

Simultaneous OH and HCHO laser induced fluorescence on premixed flames of various hydrocarbons

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During the past decades, an important amount of experimental works has been dedicated to the detection of the local Heat Release Rate (HRR) which is of great interest in understanding the behaviour of turbulent flames, in particular in IC engines. Previous studies have shown that convolution of Laser Induced Fluorescence signals of hydroxyl (OH) and formaldehyde (HCHO) under atmospheric conditions was a promising way to estimate the heat release rate [1-4]. However, before applying this method in realistic IC engines, it is necessary to study the influence of pressure and fuel on OH and HCHO LIF signals and the result of their convolution. In this study, we investigate the performance of simultaneous LIF measurements of OH and HCHO for laminar stoichiometric premixed methane, n-heptane and isoctane counter-flow flames from 1 to 5 bar.

Experiments were carried out in an axi-symmetrical premixed counter-flow burner producing two planar flames stabilized around the stagnation plane [5, 6]. The burner consists of two 10 mm diameter nozzles. The distance between the two nozzle exits is $d = 10$ mm. Gaseous fuels and air are mixed in a mixing chamber before introduced in the nozzles. Liquid fuels are injected through a vaporization system. Airflow bubbles in a tank filled with the liquid fuel. The tank is placed in a heated water bath which temperature is set to reach saturation conditions in the bubbles of air in fuel. Fuel saturated air is conducted to the mixing chamber where additional air is added. The premixed gas flow is then divided in two flows feeding the two parts of the burner providing the same velocity on both sides (1 m/s). In both burners, a concentric nitrogen screen is injected around the opposed nozzles to prevent inner premixed flow from external perturbations. The burners and the mixing chamber are placed in a 40 L high-pressure vessel which maintains a uniform pressure in the whole experimental area. The high-pressure vessel is equipped with four large quartz windows (40 mm diameter) [7].

The flames are excited by two vertical coplanar laser sheets crossing the burner's axis. The first laser sheet is generated by a frequency-doubled Nd:YAG laser pumping a Dye laser (Rhodamine 590), which frequency is doubled, is used in order to excite the OH radical in the $A^2\Sigma - X^2\Pi$ (1-0) $Q_1(6)$ band at 282.93nm (25 mJ, 7 ns pulse duration). The second laser sheet is generated by a Nd:YAG laser frequency tripled at 355 nm (50mJ, 7ns pulse duration) in order to excite HCHO in the $A^1A_2 - X^1A_1$ 4^1_0 band. The two laser beams are

synchronized and expanded by cylindrical and spherical lenses to form two coplanar sheets (0.5 x 15 mm). The LIF signals are collected by two Intensified CCD cameras (Princeton Instruments, 512 x 512 pixels, 16 bits) equipped with two different interferential filters (305-390 nm for OH and 385-450 nm for HCHO).

OH and HCHO profiles across the flames are measured from the LIF images and are convoluted to obtain HRR for all hydrocarbon fuels and pressures between 1 and 5 bar. The heat release rate profiles have also been used to determine the laminar flame speed by computed the distance between the two flames fronts. We could also estimate the flame thickness that corresponds to the half width distance of the HRR peak.

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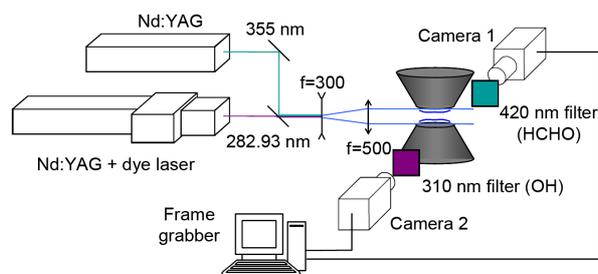


Fig. 1 Schematic view of the optical mount