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In Application

Temperature Imaging in a Heated Jet Flow

2-color Anisole-LIF Thermometry

Gas temperature imaging using 2-color Anisole-LIF

Temperature imaging using Anisole-LIF is applied in a heated air jet close to the nozzle in a nearly laminar and stable flow region of almost axisymmetric structure. The covered temperature was in the range of 300 K to 800 K. More detailed information can be found in the paper of Fuest et al. [1].

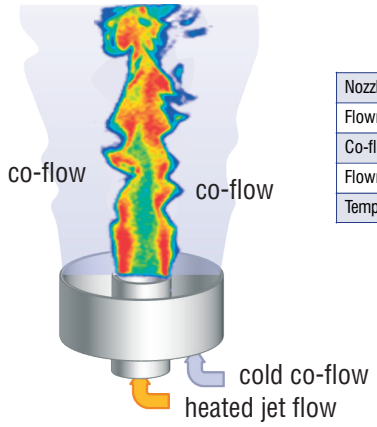
Compared with traditional LIF tracers the anisole tracer generates higher LIF signals at much lower seeding concentration levels [2]. The applied LIF method is based on the change of the anisole fluorescence spectrum with temperature. A 2-color ratiometric imaging approach is used to compensate for seeding density variations as well as laser intensity fluctuations.

Experimental setup

A schematic drawing of the measurement system is shown in Figure 2. The beam from a frequency-quadrupled Nd:YAG laser at 266 nm is guided through a sheet forming optics to generate a divergent light sheet of 55 mm height at jet center line. The laser sheet has a thickness of about 1mm and is placed in the central symmetry plane of the heated jet. The average laser pulse energy in the observation area is 15 mJ.

In LIF applications the fluorescence signal is spectrally separated from the excitation wavelength using optical filters. The Anisole-LIF filter set and corresponding beamsplitter are specifically designed for 2-color LIF measurements such as ratiometric temperature measurements in gaseous flows using anisole tracing.

Following a 2-color strategy for measuring the temperature the anisole fluorescence is spectrally separated into a “blue” and a “red” part by means of a 310 nm dichroic beamsplitter (LP 310).



Nozzle diameter	9 mm
Flowrate jet	10 lpm (unheated air)
Co-flow diameter	35 mm
Flowrate co-flow	200 lpm (cold air)
Temperature range	300 K to 800 K

***Figure 1**: Sketch of the heated air jet nozzle with operation conditions*

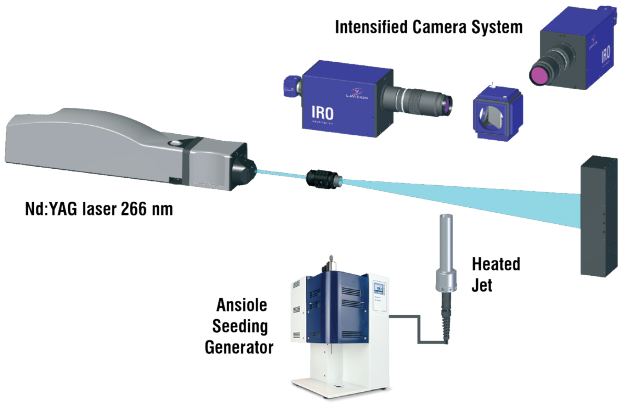


***Figure 2:** Experimental setup for gas temperature imaging using 2-color Anisole-LIF*

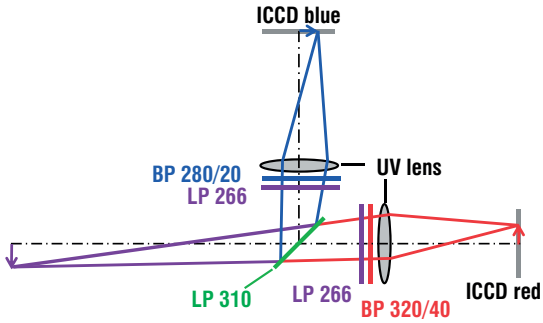


***Figure 3**: Schematic setup of the 2-color Anisole-LIF imaging system including filter set and beamsplitter*

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A 266 nm longpass edge filter (LP 266) in front of each camera lens suppresses remnants of excitation laser light. In addition, bandpass filters at 280 nm ± 10 nm and 320 nm ± 20 nm further narrow the "blue" and "red" spectral range of LIF signal detection, respectively.

Two intensified CMOS cameras (IRO image intensifier lens-coupled with Imager M-lite 2M camera) with UV lenses (f=100 mm, f/2.0) record the spectrally separated LIF signals.

The anisole seeding generator is used to produce a homogeneous and stable anisole seeding of the N_2 gas jet.

Image processing and data evaluation

The recorded data are preprocessed applying background and white field correction, image mapping and signal ratioing. Finally, the corrected ratiometric data are converted to temperature values including uncertainty quantification using the previously recorded calibration curve. This dedicated processing sequence is executed in the right order with a single keystroke in our DaVis LIF software package.

Such measured temperature fields in the air jet at 700 K are shown in Figure 6 below.

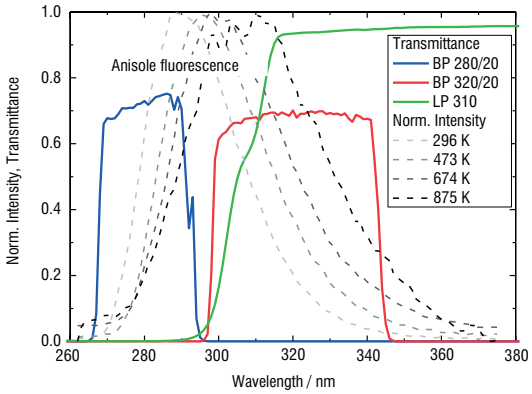

Figure 4: *Typical spectral transmission of filter set and beamsplitter*

Figure 5: *Anisole seeding generator*

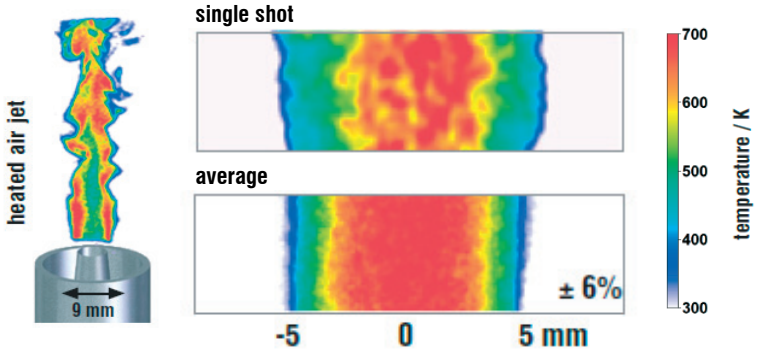

Figure 6: *Single shot and averaged temperature fields measured in the heated air jet at 700 K using 2-color Anisole-LIF*

Reference

[1] Fuest, Frederik et al. "Gas thermometry using four different optical methods", 19th Intl. Symposium on the Application of Laser and Imaging Techniques to Fluid Mechanics, Lisbon 2018

[2] Faust, Stephan et al. „A comparison of selected organic tracers for quantitative scalar imaging in the gas phase via laser-induced fluorescence", Applied Physics B 117.1 (2014): 183-194

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