

Reduction of Discharge Oscillations and High Density Plasma Ion Extraction on a Hall Thruster

Yoshihiro Arakawa

(Professor, School of Engineering, University of Tokyo)

【 Outline of survey 】

A Hall thruster is a kind of electric rocket propulsion, which utilizes solar electric energy and converts it to the kinetic energy of a plasma gas for thrust production. Because it delivers much higher specific impulse than chemical propulsion and produces high energy conversion efficiency, a Hall thruster is considered one of the most prospective space propulsion devices for orbital transfer and station keeping of satellites. However it has a significant problem to overcome for practical use in space. Discharge instabilities and oscillations appear in most operating conditions, especially in high power modes. The purpose of this study is 1) to clarify the mechanism of discharge instabilities, 2) to reduce the oscillations as low as possible, and 3) to produce high-density plasma plume. In the present study, we investigate plasma properties inside the acceleration channel of the thruster by using a high-speed camera, laser-induced fluorescent (LIF) diagnostics and a resonance absorption method. Also, a simulation model to express discharge instabilities in the channel is constructed in order to investigate their effects not only on thruster performance but also on the durability of the thruster required for practical use.

【 Expected results 】

A Hall thruster is an electromagnetic accelerator in which plasma ions produced in a coaxial channel are accelerated by Lorentz force between circularly induced Hall current and radially applied magnetic fields. Since it produces high plasma density and high energy conversion efficiency, it delivers higher thrust-power-ratio than the other type of electric propulsion thrusters. If the discharge oscillations were reduced to a low level, Hall thrusters could be functioned for orbit transfer and station keeping of satellites and would be primary propulsion devices for near-earth space missions. Also, it is expected that a Hall thruster is applied for other industrial devices since it produces broad ion beams with much higher density than ion sources.

【 References by the principal researcher 】

K. Kuriki and Y. Arakawa: Introduction to Electric Propulsion, University of Tokyo Press (2003)
N. Yamamoto, Y. Arakawa et al., Discharge Plasma Fluctuations in Hall Thrusters, Vacuum, Vol.65, 375-381 (2002)

【 Term of project 】 F Y 2004 - 2008

【 Budget allocation 】 85,100,000 yen

【 Homepage address 】

<http://www.al.t.u-tokyo.ac.jp>