Frank K. Tittel Rice Quantum Institute
MS 366, Rice University, 6100 Main St., Houston, TX 77005

This talk will focus on recent advances in the development of sensors based on infrared semiconductor lasers for the detection, quantification and monitoring of gas species and their applications to sustainable energy technologies, specifically environmental monitoring. Ultrasensitive chemical analysis of gases based on molecular absorption laser spectroscopy is a well-established technology. 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 emphasized. QC and IC lasers permit the targeting of strong fundamental rotational-vibrational transitions in the mid-infrared, that are one to two orders of magnitude more intense than overtone transitions in the near infrared.
The architecture and performance of several sensitive, selective and real-time gas sensors based on near and mid-infrared semiconductor lasers will be described. High detection sensitivity at ppbv and pptv concentration levels requires sensitivity enhancement schemes such as multipass gas absorption cells, cavity absorption enhancement techniques, 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 environmental monitoring will be reported.

Bio:
Professor Frank Tittel has been involved in many innovative developments in quantum electronics and laser technology since the discovery of the laser in 1960, with applications ranging from laser spectroscopy to environmental monitoring. Current research activities by Professor Tittel, together with Professor Robert Curl of the Chemistry Department, have led to the development of several advanced, state of the art, computerized laser spectrometers. The most recent designs utilize telecommunications technology and novel quantum cascade lasers to achieve compact, robust instrumentation that can be deployed for field applications, such as at NASA's Johnson Space Center related to air and water quality issues relevant to the International Space Station, by the Environmental Protection Agency for urban formaldehyde monitoring, and by the National Institute of Health for non-invasive NO and CO detection in biomedical systems. Long-term, sensitive, selective, and real time trace gas monitoring and quantification has been realized for trace gas concentrations ranging from the part per million to the part per trillion levels in ambient air using laser absorption spectroscopy with fiber amplified diode laser and quantum cascade laser based gas sensors.
Professor Tittel is a Fellow of the Institute of Electrical and Electronic Engineers, the Optical Society of America, and the American Physical Society. He received an honorary Dr.Sci. degree in June 1993 from JATE University in Szeged, Hungary. Since 1996 he has been an Associate Editor of *Applied Physics B*.