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超音速ガスパフ燃料供給によるヘリコンプラズマスラスターの性能改善
Performance Improvement of Helicon Plasma Thruster using Supersonic Gas Puffing Method

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1. Introduction

A high-density helicon plasma is promising for a plasma source in a future electric thruster with electrodeless condition [1]. However, it may have a problem of depletion of neutral particles near the central part of the plasma [2], limiting increases of an electron density and plasma thrust. In addition, collisions between a plasma and an inner wall of a discharge tube leads to other problems of an increased plasma loss, a decrease of a fuel efficiency, larger sputtering and higher heat load to the wall.

As Figure 1 (a) shows, neutral particles diffuse throughout the discharge tube in the conventional method. This uniform distribution is considered as the main reason of the problems. Therefore, we have proposed the Supersonic Gas Puffing (SSGP) method [3] and the Internal Feeding Tube method (IFT). Both of these methods, whose details are described after, supplying neutral particles locally into the central part of the helicon plasma is expected to solve these problems.

2. Supersonic Gas Puffing Method (SSGP)

Figure 1 (b) is a schematic view of the SSGP method. This method supplies pulsed neutral particles into the central part of the helicon plasma by a concentrated supersonic gas flow made by the Laval nozzle.

3. Internal Feeding Tube Method (IFT)

Figure 1 (c) shows a schematic of the IFT method. This supplies steady gas flow directly into the central part of the plasma through a small hole in a small-diameter quartz or alumina tube.

4. Experimental Result

We have measured the pressure distribution of neutral gas flow injected via the Laval nozzle, using a developed small-Pirani gauge. Here, supplying pressure is 6 MPa. Figure 2 is the result ($x = z = 0$ is the nozzle exit) of the concentrated gas flow made by the SSGP method.

Using the IFT method, it was observed the plasma thrust increases by up to 51% compared with the conventional method. This result shows the possibility to improve the plasma characteristics by changing a neutral gas supply method. Other experimental results will be also presented in the meeting.

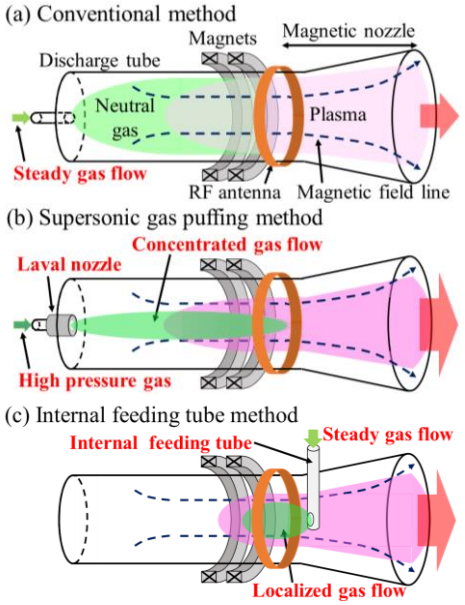

Fig.1. Schematic of conventional and developed gas supply methods.

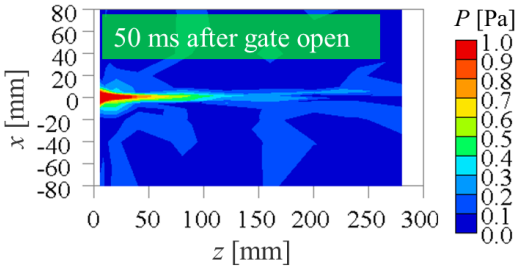

Fig.2. A neutral particle distribution

References

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