§15. Development of Multi-Antenna rf Ion Source

Shoji, T., Sakawa, Y. (Dept. Energy Eng. and Sci., Nagoya Univ.), Oka, Y

As a filament less NBI source, rf ion sources have several advantages, such as easy maintenance, long operation time, less contamination from the filament metals etc. For the practical use in a fusion research high beam current and large diameter beam are necessary to be developed. We have been developing the multi- antenna RF system 1-2) for the large diameter ion source. We report here the characteristics of the plasmas produced by using the segmented rf antennas.

In order to achieve the high rf power input on the antennas, the voltage breakdown on the antenna needs to be solved. The multi- antenna system can reduce the antenna inductance and reduce the RF voltage as a result. The antenna elements are made of copper rods and placed in ceramic pipes to avoid taking the net electron current from the plasma, which raise the plasma potential. The antennas are installed in 35 cm x 35 cm x 18 cm rectangular bucket chamber and are connected electrically outside the chamber as shown in Fig. 1(a). We studied the effect of the antenna segmentations on the plasma production characteristics for four types of the antenna configurations as shown in Fig. 1, (b)- (d). The maximum rf power is ~50kW and frequency is 9MHz. The ion saturation current I_{ion} is measured by Langmuir probe at the center of the discharge chamber. In Fig.2, I_{ion} as a function of the input rf power for various kinds of antennas are shown. In case of the single loop antenna, available rf power is limited up to 6kW because of the rf voltage break down at the feed through, however there is no such break down for the 2-8-parallel antennas due to the reduction of the inductance of the antennas. For the 2,4-parallel antennas, I_{ion} has a jump around 10kW and increases rapidly with the rf power up to 20kW and then tends to saturate. The jump around 10kW is considered as the change in discharge modes from the electrostatic (capacitive) to the inductive ones. In this size of the antennas or the chamber, 2, 4-parallel antennas show better performance for efficient plasma production. On the basis of those results, experiment on more high power rf up to few hundred kW using new multi-antenna system is planned.

Reference

1) Oka, Y., Shoji, T. 5th JA-EU Workshop on NBIs (Super JDC), Sept. 18. 2000, CIEMAT Madrid.

2) Oka, Y., Shoji, T., 10th ICIS2003, Sep.2003, Dubna, Russia

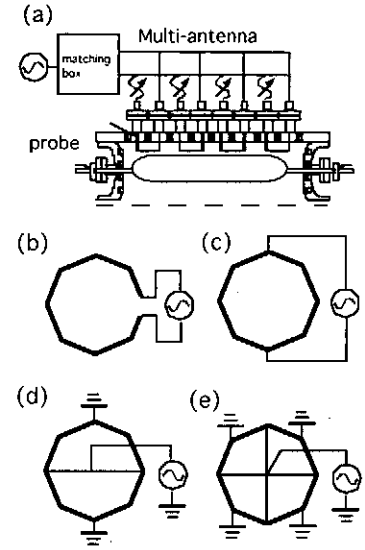

Fig. 1 (a) Multi-antenna RF ion source and segmented antennas. (b) Single loop, (c) 2-parallel, (d) 4-parallel and (e) 8-parallel antennas.

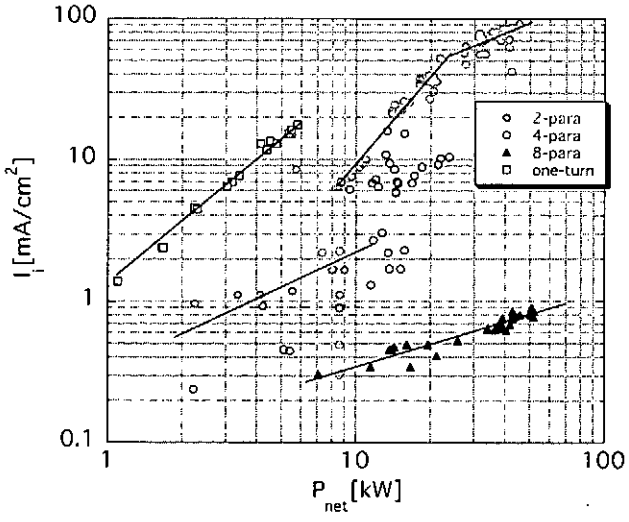

Fig. 2 Ion saturation current versus rf power for various antenna systems. f=9MHz, $P(H_2)$=0.5mtorr.