HIGH-ENERGY, PULSED LASER DIAGNOSTICS FOR REAL-TIME MEASUREMENTS OF RECIPROCATING ENGINE PM EMISSIONS

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With stricter particulate matter (PM) emission regulations looming ahead in 2004 and 2007, there is a need for new instrumentation capable of real-time measurements with high sensitivity. We foresee applications for both extractive sampling and *in situ* measurements, where the former is the simplest approach to implement, and the latter is needed to characterize engine-out/aftertreatment in conditions for design optimization and life-cycle simulation. High-energy, pulsed-laser diagnostics are well suited for these tasks, and offer a wide range of measurement capabilities that include the following: (1) laser-induced incandescence (LII) for soot volume fraction and primary particle size; (2) elastic light scattering (ELS) for total volume fraction; (3) laser-induced desorption (LID) with ELS (LIDELS) for volatile fraction; (4) LII with ELS for aggregate size, number, and structure; and (5) laser-induced breakdown spectroscopy (LIBS) for metallic-ash species and concentration.

The principles behind these diagnostics will be briefly discussed, followed by a description of a compact, mobile instrument for "hands-off" implementation based on PC control. Three demonstrations of the instrument's use will be presented: (1) LII measurements during cold-start of a gasoline engine, comparing open- and closed-valve fuel injection; (2) LII measurements of transient diesel PM emissions for a cranking-start/idle/shutdown sequence and on/off cycling of exhaust gas recirculation (EGR); and (3) real-time LIDELS measurements of the volatile fraction during EGR and load sweeps.