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SPACE PROPULSION SYMPOSIUM (C4)
Advanced and Combined Propulsion Systems (8)

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STUDY OF LASER PROPULSION: ONE-DIMENSIONAL MODELING OF LASER-SUPPORTED DETONATION

Abstract

A pulse-laser induced shockwave in a gas is attracting great interests for laser propulsion, etc. In terms of energy conversion, laser-supported detonation (LSD) is important phenomenon. Advancement mechanism of ionization wave is elucidated by the pre-ionization ahead of the head. The seed electrons produced by the photoionization lead the electron avalanche and the following ionization. The avalanche ionization requires a relatively high concentration of seed electron due to the photoionization in front of ionization domain. Thus, the LSD absorbs the laser beam and its ionization front propagates in the direction of the radiation source might be elucidated in the same manner as streamer discharge. Specially, in low Mach-number (less than 10) flow, the photoionization and following ionization process play the main role rather than the shock-induced ionization. Then, behaviour of shock-wave and its flow-field are affected by the ionization head. To investigate flow-field of LSD wave affected by ionization wave advancement, present study shows the design of a narrow tube (rectangular cross-section) that allows quasi-1D LSD wave propagation. The displacement of shock wave and plasma were observed by laser-shadow grapy using ICCD camera. To comparison with the experimental result and RF microwave discharge, one-dimensional CFD analysis consisted of Eular-equation including laser-heating source was conducted. This simply simulation method is needless to assume any specific heat constant for laser heating process. The results reveal that shock wave induced by the optical discharge is elucidated by the behaviour of ionization wave despite of ionization mechanism.