§7. Development of Antenna System for High Power rf Ion Source

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1, Faradat shielded multi-antenna rf ion source

We have been developing the multi-antenna rf system for large size and high power sources [1-2]. The antenna consists of four parallel copper pipes (6ϕ, 20cm long) inserted into 20ϕ quartz tubes and is placed in *sus* Faraday shield cage. the antenna is installed in 35 cm x 35 cm x 21 cm rectangular plasma chamber as shown in Fig.1. An extractor installed on the bottom of the chamber has a single hole with 5 mm in diameter. The rf power of 300kW at 9MHz and the pulse width of 10msec is connected to the antenna through the matching circuit.

2, High rf power operation

Faraday shielded antenna has been developed for high rf power operation with low plasma potential (Vp). Plasmas are produced by the inductive rf electric fields near the antenna and diffuse toward the extraction electrode. The available rf power was limited around 40kW for no Faraday shielded antenna due to the break down at antenna inside the chamber. The maximum ion current density (Ii) and electron temperature (Te) are ~15mA/cm^2 and ~20eV, respectively, and Vp increases with Prf. With the Faraday shielded antenna, available input Prf and the resultant Ii increase as shown in Fig. 2. The discharge mode changes around 90kW and Ii tends to saturate around 200kW. The hydrogen gas pressure dependences on Vp, Te and Ii are shown in Fig. 3. Te and Vp are kept <10eV and <5V for Prf=160-170kW and those values are reduced compare to the case without Faraday shield.

At rf power of 130-160kW, H^- ion current reached about 0.05mA. This corresponds to a negative ion current density of 0.25mA/cm^2 at the PG hole. Under a high power level, 0.7 ~ 1.5mA/cm^2 appeared. H^- ion current decreased with the increase of gas pressure. In the extraction of positive ions, maximum ion current density reached 30mA/cm^2 in the external magnetic filter.

[1]T.Shoji, Y.Oka, NBI Group, Rev.Sci.Instrum. **77**, 03B513 (2006)

[2] T. Shoji and Y. Oka, Rev, NIFS, (2006) 142

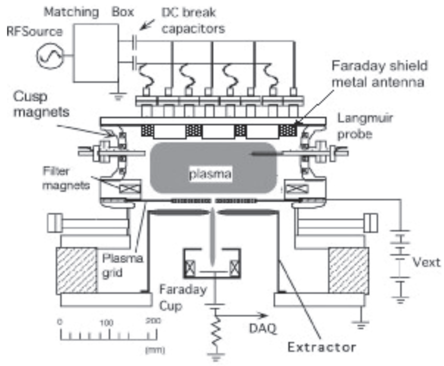

Fig. 1 4-para multi-antenna rf ion souurce

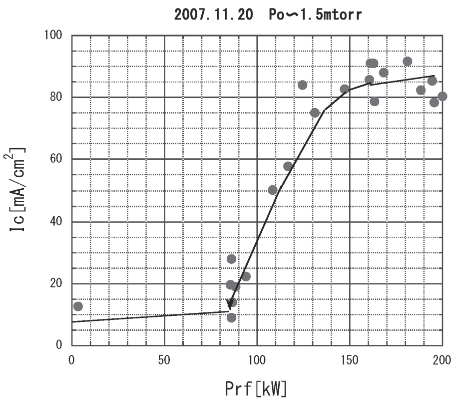

Fig. 2 Dependences of ion current (Ii) on rf power for Faraday shielded antenna. P_0~1.5mtorr (H).

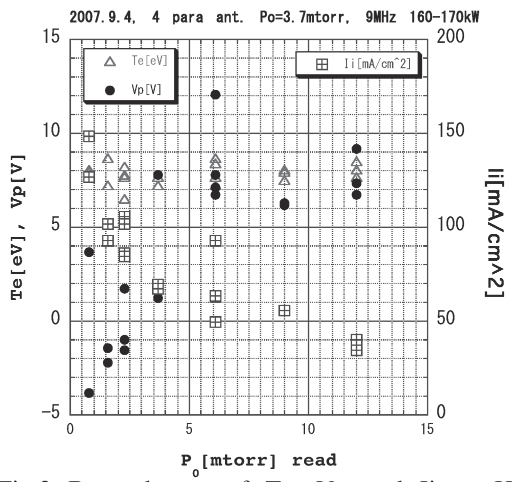

Fig.3 Dependences of Te, Vp and Ii on H gas pressure. Prf=160-170kW.