APPLICABILITY OF LASER-INDUCED BREAKDOWN SPECTROSCOPY FOR LOCAL EQUIVALENCE RATIO MEASUREMENTS

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The formation of fuel/oxidizer mixture is of significant importance in combustion systems. Spectroscopic techniques suitable for the measurement of local equivalence ratio in laboratory and in practical combustion systems are currently under study. In the last two decades techniques involving spark spectroscopy have gained the attention of the combustion community. Typically the spark can be originated either by an electric discharge (i.e. engine spark plug) or by a focused laser pulse. Electrical spark emission spectroscopy is mainly restricted to the study of SI engines while Laser Induced Breakdown Spectroscopy (LIBS) is applied on many combustion systems. In principles, due to its simplicity, LIBS represents a very attractive measurement method for sensing the local equivalence ratio in every type of optically accessible combustion environment. In fact, a calibration curve linking the equivalence ratio to the ratio of two characteristic spectral lines of fuel and oxidizer can be easily obtained. However some problems arise when applying the technique to a practical system. Therefore a careful study of the behaviour of the LIBS measurements in a well known and controlled flame is required. In this work, LIBS measurements have been performed in a Bunsen type methane-air premixed flame. In order to evaluate the applicability of the LIBS technique for flames investigations, the spark behaviour and its effects on the flame have been analyzed by visualizations. It has been observed that the plasma is strongly influenced by the local thermodynamic conditions of the gas before the breakdown and every breakdown is followed by a shock wave that tends to disrupt the normal structure of the flame. Therefore, since the plasma characteristics strongly affect the measurements, a proper method for collecting in a single spectrum both plasma information and the characteristic spectral lines of fuel and oxidizer is required. To the same purpose the spectral resolution of the detection system has to be properly fixed.
Moreover, the influence of laser parameters, such as the laser energy and the laser repetition rate, on the LIBS signals have also been investigated and optimized.
Finally, LIBS equivalence ratio measurements at different locations in the flame have been performed and discussed.

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