Summary on Discussion session "Coupling techniques"
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Motivation

In this Discussion Session a brief overview of the papers reported in the last years as well as the work presented in the LII workshop concerning the combination of the Laser-Induced Incandescence technique with other optical and/or non-optical diagnostics are given. The main goals are:

- better understanding of LII
- better characterization of carbonaceous particles
- providing information beyond LII (to increase the knowledge of soot properties (e.g. aging, optical, and so on)

The discussion of few burning issues aimed to trigger the objectives for future work (see section on challenges).

Coupling techniques (optical and no-optical) for SVF and size

LII / ELS (1D, 2D) A number of work has been reported in the literature on the combination of LII with Elastic Light Scattering for point and 2 Dimensional measurements

LII / ELS possibilities: ELS collected at 1 angle (90°) to measure the radius of gyration; ELS measured at 35° useful to increase the sensitivity of the measurements for R_g up to 200 nm; ELS collected at two angles (e.g. 30° and 150°), WALS (wide-angle light scattering) to have in one measurement the scattering at each angle.

LII / ELS Instantaneous 1 point / 1 angle for SVF, aggregate radius of gyration and primary particle diameter.

2-color TiRe-LII / Extinction / Soot spectral emission

TEM analysis

Photoacustic

Coupling techniques (optical and no-optical) for other combustion information

LII / LIF New approach to discriminate LIF or LII signal from LIE. LIF measurements preformed with UV (at 266 nm and 355 nm) and visible (at 532 nm) excitations in a diesel diffusion flame. In a premixed flame (mature soot zone), the analysis has been carried out at 660 nm.

2D LII / LIF (for PAH detection)

2D LII / OH PLIF to obtain also a mapping of the flame front (e.g. structure / flow in turbulent flame)

2D LII / TLAF to obtain correlations of soot volume fraction with temperature in turbulent flames

Challenging and standard applications

Standard Flames

Turbulent, non-premixed non-steady flames (high property gradients / non-equal sampling)

High pressure burner

Engine-relevant conditions

Challenges

- Thermophysical model parameters (e.g. E(m), α, ..) at atmospheric and high pressure.

- TEM analysis. The sampling perturbation can produce effects on the size diameter compared to LII measurements (Schulz' team): small particles existing in the agglomerates can be fused within the surface layer, remaining invisible. Effect also of the sampling time. In oxygen excess and high temperature, soot particles loosely attached to the film and not enough cooled by the grid copper can continue to oxidize producing a decrease in the size or even a reduction in the particle number. Best strategy is to keep the exposure time as short as possible.

- SMPS and AMS analysis can give more information on the particle size and composition. By analyzing the ion signals coming from different fragments, information on the particle composition related to the soot aging can be derived.

- Application of other techniques: Near-Edge X-ray Absorption Fine Structure Spectroscopy (NEXAFS), Small-Angle X-ray Scattering (SAXS), wide-angle X-ray Scattering (WAXS), Centrifugal Particle Mass Analysis (CPMA) can be used to investigate the structure and composition of the particles under analysis. The aim is also the investigation of nascent soot and precursors.