§12. Dependence of H⁻ Extraction Probability on Gas Pressure and Filter Magnetic Field in a Volume-Type Negative Ion Source

Matsumoto, Y., Nishiura, M., Matsuoka, K.,
Sasao, M. (Tohoku Univ.)
Wada, M. (Doshisha Univ.)
Yamaoka, H. (RIKEN)

Volume type negative ion sources in the neutral beam injector are used for the heating of thermo nuclear fusion plasmas. The study of H^- transport process in plasma is important theme for the development of higher efficient negative ion sources.

For the measurement of H^- information in plasma, PD-LP (photodetachment method assisted with Langmuir probe) was developed by M. Bacal[1]. This is the measurement method for H^- density and velocity information in plasmas. This method widely has been used for H^- study. However, PD-LP method is used to measure the H^- information inside plasma, it does not give direct information about the extracted H^- ions which is need to study the H^- transport process and H^- extraction probability from a ion source.

To study the H^- transport process and the extraction probability, we device and develop the newly photodetachment method, PD-FC (photodetachment with Faraday cup) which utilizes temporal change of the ion beam current by photodetachment reaction.[2] Fig.1 shows the experimental apparatus. When ion beam is extracted from an ion source, a pulse laser light is injected into extraction region of the ion source. The pulse laser destroys H^- ions with photodetachment reaction, which are originated on the laser path and extracted from the ion source as ion beam components. Therefore, ion beam current detected by the Faraday cup is dropped suddenly due to destruction of beam components. This time resolution of beam current is reflected to H^- density on the laser path and H^- transports from the laser path to the extraction hole. We can obtain the information of the H^- transports and the number of extracted H^- ions on the laser path, defined as ΔN_{ext}, from these signals. H^- extraction probability from all points of laser path, defined as P_{ext}, can be calculated by follow equation;

$$P_{ext}(Z) = \frac{\Delta N_{ext}(Z)}{\Delta N_{all}(Z)} = \frac{\Delta N_{ext}(Z)}{n^-(Z) \cdot V_L}$$

Z is the distance from the plasma electrode, ΔN_{all} is the total number of H^- ions in laser path and V_L is the volume of laser path. The $n^-(Z)$ is the spatial distribution of H^- density which is measured by PD-LP method with movable Langmuir probe showed in Fig.1. We measure the H^- extraction probability under several gas pressure and magnetic field conditions to study the influence of these conditions for H^- transport.[3]

Fig.2 shows that the dependence of the spatial distribution of the H^- extraction probability on filter magnetic field strength. Fig.2(a) is the low gas pressure case. In this case, the extraction probability is affected by filter magnetic field strength. While, under higher gas pressure case in Fig.2(b), H^- extraction probability is not changed by the difference of filter magnetic field. It is thought that higher gas pressure disturbs the H^- gyro motion by magnetic field, because of the mean free path become shorter. Therefore, we conclude that the filter magnetic field effectively affects the H^- transports in low gas pressure conditions.

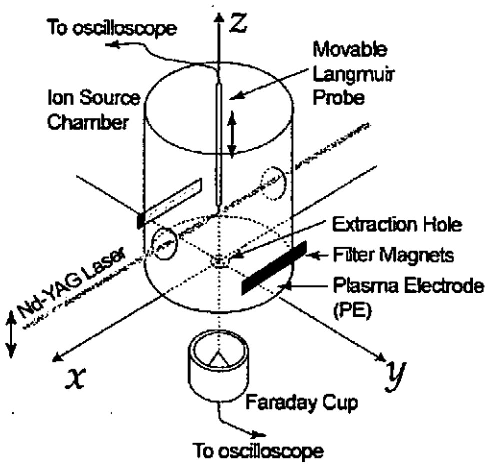

Fig. 1. Experimental apparatus

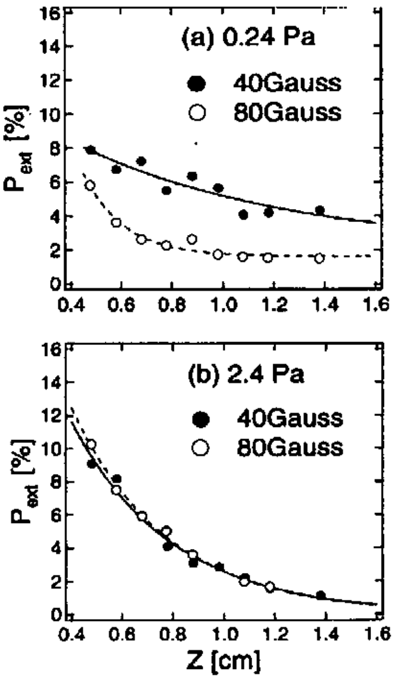

Fig. 2. Dependence of H^- extraction probability on filter magnetic field strength under low gas pressure (0.24Pa) and high gas pressure (2.4Pa) condition.

Reference

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3) Y.Matsumoto, M.Nishiura, K.Matsuoka, M.Sasao, M.Wada and H. Yamaoka, *Thin solid films* (To be submitted)