Paper 23.3

Soot Volume Fraction Characterization Using the Laser-Induced Incandescence Detection Method

David R. Snelling, Gregory J. Smallwood, and Ömer L. Gülder
National Research Council Canada
ICPET Combustion Research Group, Building M-9
1200 Montreal Road
Ottawa, Ontario K1A 0R6
Canada
William D. Bachalo and Subramanian Sankar
Artium Technologies
150 W. Iowa Ave., Suite 101
Sunnyvale, CA, 94086
USA

ABSTRACT

The need is demonstrated for a method and apparatus that measures particulate concentration and primary particle size, that is spatially and temporally resolved, that is capable of real-time measurement and analysis, and that has high sensitivity, wide measurement range, and wide dynamic range, with laser-induced incandescence offering the required capabilities.

The state-of-the-art in LII methodology is briefly reviewed. Details on the effects of laser fluence spatial profile and the effects of the temporal laser fluence distribution are presented, demonstrating the significance of the spatial profile on the excitation curve, and the temporal distribution on the particle temperature and size. The usefulness of LII as a diagnostic instrument for the precise measurement of particulate concentration and primary particle size is demonstrated. Measurements were performed in laminar diffusion flames, the exhaust of a single cylinder DI research diesel engine, and with carbon black.

The use of three wavelength detection to determine particle surface temperature, combined with absolute sensitivity calibration, provides a sensitive, precise, and repeatable measure of the particulate concentration over a wide dynamic range. The LII technique produces good correlation with the gravimetric filter method measurements in the diesel engine exhaust on a mode-by-mode basis over a wide range of operating conditions. The primary particle size can be determined from the LII signals, and the method is precise enough to distinguish particle sizes for different operating conditions in a diesel engine. Once the particulate concentration and primary particle size are known, it is possible to determine the number density of primary particles.