Neutral-depletion-induced plasma structure and momentum transport in a helicon source

Kazunori Takahashi[1], Aiki Chiba[1], Yoshinori Takao[2], Atsushi Komuro[1], and Akira Ando[1]

Tohoku University, Sendai 980-8579, Japan

Yokohama National University, Yokohama 240-8501, Japan

e-mail : kazunori@ecei.tohoku.ac.jp

Thrust imparted by an electric propulsion device corresponds to a momentum emitted from the system in space. Recently, a helicon plasm thruster is one of vigorous research topic in the electric propulsion community since the system requires no electrode and is suitable for long-term space mission. The helicon plasma thruster consists only the helicon source and magnetic nozzle, where the high density plasma produced by the helicon discharge is accelerated by the magnetic nozzle and emitted into the space. It is very important to understand the momentum transport inside the source and the magnetic nozzle for further development.

The thrust generation mechanisms by the helicon plasma thruster are very briefly reviewed here, which can be found in Refs. [1-3]. Moreover, when increasing the propellant utilization efficiency (highly ionized plasma), the effect of neutral depletion is shown, where the plasma structure is modified by the neutral depletion. When the ions accelerated by electric field in the plasma core lose to the lateral source wall, they deliver their axial momentum to the wall and the thruster performance is degraded [4]. This momentum loss term is typically assumed to be negligible since the ions are accelerated in the radial direction by a plasma sheath. However, the presently discovered momentum loss process is a common problem for bounded laboratory plasmas beyond the thruster development. The preliminarily result with a particle-in-cell simulation is also briefly presented [5].

[1] K. Takahashi *et al*., Phys. Rev. Lett., **107** (2011) 235001.

[2] K. Takahashi et al., Appl. Phys. Lett., **97** (2011) 141503.

[3] K. Takahashi *et al*., Phys. Rev. Lett., **110** (2013) 195003.

[4] K. Takahashi *et al*., Phys. Rev. Lett. **115** (2015) 195001.

[5] Y. Takao and K. Takahashi, Phys. Plasmas, *to be published*.