Acetone PLIF

Principal Investigator: Dr. Ronald K. Hanson

Research Associates: Dr. Jay Jeffries; Dr. David Davidson

Overview

The advantages that have in the past made acetone concentration imaging attractive have recently been exploited for temperature imaging, using acetone PLIF with single-or dual-wavelength excitation. Taking advantage of experimental data mapping out the excitation-wavelength-dependent variation of acetone fluorescence with temperature, thermometry has been performed on a variety of flows.

Below, a steady flow of acetone-seeded air over a 3 mm diameter heated cylinder is visualized. Using a single-wavelength PLIF technique with a 248 nm excimer laser, the temperature in the flow is measured and is shown using a repeated color table. From this image it is inferred that precision of 1 K is quite reasonable.

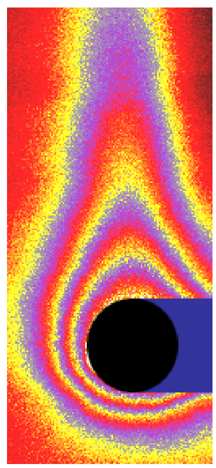

Figure 1: Steady flow of acetone-seeded air over a 3 mm diameter cylinder

The ability of acetone PLIF thermometry to resolve instantaneous flow structure is shown below. Using a frequency-quadrupled Nd:YAG laser at 266 nm, the Kelvin-Helmholtz type instabilities of a heated jet in cold crossflow (jet Reynolds number= 100) are visualized.

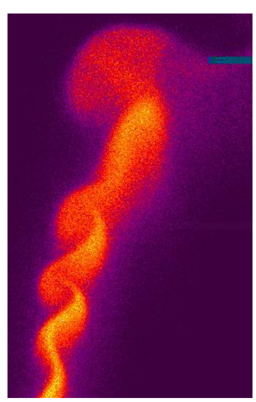

Figure 2: Instantaneous flow field structure

Below, a dual-wavelength excitation technique has been used to measure temperature and mixture fraction nearly simultaneously in a turbulent heated jet. 65 mJ laser pulses at 248 and 308 nm are separated by 800 nsec and collected separately by a fast frame-transfer camera. Temperature resolution is about 7 K while mixture fraction can be resolved to 2%.

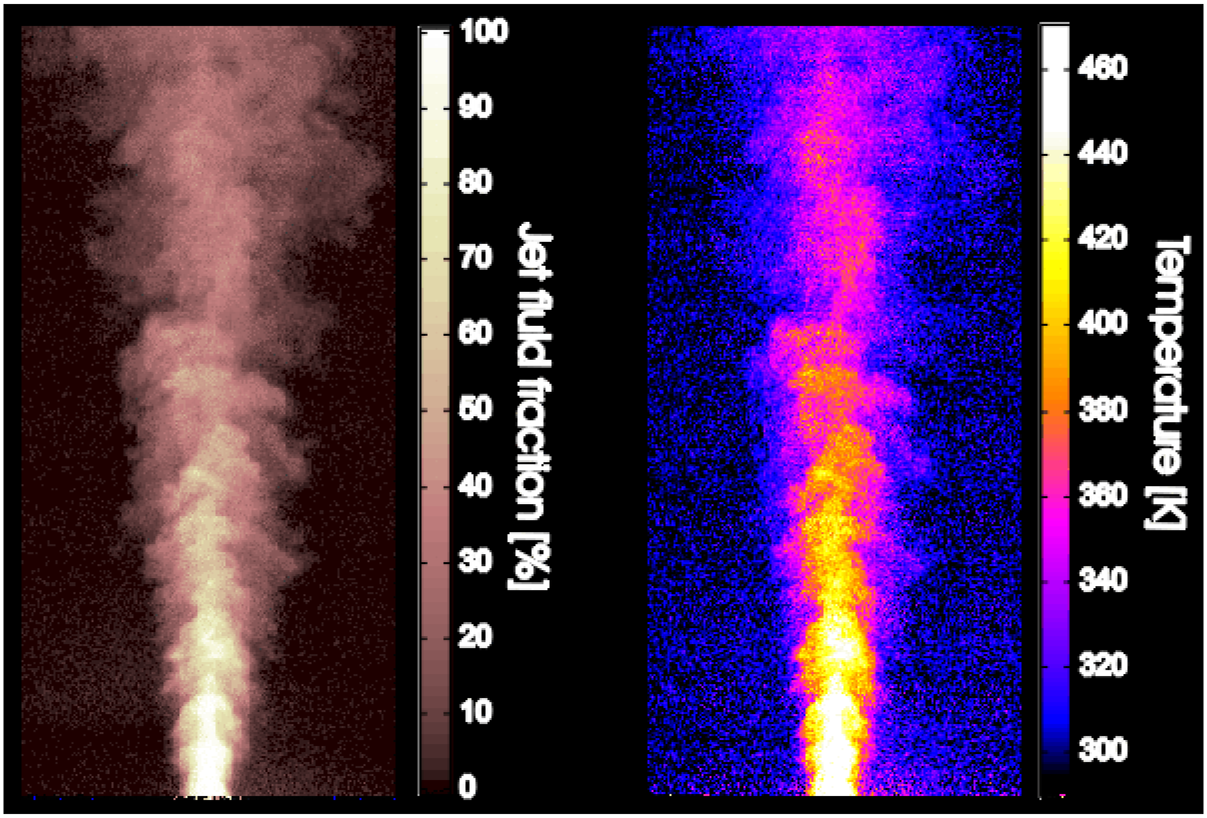

Figure 3: Dual-wavelength excitation technique

References

1. Thurber, M.C. "Acetone Laser-Induced Fluorescence for Temperature and Multiparameter Imaging in Gaseous Flows," Ph.D. Thesis, Stanford University Mechanical Engineering Department, March 1999.
2. Thurber, M.C. and Hanson, R.K. "Simultaneous imaging of temperature and mole fraction using acetone planar laser-induced fluorescence," Experiments in Fluids. Vol. 30 No. 1, 2001
3. Thurber, M.C. and Hanson, R.K. "Pressure and composition dependences of acetone laser-induced fluorescence with excitation at 248, 266, and 308 nm," Applied Physics B Vol. 69 No. 3, 1999.
4. Thurber, M.C., Kirby, B.J., and Hanson, R.K. AIAA Paper 98-0397 "Instantaneous Imaging of Temperature and Mixture Fraction with Dual-Wavelength Acetone PLIF," presented at the 36th AIAA Aerospace Sciences Meeting and Exhibit, January 12-15, 1998, Reno, NV
5. Thurber, M.C., Grisch, F., Kirby, B.J., Votsmeier, M., and Hanson, R.K. "Measurements and Modeling of Acetone Laser-induced Fluorescence with Implications for Temperature-imaging Diagnostics," Applied Optics Vol. 37 No. 21, 1998.
6. Thurber, M.C., Kirby, B.J., Grisch, F., and Hanson, R.K. AIAA Paper 97-0151 "Instantaneous Temperature Imaging with Single-Wavelength Acetone PLIF," presented at the 35th AIAA Aerospace Sciences Meeting and Exhibit, January 6-10, 1997, Reno, NV
7. Thurber, M.C., Grisch, F., and Hanson, R.K. "Temperature Imaging with Single-and Dual-Wavelength Acetone Planar Laser-Induced Fluorescence," Optics Letters Vol. 22, No. 4, 1997.

8. Grisch, F., Thurber, M.C., and Hanson, R.K. "Mesure de temperature par fluorescence induite par laser sur la molecule d'acetone," Revue Scientifique et Technique de la Defense, 1997.
9. Thurber, M.C., Grisch, F., and Hanson, R.K. AIAA Paper 96-2936 "Temperature Imaging with Single-and Dual-Wavelength Acetone PLIF," presented at the 32nd AIAA/ASME/SAE/ASEE Joint Propulsion Conference, July 1-3, 1996, Lake Buena Vista, FL
10. Grisch, F., Thurber, M.C., and Hanson, R.K.Paper 95F-192 "Acetone Fluorescence for Temperature Measurement," presented at the Fall 1995 meeting of the Western States Section of the Combustion Institute, October 30-31, 1995, Stanford, CA