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Internal Structure and Precursor of Laser Supported Detonation

－ レーザー支持爆轟波のプリカーサーと内部構造－

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The present paper is concerned with laser-supported detonation (LSD) that has been investigated intensively in the last decade and represents a possibility of application for laser propulsion. The laser wavelength dependency on LSD wave is discussed in the first part of the paper. A development of high power Neodymium glass (Nd:glass) laser makes a application possibility on laser propulsion. The Nd:glass laser is one of a candidate of the driver for the propulsion. Since the wavelength of Nd:glass laser is shorter as compared with CO_2 laser, the absorption coefficient for glass-laser plasma is smaller than that for CO_2 laser. Thus, Nd:glass laser has been recognized as absorbing laser energy at low efficiency. However, previous study found that laser absorption efficiency for glass laser is much higher than that for CO_2 laser. It also showed that plasma induced using the glass laser absorbed the laser energy during short LSD regime as compared with CO_2 laser. To investigate a influence of laser wavelength for LSD wave in comparison with the CO_2 laser, we used plasma emission spectroscopy and measured the electron temperature and electron density. Results reveal that a high dense and high temperature plasma are sustained as compared with CO_2 laser. The photon mean free path for the plasma induced glass laser is longer than that for CO_2 laser. Thus, despite of short wavelength, the glass laser can absorb the laser energy in long the path at high dense and high temperature.

The second part is concerned with photoionization ahead of shock wave induced by UV radiation. Precursor electrons ahead of a shock wave have been recognized as certain role, like absorbing the laser energy, for sustaining the LSD wave. Photoionization by Ultraviolet (UV) radiation behind the shock wave generate the electrons. To evaluate UV photons emission from plasma, we measured a number density of electrons and the electron temperature and estimated the absorption layer and the radiation volume. And high-purity argon was used as the test gas for comparison with air. Argon gas is one of the inert gases and its ionization and excitation processes are simple comparing with air. As a result, the both of electron temperature and density in the argon laser plasma behind the shock wave were higher than in air plasma. The argon plasma emitted a thousand photons-contributing photoionization at LSD termination, which was higher value as compared with air plasma. From the comparison of the argon plasma and air plasma, it can be concluded that the LSD in argon sustains high dense plasma and generates the photons in relatively large number. Thus, the LSD wave in argon gas was sustained longer than that of air.