3-Pentatone PLIF

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Overview

Other members of the ketone family besides acetone are also good candidates for quantitative flow tracers. 3-pentanone, a molecule that may be loosely termed a larger version of acetone, has many of acetone's desirable characteristics mentioned above. A few key differences between these compounds including boiling points and diffusion characteristics make 3-pentanone a better tracer under some conditions. For example, 3-pentanone will evaporate much like iso-octane evaporates, and as a result, researchers in the automotive industry prefer 3-pentanone to acetone in order to study mixing within an internal combustion engine cylinder.

It is necessary to understand the physics behind the fluorescence process to get quantitative data from fluorescence images. To that end, the fluorescence signal intensity of 3-pentanone in nitrogen as a function of temperature was measured, and the figure below shows the results of those measurements. Measurements were also made of the effects of oxygen quenching on signal intensity. A fluorescence model based on the fundamental photophysics is currently under development and will ultimately be tested against high temperature and pressure fluorescence measurements, similar to the conditions found in internal combustion engines.

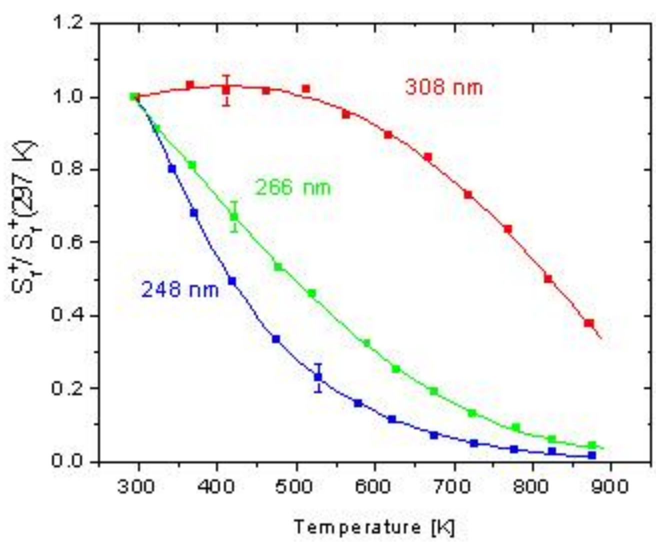

Figure 1: Fluorescence signal intensity of 3-pentatone in nitrogen as a function of temperature

The next image below demonstrates the capabilities of 3-pentanone fluorescence. The flow in this image is a 650 K turbulent jet injected into a room temperature coflow. The 3-pentanone concentration is 4.5% in the main jet and 1.5% in the coflow. The jet was excited at 266 and 308 nm, and the fluorescence was captured using an interline-transfer, unintensified camera. The RMS variations of temperature in relatively uniform regions of the flow is about ±15 K.

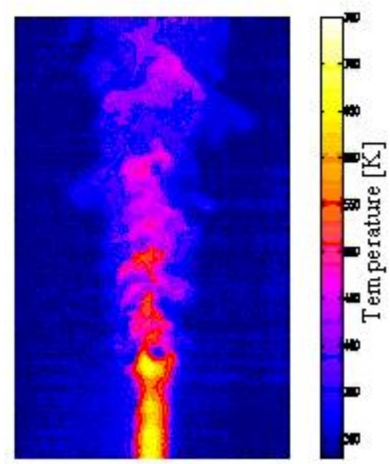

Figure 2: 650 K turbulent jet injected into a room temperature coflow

References

1. Koch J., Hanson R. K. “Temperature and Excitation Wavelength Dependences of 3-Pentanone Absorption and Fluorescence for PLIF Applications.” Applied Physics B 76(3). 2003.
2. Koch J., Koban W., Schulz C., Hanson R.K. “Rayleigh-Calibrated Fluorescence Quantum Yield Measurements of Acetone and 3-Pentanone.” Applied Optics LPEO in press.