High-Speed OH* and CH* Chemiluminescence Imaging and OH-PLIF Diagnostics in Spherically Expanding Flames

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A series of experiments were performed in spherically expanding laminar and turbulent flames of premixed hydrocarbon-air mixtures in an optically accessible constant-volume high-pressure vessel. The primary diagnostics used were species-specific high-speed chemiluminescence imaging and single-shot, hydroxyl (OH) radical planar laser-induced fluorescence (PLIF). To the best of our knowledge, the present work is the first-time demonstration of these diagnostics for spherically expanding flames. A high-speed CMOS camera coupled with a high-repetition-rate intensifier was used to acquire the volume-averaged OH* and methylidyne (CH*) chemiluminescence signals at 2 kHz frame rate during the flame propagation. The OH* emission represents the reaction zone and CH* is the marker of the flame front with its spatially resolved form obtained after Abel inversion. Subsequently, a 10-Hz, nanosecond, Nd:YAG laser pumped tunable dye laser was used to perform phase-locked OH PLIF, and images were acquired using an ultraviolet, intensified charge-coupled device (ICCD) camera. These OH PLIF images acquired from the sequential experiments show the temporal distribution of flame diameter and OH radical distribution ensuing the $Q_1(5)$ rotation of the A \leftarrow X (1,0) transition. In addition, an adiabatic Hencken burner calibration was used to calculate the OH number density from the images of OH fluorescence. Further studies will involve the use of these diagnostic techniques as an extension of research on current laminar and turbulent flame conditions as well as the detailed kinetics modeling of spherically expanding flames.

Keywords: Chemiluminescence, High-Speed Imaging, OH-PLIF, Spherical Flames