as multipass gas absorption cells, cavity absorption enhancement, or photo-acoustic absorption spectroscopy. These methods can achieve minimum detectable absorbances in the range from 10^{-4} to 10^{-5} for field deployable gas sensors. Several recent examples of real world applications in atmospheric chemistry, medical diagnostics and the monitoring of air quality in spacecraft habitats will be described.

References: <http://www.ece.rice.edu/lasersci>