§33. Development of Deuterium Negative Ion Sources and Its Database Construction

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In a tandem volume source, H^- ions are generated by the dissociative attachment of slow plasma electrons e_S ($T_e \sim 1$ eV) to highly vibrationally excited hydrogen molecules $H_2(v")$ (effective vibrational level $v" \geqq 5 \sim 6$). These $H_2(v")$ are mainly produced by collisional excitation of fast electrons e_f with energies in excess of 15-20 eV. Namely, H^- ions are produced by the following two step process.

$$H_2(X^1\Sigma g, v"=0) + e_f \rightarrow H_2^*(B^1\Sigma u, C^1\Sigma u) + e_f' \quad (1a)$$

$$H_2^*(B^1\Sigma u, C^1\Sigma u) \rightarrow H_2(X^1\Sigma g, v") + h\nu \quad (1b)$$

$$H_2(v") + e_S \rightarrow H^- + H \quad (2)$$

Production process of D^- ions is believed to be the same as that of H^- ions. To develop efficient D^- ion sources, i.e. to extract high current density applying for the NBI system, it is important to know what happens in H_2 and D_2 plasmas, and to understand difference in the two step process between H_2 plasmas and D_2 plasmas.

For this purpose, we are interested in estimating highly vibrationally excited molecules and negative ions in the source. The production process for $H_2(v")/D_2(v")$ is discussed[1] by observing the photon emission, i.e. VUV emission, associated with process (1b). H^- or D^- ions in the source are measured by the laser photodetachment method. In this paper, we present the preliminary results concerning production and extraction of H^- ions.

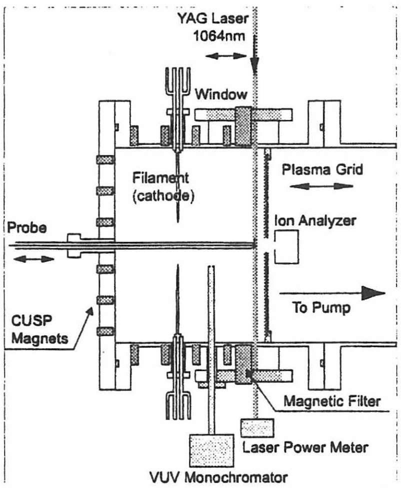

Fig. 1. A schematic diagram of the ion source.

Figure 1 shows a schematic diagram of the ion source. The arc chamber (plasma generator) is 25×25 cm in cross-section and 20 cm in height. Two tungsten filaments of 1.0 mm in diameter are installed from the side walls of the chamber. The line cusp magnetic field consists of Sm-Co magnets which surround the arc chamber. The external filter is adopted for the magnetic separation. The external filter has the advantage in that any structure are not necessary in the arc chamber. The dipole magnetic field is produced by a pair of Nd-Fe magnets equipped in front of the plasma grid in the arc chamber, and the field separates extraction region from a high temperature bulk plasma produced by arc discharge between filaments and chamber anode.

Plasma parameters are measured by Langmuir probes. Negative ions in the source are measured by the laser photodetachment method. A magnetic deflection-type ion analyzer is used for relative measurements of the extracted H^- or D^- currents.

Figure 2 shows plasma parameters (ne and Te) as a function of discharge power. These are measured at the center axis under the magnetic filter. Corresponding to those plasma parameters, H^- ion density in the source and extracted H^- current are measured. An example is shown in Fig. 3. Extracted H^- current and H^- density increase linearly with discharge power. Details are under study.

References

1) Fukumasa, O. et al., 9th Inter. Symp. Pro. Neutral. Negative Ions and Beams (May 30-31, 2002).

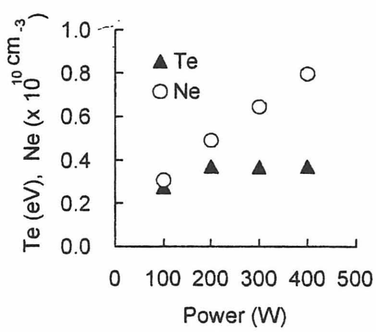

Fig. 2. Plasma parameters (ne and Te) versus discharge powers.

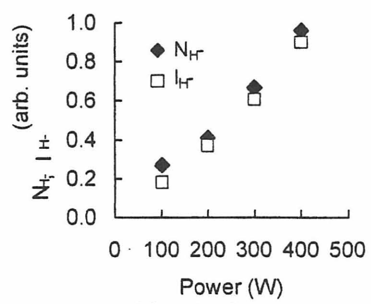

Fig. 3. H^- ions densities in the source and extracted H^- current versus discharge power.