CO2 UV Absorption and LIF

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Shock Heated Carbon Dioxide UV Absorption

Absorption of UV light by carbon dioxide in high temperature & high pressure conditions is studied in our shock tube facility. Spectrally resolved UV absorption cross-sections between 190 and 320nm are measured in shock heated CO2 between 880 and 3050K and H2O between 1230 and 2860K. Absorption spectra were acquired with a kinetic spectrograph, thereby enabling comparisons with time-dependent chemical kinetic modeling of post-shock thermal decomposition and chemical reactions. CO2 absorption cross-sections were calculated as function of temperature and wavelength.

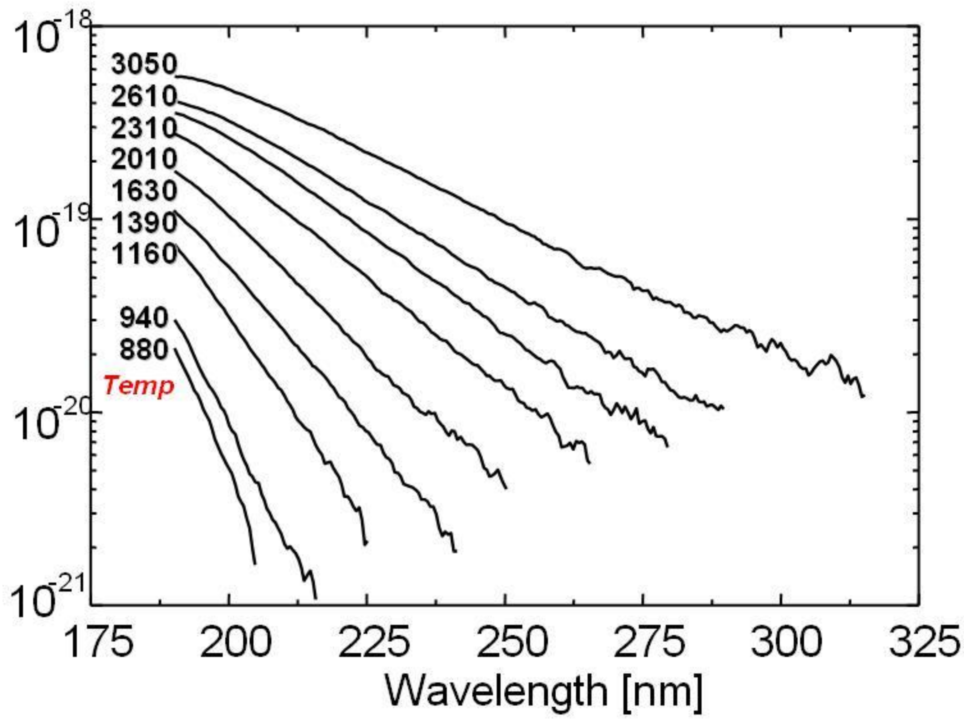

Figure 1: Absorption cross-section of CO2 versus temperature and wavelength

Carbon Dioxide UV LIF in High-Pressure Flames

Laser-induced fluorescence (LIF) of carbon dioxide was investigated with excitation between 215 and 255nm with spectrally resolved detection in 5-40 bar premixed CH4/O2/Ar flames for different air/fuel ratios. Carbon dioxide LIF signal consists of a broad (200-450nm) continuum with a faint superimposed structure. Evidence of this signal of being carbon dioxide is from the fact that signal variations with excitation wavelength, equivalence ratio and flame temperature all correlate with CO2 absorption cross-sections. The signal is linear with pressure and laser fluence within the investigated ranges.

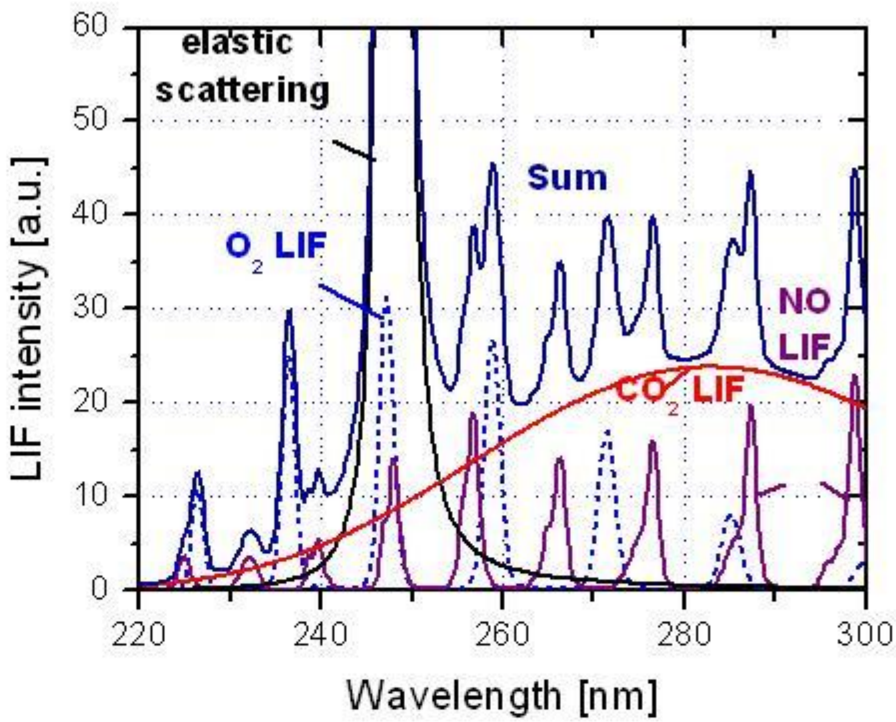

Figure 2: CO2 with 248 mm laser excitation

PLIF Imaging with CO2 UV LIF

Since carbon dioxide UV-LIF signal increases linearly with pressure, it offers possibilities for diagnostics in isothermal high-pressure mixing processes or for temperature field imaging in high-pressure systems with constant CO2 concentrations. This offers a unique advantage to other signal tracers which are adversely effected by pressure due to collisional quenching of the LIF signal. UV planar laser-induced fluorescence (PLIF) images of hot carbon dioxide (CO2) were obtained in a laminar flame (CH4/air) at high pressure (20 bar) with excitation wavelength at 239.34 nm and 242.14 nm. Excitation wavelengths are chosen to minimize the contribution of nitric oxide and molecular oxygen LIF signals. Spectrally resolved single point measurements are used for correction of remaining oxygen LIF interference. The continuum LIF signal from electronically excited CO2 is detected in a broad (280–400 nm) emission region. The UV PLIF of hot CO2 has the potential for application to a wide variety of diagnostic needs in high-pressure flames, combustors, and engines.

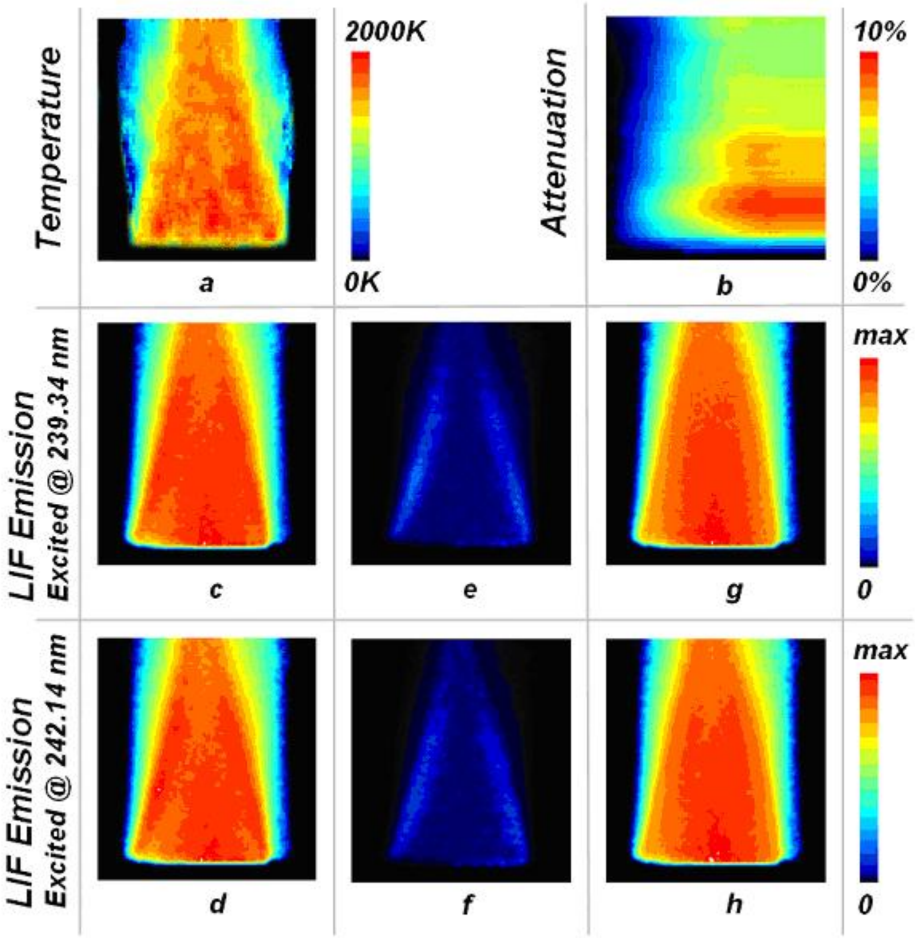

Figure 3: Results of imaging analysis of CO2 UV-PLIF. a temperature field obtained from NO-LIF thermometry. b total attenuation due to hot CO2 and H2O (239.34 nm excitation); c and d CO2-LIF and O2-LIF combined image for 239.34 nm and 242.14 nm excitation, respectively; e and f O2-LIF contribution for 239.34 nm and 242.14 nm excitation, respectively; g and h final CO2-LIF image with O2-LIF correction for 239.34 nm and 242.14 nm excitation, respectively. Images c-h share same scale.

References

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