MID-INFRARED SEMICONDUCTOR LASER BASED PHOTOACOUSTIC SPECTROSCOPY FOR INNOVATIVE TRACE GAS SENSOR APPLICATIONS

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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 in atmospheric chemistry, medical diagnostics, life sciences, industrial process control and national security [1-2]. The development of compact trace gas sensors, in particular based on quantum cascade and interband cascade lasers which permit the targeting of strong fundamental rotational-vibrational transitions in the mid-infrared and that are one to two orders of magnitude more intense than overtone transitions in the near infrared. Specifically, the spectroscopic detection and monitoring of five molecular species, such as carbon monoxide (CO) [3], nitric oxide (NO) [4], methane (CH_4), nitrous oxide (N_2O), ammonia (NH_3) [5] and sulfur dioxide (SO_2) will be described. These molecules were detected using conventional photoacoustic (CPAS) and quartz-enhanced photoacoustic spectroscopy (QEPAS). CPAS and QEPAS can achieve minimum detectable absorption losses in the range from 10^{-8} to 10^{-11} $cm^{-1}/\sqrt{Hz}$. Several recent examples of real world applications of field deployable gas sensors will be described. Future work includes the detection of environmental important target analytes, such as H_2O_2 and CH_2O in the mid-IR and the development of cavity-enhanced optical feedback –assisted CPAS and QEPAS in order to obtain significantly lower minimum detectable gas concentration levels of < 10 pptv [6].

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