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高密度ヘリコンプラズマによる完全無電極電気推進の研究(III):
m = 0コイルによる加速

Study on Completely Electrodeless Electric Propulsion System using High-Density Helicon Plasma (II): Acceleration by m = 0 Coil

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An electric rocket engine in space has a higher specific impulse compared to a chemical one. However, in most of the present system, lifetime of the electric rocket is limited by an erosion of electrodes due to direct contacts between a plasma and electrodes. To overcome this problem, we are proposing an electrodeless electric propulsion system with a high efficiency and a long lifetime as the Helicon Electrodeless Advanced Thruster (HEAT) project [1]. This scheme employs a high density (~10^{13} cm^{-3}) helicon plasma accelerated by the Lorentz force, which is generated by the product of the azimuthal current j_θ induced in the plasma and the radial component of the external magnetic field B_r.

The m = 0 coil acceleration is based on a half cycle one by the use of a low frequency coil current [2-3]. Figure 1 shows a conceptual diagram of this scheme. It is an electromagnetic acceleration by the product of B_r and induced j_θ in plasmas with m = 0 coil. Conditions required for the acceleration are as follows: 1) accelerated plasma needs an exhaust from the m = 0 coil region before undergoing a deceleration phase, 2) an impedance from an inductance part of the plasma is dominant than that of a resistance one, 3) electric and magnetic fields generated by m = 0 coil need to be penetrated into a plasma.

Critical operating parameters to achieve an efficient acceleration condition is an external magnetic field strength**,** a driving frequency and magneto motive force of an m = 0 coil. Initial simulation results have shown an operation window in an ion cyclotron frequency range. In addition, this operation requires high plasma density, and a low-pressure for reducing neutral particle collisions. In order to carry out the low-pressure operation, plasma discharge using filament is tried.

The m = 0 coil is designed as follows: a number of coil winding is 10 turns, and magnetomotive force is ~ 200 A·T with AC coil current frequency of ≦ 80 kHz. Here, changes of plasma parameters are measured by Langmuir probes. Figure 2 shows a setup of m = 0 coil on a Large Mirror Device (LMD) [4].

Initial acceleration experimental results will be presented in this conference.

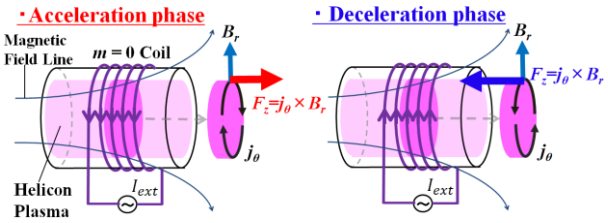

Fig. 1 Principle of m = 0 acceleration.

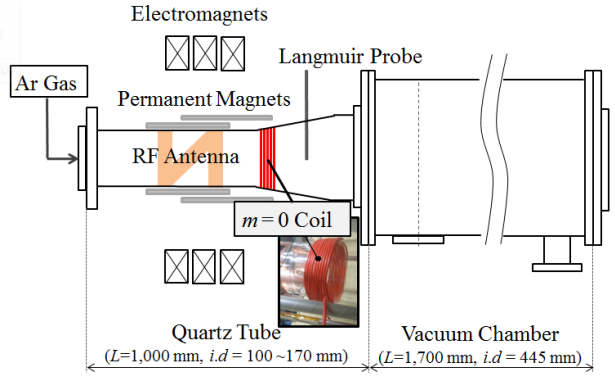

Fig. 2 m = 0 coil setup on LMD.

[1] S. Shinohara *et al.*, *Proc. 32nd Int. Electric Propulsion Conf.*, (2011), IEPC-2011-056.
[2] S. Shinohara *et al.*, Trans. Fus. Sci. Technol. **63** (2013) 164.
[3] S. Shinohara *et al.*, Phys. Plasmas **16** (2009) 057104.
[4] S. Shinohara, S. Takechi and Y. Kawai, Jpn. J. Appl. Phys. **35** (1996) 4503.