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DEMONSTRATION OF THE LOW-POWER HALL THRUSTER WITH WATER PROPELLANT

Abstract

Propulsion systems for micro-/small spacecrafts are attracting attention as devices that enable various advanced missions. Although micro-/small spacecrafts have advantages such as low cost and short-term development, their volume and power generation are limited, and the installation of propulsion systems is still in the development stage. Cold-gas jet thrusters and pulsed plasma thrusters (PPTs), which are currently in practical use, can reach ΔV of 10 m/s. The Hall thruster is an electric propulsion system with a moderately high specific impulse, and it is expected to achieve a higher ΔV when installed in micro-/small spacecrafts. In addition, Hall thrusters operate at high thrust density, which leads a relatively short maneuver time. From these points of view, research and development of low-power Hall thrusters for micro-/small spacecrafts have been actively conducted.

Xenon is often used as a propellant for the Hall thrusters, but the handling as a high-pressure gas and the low availability on the earth defy the advantages of micro-/small spacecrafts. Water has been proposed as an alternative propellant, which is liquid in the standard state and easily acquired. In addition, water is superior in terms of safety, non-toxic, low molecular mass, and future procurement in space. On the other hand, the difficulty of plasma ignition and maintenance is expected due to the low ionization cross section. Oxidation by water is also challenging, especially for cathode operation.

To demonstrate the operation of the low-power Hall thruster with water propellant, a miniature Hall thruster with a channel diameter of 20 mm and a channel width of 6 mm has been developed. In addition, for endurance of oxidation by water, a thermionic electron-emitting cathode with a LaB6 chip is under development. For water vapor supply, a modified supply system which was developed for a microwave discharge ion thruster with water propellant will be used.

In this study, we focus on the anode and demonstrate an operation with water. In addition, the discharge characteristics will be obtained with water and xenon. Moreover, the thrust will be measured directly using a pendulum-type thrust stand. By comparing the operating characteristics using water and xenon, the feasibility of the low-power Hall thruster with water propellant will be discussed.