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Fluorescence spectroscopic measurements in methane/air and hydrogen/oxygen atmospheric pressure flames in the excitation wavelength range of 303 nm to 240 nm

by

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ABSTRACT

Laser induced fluorescence (LIF) is a well-known technology to detect different species in combustion processes. One of the most important species is the OH radical, which provides information about combustion kinetics, flame front etc. An other component, the pollutant NO, responsible for the formation of unhealthy ozone O_3 is formed in different kinds of flames.

In the presented work the flame of a methane/air Bunsen burner and a flame of a hydrogen/oxygen welding torch, are investigated, using a laser diode pumped Nd:YAG laser system, tuneable in the UV wavelength range of 325 nm to 210 nm. The tuning device of the laser consists of an OPO (Optical Parametric Oscillator, Type II) and a frequency-doubling device (SHG, Second Harmonic Generator). The laser output frequency has a bandwidth of 15 cm^{-1}. What we aim at with this paper is to show the application possibilities of a tunable OPO laser system in flame research.

In order to find appropriate electronic transitions to excite combustion species like OH, NO or O_2 for selective laser-induced fluorescence measurements, the excitation wavelength range from 303 nm to 240 nm (excitation frequency: 33003 cm^{-1} to 41667 cm^{-1}) was scanned. The transitions of the hydroxyl radical $A^2\ ^+ \leftarrow X^2$ (1,0), (2,0) and (3,0) bands could be excited and were investigated more intensely. Detected OH LIF (laser-induced fluorescence) signals of the (1,0) band are about one hundred times more intense than LIPF (laser-induced predissociative fluorescence) signals of the (3,0) band. With the high fluorescence signal intensity of the OH (1,0) band, it is possible to get images of 2-dimensional time-resolved qualitative OH distribution. In Fig. 1 a 2-dimensional time-resolved OH LIF measurement of a methane/air Bunsen burner flame is shown. The excitation frequency of the Nd:YAG laser was set to 38322 cm^{-1}.

In addition, laser-induced fluorescence of nitrogen monoxide in the $A^2\ ^+$ X^2 (0,2) transition was detected. It is shown, that it is possible to excite NO selectively with the tunable Nd:YAG laser described in the paper.

The results of these investigations are aimed to support an application of the laser system in a combustion chamber, where industrial burners of up to 200 kW thermal output could be analyzed.

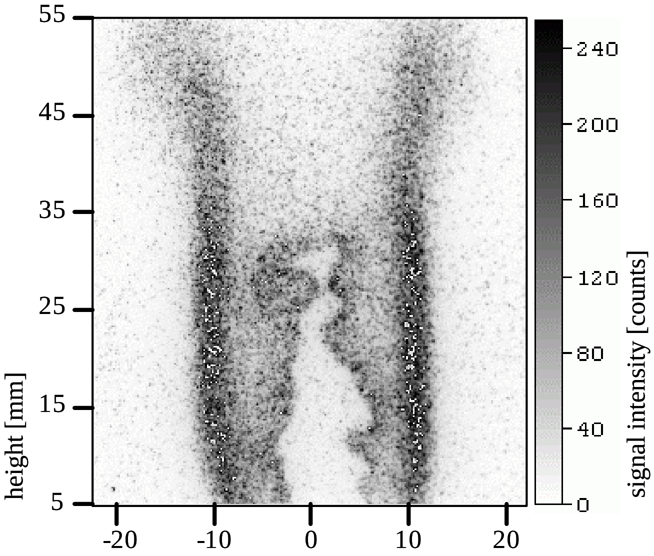

Fig. 1: OH LIF single shot measurement in a methane/air Bunsen burner flame. Excitation frequency at 38322 cm^{-1}.