MODEL EXPERIMENT OF A MAGNETIC THRUST CHAMBER SYSTEM FOR LASER FUSION ROCKET

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The interaction between high-temperature plasmas and external magnetic field is observed in various physical phenomena, for example, in laboratory: magnetic confinement fusion, fusion reactor wall, and laboratory experiments to study astrophysical phenomena, and in astronomy and space plasmas such as magnetic reconnection in solar system, solar wind interacting with earth's magnetic field, and astrophysical jet formation. Furthermore, the magnetic field can convert the plasma thermal energy to kinetic energy by using a magnetic nozzle to generate thrust for space propulsion systems. This system is called magnetic thrust chamber.

The magnetic thrust chamber is one of the strong candidates as the thrust system of laser fusion rocket (LFR). Previous numerical and theoretical works have shown that it produces both large impulse and high specific impulse which are required for manned interplanetary spaceflight. Recently, Maeno *et al.* have directly measured the impulse from the demonstrated magnetic thrust chamber with a permanent magnet and a laser-produced plasma[1] and Yasunaga *et al.* have measured the magnetic cavity formed as a result of diamagnetic current in a laser-produced plasma[2]. However, the plasma structure and the behavior in the magnetic thrust chamber have never been observed experimentally.

In this paper, we report the plasma propagation and structure formed as a result of the interaction with an external magnetic field in a magnetic thrust chamber. The experiment was performed with the Gekko-XII (GXII) laser and Extreme Ultra-Violet (EUV) database laser at Institute of Laser Engineering, Osaka University. A plastic (CH) sphere target with the diameter of 500 μm was irradiated by multiple laser pulses to simulate the expanding plasma from the inertial confinement fusion. The plasmas were diagnosed by interferometry, gated optical imager (GOI), and charge collectors for measuring density and ion spatial distribution. The plasma shows shell-like structure and its size and thickness depend on the drive-laser energy. These results indicate the field compression by the expanding plasma and magnetic cavity formation. We present these experimental results and the analysis with the radiation hydrodynamic and hybrid simulations[3].

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[3] A. Maeno *et al.*, *J. Propul. Power* **30**, 54-61 (2014)