Chemiluminescence Spectroscopy to Explore the Flame Temperature

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1 Extended Abstracts

There is a wide interest in the detailed structure and dynamics of premixed turbulent flames in the flamelet regimes. In particular, the local extinction in turbulent premixed flames is one of the essential problems that have been closely related to a long time question; “How fast can we burn?”. Although the local extinction in turbulent premixed flames has been predicted in theoretical studies, little experimental evidence has been obtained because a definitive technique to detect the local extinction has not been established. If the local flame temperature in turbulent premixed flames can be measured, the local extinction may be estimated because temperature of the near-extinction flame should decrease. It was shown in a theoretical study that a unique relation exists between the chemiluminescence emissions of the C_2 Swan Bands (515, 470nm bands) and the flame temperature in hydrocarbon/air premixed flames. It implies that the flame temperature in hydrocarbon/air premixed flames can be estimated by measuring emissions of the C_2 Swan Bands. However, emissions of the C_2 Swan Bands are feeble especially in lean hydrocarbon/air flames. In order to detect feeble emissions of the C_2 Swan Bands in lean hydrocarbon/air flames, a spectrometer, composed of dichroic mirrors, band pass filters, photo-multiplier tubes and an I/V amplifier has been newly developed in our laboratory. Use of the newly developed spectrometer together with Cassegrain optics enables to detect feeble emissions of the C_2 Swan Bands with high spatial resolution on the order of 0.1mm. In this study, in order to explore the behavior of the near-extinction flamelet in turbulent premixed flames, the relation between the emission intensity ratio of 515/470nm band of C_2 ($C_2^*(0,0)/C_2^*(1,0)$) and the flame temperature for various strain rates has been sought in strained methane, propane and butane flames by using a counter-flow burner. As the strain rate increases with the equivalence ratio of the mixture is constant, the flame temperature decreases, and the emission intensity ratio of 515/470nm band of C_2 decreases. It can be concluded that if the equivalence ratio of the mixture is known, the flame temperature of strained flames can be estimated.

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