Measurement of two-phase hydrocarbon spray flows using laser plasma spectroscopy

**S. H. Lee1, J. J. Yoh2**

*1Division of Physical Metrology, Korea Research Institute of Standards and Science,*

*267 Gajeong-ro, Yuseong-Gu, Daejeon 34113, South Korea*

*2Department of Mechanical and Aerospace Engineering, Seoul National University*

*1 Gwanakro, Gwanakgu, Seoul 151-744, South Korea*

*E-mail (corresponding author): seokhwan.lee@kriss.re.kr*

Performance and emission characteristics of direct injection (DI) engines are greatly influenced by many factors such as the local fuel/air equivalence ratio and condensed-fuel concentration. Picturing the inhomogeneous distributions of the flow properties is essential in understanding the ignition processes in two phase hydrocarbon spray flows. Simultaneous laser ignition and spectroscopy is a scheme that enables rapid determination of the local equivalence ratio and condensed fuel concentration during a reaction in two phase spray flows. In parallel with laser ignition, the equivalence ratio and droplet characteristics such as the concentration, size, and distribution of hydrocarbon spray flows are simultaneously obtained for a feedback control system. The plasma characteristics of fuel droplets are evaluated initially by shadowgraph, and the high-speed imaging of air and spray breakdown provides visualization of the transition from the plasma to a flame kernel. The flow fields of the spray are obtained using the time-resolved PIV (Particle Image Velocimetry) method during the laser ignition. The spectrum in the spray is evaluated according to droplet characteristics such as size and number density. The probability density function is used to analyze the interaction between the fuel droplets and the laser plasma with laser-induced breakdown spectroscopy (LIBS) measurements. In this research, we have conducted quantitative analysis of the LIBS signals according to the equivalence ratio, droplet size, droplet number density and droplet concentration for development of a control strategy for flame ignition and stabilization with simultaneous in situ two-phase hydrocarbon flow diagnostics.

*Keywords*: two-phase hydrocarbon spray flows, laser induced plasma, droplet, laser induced breakdown spectroscopy (LIBS)