Characterization of a supersonic flowfield using different laser based techniques

by

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ABSTRACT

An experimental study for supersonic ramjet (Scramjet) application has been performed in a model combustion chamber. The combustion chamber has a very flexible design and has been equipped with uv transmittive quartz windows from all four sides. Hydrogen fuel is injected with a Mach number of 2.0 parallel to the supersonic air flow (M=2.0). The non-reacting, compressible and turbulent flow has been studied using planar Rayleigh scattering and planar Mie scattering. The velocity distribution of the supersonic flow field has been determined by a Laser-Two-Focus technique (L2F). The shock and expansion waves have been visualized with high spatial and temporal resolution by the planar laser based techniques. Absolute shear layer thickness data based on the full width at half maximum criterion of the measured profiles have been determined from the visualized flow field. It is shown that planar Rayleigh scattering suffers considerably from low signal intensities especially at far downstream positions of the supersonic flow field. With the help of particle seeding methods using planar Mie scattering the intensity signal between regions of hydrogen and air has been much enhanced leading to high signal-to-noise ratios. The normalized shear/mixing layer growth rate has been determined in dependence of the convective Mach number M_c. With increasing compressibility level the normalized shear/mixing layer growth rate decreases which agree reasonably well with previous results by other experimenters. A shock wave generated at the inclined upper model combustion chamber wall interacts with the shear/mixing layer leading to enhanced spreading of the shear layer. It is shown that the normalized shear/mixing layer growth rate with shock impingement is only slightly higher than for the case without shock impingement.