Abstract

論 文 の 内 容 の 要 旨

論文題目　マイクロ波放電式中和器の性能向上及びプラズマ計測
Performance Enhancements and Plasma Diagnostics of Microwave Discharge Cathode

氏　名　森下　貴都

The microwave ion thruster μ10 was first demonstrated in space by the Japanese asteroid explorer Hayabusa. In its successor Hayabusa2, the thrust was increased by 25%. To apply ion thrusters to future missions, it is necessary to increase the ion current of the ion sources, which in turn requires the electron current of the microwave discharge cathode to be increased.

In this dissertation, two types of performance enhancements are reported. Firstly, the performance was improved by weakening the magnetic field at the cathode's nozzle using a coil. It was confirmed that when the axial magnetic field of the plume of the microwave discharge cathode is weakened to 14 mT in this way, the anode current increases from 180 mA to 260 mA at a constant anode voltage of 37 V. Secondly, the magnetic field intensity and mirror ratio in the discharge chamber were increased. By increasing the magnet field intensity by 10 mT and the mirror ratio from 2.0 to 8.3, the electron current was increased from 300 mA to 560 mA.

To investigate the plasma inside and outside the microwave discharge cathode, a microwave discharge cathode with a small optical window was developed. It was confirmed that the I-V characteristics of the developed viewable cathode

matches that of the flight-model of Hayabusa2 within 7% accuracy. Laser-induced fluorescence (LIF) spectroscopy was performed on the cathode under nominal conditions. The axial and radial ion velocity distribution functions (IVDFs) in the plume region and the axial IVDFs inside the cathode were measured and found to exhibit multimodal characteristics. The measured functions, which represent the number density of Xe II $(^3P_2)6p[3]_{5/2}$, were compared to a previously reported relative number density of xenon ions measured by an electrostatic probe on the plume. In order to discuss the multimodal characteristics, anode current oscillation and radiated emission measurements were conducted. Theoretical models based on the measured current oscillation support the multimodal characteristics. Finally, LIF measurements were conducted on the improved cathodes with the performance enhancements applied. In both improved cathodes, it was confirmed that the density was twice that of the nominal model in the plume, suggesting that the dense plasma contributes to the improvements.