§22. Electron Transports at Extraction Region in a Hydrogen Negative Ion Source

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Tandem type hydrogen negative ion (H^-) source are utilized for beam source of neutral beam injection (NBI) systems. Production of H^- ions in hydrogen plasmas requires two kinds of temperatures range for electrons whose threshold is about 1 eV. Electrons in a higher temperature group generate excited vibrational state of hydrogen molecules by particle collisions. The molecules are needed for dissociative attachment with lower temperature electrons in a final reaction of H^- production process. Ion source plasmas constructed with the two kinds of temperature groups are realized by introduction of filter magnetic field. The field allows only lower temperature electrons to diffuse into vicinity of a beam extraction hole separating from higher temperature ones in order to effectively produce H^- ions near the hole. However, transport mechanism of lower temperature electrons across the filter magnetic field have not been fully understood. This study investigates the mechanism using both an experiment and a simulation to obtain fundamental knowledge for control of electron transport in the magnetic field to realize more effective H^- production near the extraction hole.

Figure 1 shows an apparatus of the experimental setup. It uses a small ion source with cylindrical shape whose diameter is 9 cm and height is 11 cm. The ion source plasma is maintained by a pair of hair-pin shape filaments installed at the end plate of the chamber. Filter magnetic field is produced along the perpendicular direction to the ion source axis. The plasma parameters can be measured by an axial Langmuir probe that is movable along the axis to obtain spatial distributions of the parameters.

In this study, we have prepared to install one more hair-pin filament near the extraction hole on the above system. The additional filament can be separately operated to another and supplies additional electrons from edge of the extraction region shown in Fig. 1 which is test particles we should trace to obtain transport information across the filter magnetic field. This experimental result is analyzed by simulation with Particle-In-Cell (PIC) method through comparison of them.

In this fiscal year, we have prepared PIC code for analysis of the experiment. The code is 2D3V model calculates particle positions and velocities in 2-D and 3-D space, respectively. Electron profile in the z axis calculated by the code is shown in Figure 2. The electron emission enhances density at upside region from the filament position in the z direction. The difference between the density profiles with and without the electron emission is also shown in Fig. 2. We can roughly estimate transport range of the test electrons emitted from the filament using the profile. In next year, we will obtain the electron profiles in the experiments and analyze them with the simulations to understand the electron transport in the magnetic field.

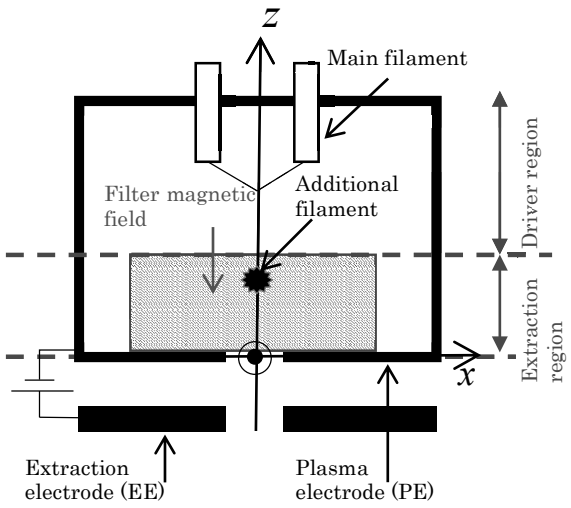

Fig. 1 Experimental Setup

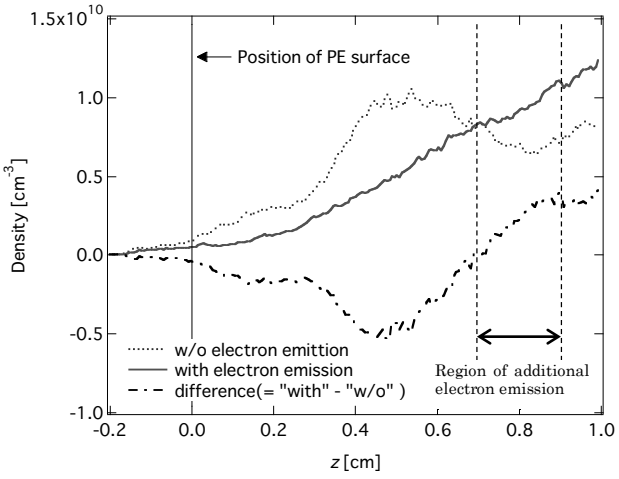

Fig. 2 Density profiles of electrons in the z direction.