International Conference on Advanced Optical Technologies
University of Erlangen-Nürnberg, March 13th – 15th 2019

High-speed measurement of temperature and fuel distribution at IC engine conditions using tracer-LIF

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Optimizing the mixing process in internal combustion (IC) engines is necessary to achieve high efficiency and less pollutant emissions. Laser-induced fluorescence (LIF) is an established measurement technique for the 2-dimensional quantitative investigation of mixing processes. Tracer-based LIF using 1-methylnaphthaline (1-MN) allows for the characterization of the mixture formation with regard to temperature and fuel distribution, which are the most influencing factors on the efficiency and pollutant emissions. 1-MN had previously been used for the simultaneous measurement of fuel partial density and temperature in a diesel spray and diesel engine conditions at a sampling rate of 10 Hz. However, high-speed investigations are necessary to enable a time-resolved analysis of the mixture formation. This work presents a high-speed study using n-heptane as fuel and 1-MN as tracer in a rapid compression machine (RCM) at diesel engine conditions. A burst-mode laser provides high repetition rates (7.5 kHz) and high pulse energies (~2.2 mJ) for the tracer excitation at 266 nm. A large light sheet of 40 mm x 0.7 mm was formed. A high-speed intensified CMOS camera equipped with an image doubler was utilized for two-color-detection. In this first high-speed application, homogenous conditions during compression were investigated as well as fuel injection at TDC (top dead center). Measurements were conducted in nitrogen atmosphere at maximal pressures of 4.5 MPa. The temperatures determined for homogeneous mixtures are slightly smaller than the calculated isentropic compression temperature. Detection of single injection cycles enabled tracking of the expanding fuel cloud after fuel injection, which reveals strong local concentration and temperature inhomogeneities due to evaporation as well as large cyclic variations.

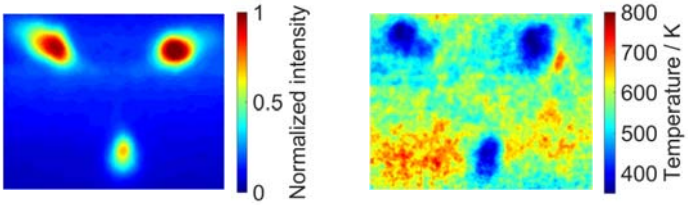

Figure 1 : Single-shot image of qualitative fuel distribution (left) and temperature (right) in a n-heptane spray using 1-MN LIF.