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Development of a small MPD arcjet for Future High-Power Space Propulsion

Kazuma Ueno, Shunsuke Otsuka, Yui Sakata, Kyotaro Daito

Department of Electrical and Electronic Engineering, School of Engineering, Chukyo University e-mail k-ueno@sist.chukyo-u.ac.jp:

An MPD (Magnetoplasmadynamic) arcjet is one of the candidate for high-power space propulsion which will be needed for interplanetary logistics or attitude control of massive space structures, because thrust and thrust density of MPD arcjet are much larger than that of other conventional electric propulsion.[1]

MPD arcjet typically consists a coaxial electrode and single arc discharge ionize and accelerate propellant gas. Thus, kA-class discharge current is required to gain large acceleration of plasma generated from the gas. Specific impulse and thrust efficiency are 1000-6000s and 10-50%. Schematic of MPD arcjet structure and acceleration mechanism are shown in Fig. 1.

Research on MPD arcjet was started in Soviet Union and first space demonstration was achieved by Soviet Union. In 1996, a quasi-steady pulsed MPD arcjet thruster was first demonstrated successfully on the Space Flyer Unit by ISAS/JAXA.[2] Toki proposed interplanetary mission by MPD arcjets in 1986. Uematsu developed 1kW MPD thruster in 1986 and summarized thrust performance for various propellants in 1985. Nakata reported geometric effect on MPD arcjet. Although a lot of research was conducted, in order to use MW-class MPD arcjet in space, reduction of electrode erosion is a problem. In this research, a small MPD arcjet experimental system is developed to conduct fundamental studies for a solution of the problem.

Experimental facility for MPD arcjet has been developed in Space Chamber (1 m-diameter and 1.5 m-long) at Chukyo University. The experimental facility is consisted of the pulse power supply with LC ladder circuit (PFN) and the gas feeding system with high-speed valves. To evaluate thrust performance, pendulum-type thrust stand consists aluminum frame and 4-wires is developed. Argon gas is used as propellant gas. Small MPD arcjet is shown in Fig. 3. The original model of small MPD arcjet is used on Magnetoplasma Sail laboratory experiment.[7]



Figure 1 Structure and Acceleration Mechanism of MPD arcjet.



Figure 2 System Configuration of MPD arcjet Experimental Facility.



Figure 3 External View of Small MPD arcjet.

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