Characterization of premixed bunsen flames: flow, temperature, and OH radical

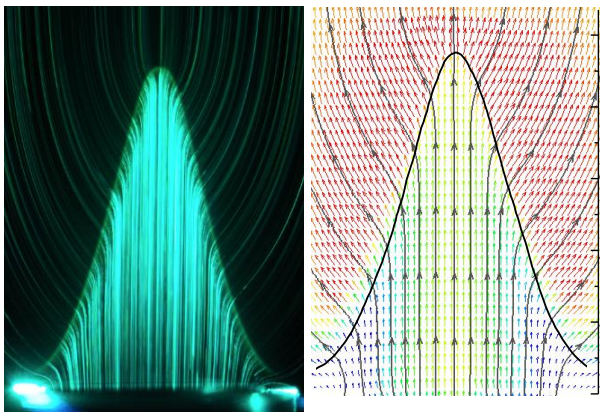
Tran Manh Vu*, Min Suk Cha*†, Byeong Jun Lee**, Suk Ho Chung*

The characteristics of premixed bunsen flame s were studied experimentally. The experiment al setup consisted of a coflow burner, flow con trol system, and various laser diagnostic syste ms to measure OH radicals, velocity, and temp erature. The inner diameter of the central nozz le was 7.53 mm and its thickness was 1.00 m m. The length of the nozzle was set to 470 m m to satisfy the fully developed condition with laminar flows. The air coflow velocity was fix ed at 5 cm/s. Methane, propane, and compress ed air were used for combustible mixtures.

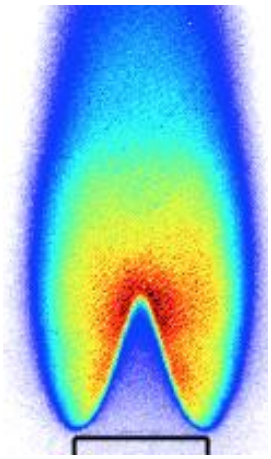
The PLIF setup consisted of a pulsed Nd:YAG laser, a dye laser, and a frequency doubler together with an intensified charge-coupled device camera. A particle image velocimetry was used to characterize flow-fields. A Coherent anti-Stokes Raman spectroscopy (CARS) system, which consisted of a pulsed Nd:YAG laser and a broadband modeless dye laser, was used to measure temperature profiles. The pathlines of the seed TiO_2 particles was also visualized by using a sheet beam of an Ar-ion laser.

The measurements of OH PLIF showed interesting characteristics near the tips of the flames. Since, unlike flame behaviors under the flow condition of positive stretch, the flow-field near the flame tip can be characterized as negatively stretched condition, a thermo-diffusive imbalance (Lewis number effect) affect the flames in an opposite way compared with the cases with positive stretch. Positive stretch used to make a rich propane flame be stronger than that with no stretch, but the flame tip became weaker when we increased the equivalence ratio to be rich. For the methane flame, on the other hand, stronger OH intensity could be found near the flame tip with fuel rich mixtures. The measurements of flow-fields and temperature fields were conducted to highlight the behavior. However, none of these measurements clearly showed the drastic moment of the tip opening.

* KAUST
** Yeungnam University
† Corresponding author,
Email: min.cha@kaust.edu.sa
TEL : Phone: +966 12 808 2709



(a) (b)



(c)

Fig. 1. Various visualization of propane/air flame with Φ = 1. (a) pathlines, (b) PIV flow fields, (c) PLIF OH radical.

Acknowledgments
Research reported in this publication was supported by Competitive Research Funding from King Abdullah University of Science and Technology (KAUST).

References
[1] B. Karlovitz, D.W. Denniston Jr, D.H. Knapschaefer, F.E. Wells, Proc. Combust. Inst. 4 (1) (1953) 613 - 620.
[2] F.A. Williams, AGARD Conference Proceedings, No. 164, 1975.
[3] S.H. Chung, C.K. Law, Combust. Flame 55 (1) (1984) 123 - 125.
[4] M. Matalon, Combust. Sci. Technol. 31 (3 - 4) (1983) 169 - 181.