Combination of various particle measurement techniques for validation of TiRe-LII in laminar high pressure flames

M. Leschowski, T. Dreier, C. Schulz

Institute for Combustion and Gasdynamics (IVG), and Center for Nanointegration (CENIDE), University of Duisburg-Essen, 47048 Duisburg, Germany, ***martin.leschowski@uni-due.de***

The method of laser-induced incandescence (LII) has become a common way for in-situ particle-size measurements and visualization of particle volume fractions in a wide range of applications [1]. For the further development of LII diagnostics for high-pressure combustion systems, measurements in well-defined laminar and stationary flames enclosed in optically accessible pressure vessels [2] are necessary. Challenges for the LII technique are the quantitative determination of soot particle size and volume fraction from time-resolved (TiRe) LII signal traces under high pressure conditions and their validation by independent calibration and sampling techniques, respectively.

For a complete characterization of the flame environment, a combination of in-situ optical as well as intrusive measurements was employed in a high-pressure burner. Two-color TiRe-LII was used to determine soot particle size, which simultaneously provides the soot volume fraction from the peak intensity of the incandescence signal trace. In our experiments soot particles were heated by the fundamental of a Nd:YAG laser and the incandescence radiation was detected in two wavelength ranges by fast photomultipliers. Additionally, for the determination of soot volume fraction, laser extinction was measured in the near infrared (785 nm) to minimize interference by absorption of polycyclic aromatic hydrocarbons.

To determine the gas temperature, soot luminescence was measured spectrally resolved and fitted with a Planck function. For the spectral radiation measurement an EM-CCD camera was coupled to a spectrometer (focal length 150 mm). To independently verify particle size with transmission electron microscopy (TEM), a pneumatically-driven thermophoretic probe sampling system was designed that allows to insert TEM grids rapidly into the flame at operating pressures up to 40 bar.

The combined information contributes to further improve LII models for evaluating particle size distributions and concentration from TiRe-LII measurements.

1. C. Schulz, B. F. Kock, M. Hofmann, H. Michelsen, S. Will, B. Bougie, R. Suntz, and G. Smallwood, "Laser-induced incandescence: recent trends and current questions," Appl. Phys. B **83,** 333–354 (2006).

2. M. Hofmann, H. Kronemayer, B. F. Kock, H. Jander, and C. Schulz, "Laser-induced incandescence and multi-line NO-LIF thermometry for soot diagnostics at high pressures," in *Proceedings of the European Combustion Meeting*, (2005).