The Summer Undergraduate Research Fellowship (SURF) Symposium
4 August 2016
Purdue University, West Lafayette, Indiana, USA

Development of a Diode-Laser Absorption-Spectroscopy Sensor for Real-Time Control of Combustion Systems

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ABSTRACT

Tunable diode-laser absorption spectroscopy (TDLAS) sensors are widely used for measuring gas properties. These sensors offer several advantages including: small footprint, affordability, applicability to harsh environments, rapid time response, and calibration-free operation. As a result, diode-laser sensors can be integrated into control-systems and have previously been used to control gas-turbine combustors. In this study, high-frequency sine waves were generated continuously by a LabVIEW program to simultaneously scan and modulate the wavelength and intensity of a diode laser. The modulated laser light was transmitted 20 cm through the air and measured on a photodetector. Custom-built lock-in software was used to acquire the photodetector signal and extract the corresponding 1^{st}- and 2^{nd}-harmonic wavelength-modulation absorption spectroscopy signals (WMS-1f and -2f) resulting from H_2O absorption. The WMS-2f/1f signal was then calculated to enable calibration-free monitoring of gases in real time. During future work, newly developed WMS signal-processing techniques will be used to convert the measured WMS-2f/1f signals into measurements of temperature and H_2O concentration, thereby enabling monitoring and control of real combustion systems.

KEYWORDS

tunable diode lasers, absorption spectroscopy, wavelength modulation spectroscopy