UCRL-JC-123110 Abs

Remote Chemical Sensing by Laser Optical Pumping*

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ORAL PRESENTATION

Conventional Differential Absorption Lidar (DIAL) remote sensing measurements are beset by precision limits imposed by the spectral decorrelation caused by speckle pattern differences between on and off resonant wavelength return signals. This limits both the accuracy and precision of the measurement and requires extensive averaging over independent speckle patterns. A second problem is spectral interferences caused by the presence of absorbers such as other gases, aerosols, or the diffusely reflecting background. We are exploring an entirely new approach to remote chemical identification that promises higher precision than can be achieved by conventional DIAL approaches. It also addresses and potentially solves the problem of detecting a target gas in the presence of an interfering gas or gases. This new approach utilizes an eye-safe infrared pumping pulse to deplete the population of a specific rotational level(s) and then sends probe pulses at the same or different wavelengths to interrogate the bleaching of the absorption. We are exploring various optical-optical double resonance schemes to optimize measurement precision and molecular identification.

We have experimentally measured optical saturation fluence levels at atmospheric pressure for a number of molecules, including HCl and methane, and find these levels to all be significantly below eye-safe limits. In the laboratory, using time delay replicated pulses at a single frequency we have made absorption measurements with precision levels approaching 0.1% on a single shot basis. These results as well as those of two color experiments will be presented.

*This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract W-7405-Eng-48.

Keywords: remote sensing, DIAL, infrared, optical pumping

Charles Stevens is a staff scientist at Lawrence Livermore National Laboratory with a Ph.D. degree in Chemistry from the University of Colorado. His research background and interests are in the areas of molecular spectroscopy and molecular dynamics. Most recently he has been developing new infrared instrumentation, both passive and laser-based, for remote chemical sensing.

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