§11. Development of a RF Driven Compact Au^- Source for Local Electric Potential Measurement of the LHD Plasma

Wada, M. (Doshisha Univ.),
Matsumoto, Y. (Tokushima Bunri Univ.),
Sasao, M., Shinto, K. (Tohoku Univ.),
Yamaoka, H. (RIKEN),
Nishiura, M., Tsumori, K.

A surface production type negative Au^- ion source delivers stably a high energy beam into the LHD plasma for the Heavy Ion Beam Probe (HIBP) System. The magnetic multicusp plasma source sustains the Cs containing Ar plasma by electron emission from hot tungsten filaments.[1] Maintenance of the ion source needs replacement of these filaments as plasma sputtering shortens the filament life time. Thus, we have initiated an investigation on how the ion source maintenance time can be prolonged.

Two approaches are common to realize a longer ion source maintenance interval. One is the radio frequency (RF) discharge sustained by the ionization applying an alternating current at the frequency far much lower than the electron plasma frequency. The other is the microwave discharge, at a frequency close to the electron plasma oscillation causing a cut off at the corresponding electron density. The RF plasma excitation is expected to enhance the yield of negative ion current, and the next generation negative ion source for HIBP is designed to equip a RF magnetron sputtering target,

The RF plasma excitation has been tested with the apparatus shown in Fig. 1. Inside a test chamber is located a 5 cm diameter sputtering target containing magnets to form circular plane magnetron magnetic field. A coax line directly feeds 13.56 MHz RF power to the target from an automated impedance matching box. The maximum input power has been limited to 200 W due to target cooling capability. This target design can be directly applied to a magnetic multicusp ion source designed tested at the National Institute for Fusion Science.

Low gas pressure in the ion source reduces charge exchange loss of negative heavy ion beam. However, the operation pressure of a usual RF sputter device ranges several Pa, and is higher than that of a typical negative ion source. Plasma ignition by a RF electric field requires several Pa of initial pressure, then the pressure can be decreased after the ignition. In Fig. 2, the minimum operational Ar gas pressure is plotted as a function of the input RF power for the experimental configuration shown in Fig. 1. As shown in the figure, the minimum operational pressure decreases as the input RF power increases. The source can be operated with the pressure below 0.1 Pa for RF input power more than 20 W. The RF driven plasma sputter negative ion source will be tested at a test bench, prior to the installation on the HIBP system.

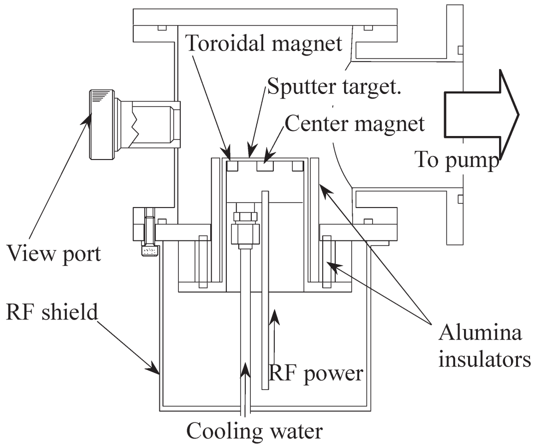

Fig. 1. A test mock-up assembled to investigate RF discharge at low pressure.

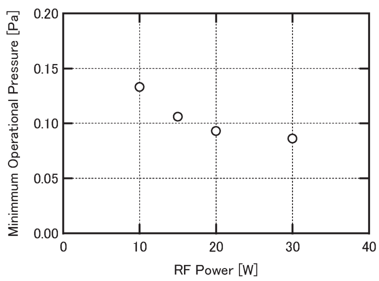

Fig. 2. Minimum Ar pressure required to sustain RF magnetron discharge.

Reference

1) M. Nishiura, T. Ido, A. Shimizu, S. Kato, K. Tsukada, A. Nishizawa, Y. Hamada, Y. Matsumoto, A. Mendenilla, M. Wada, Rev. Sci. Instrum. **77**, 03A537 (2006).