§9. Response of H⁻ Density in the Vicinity of Plasma Grid in H⁻ Source for NBI

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A cesium-seeded negative-hydrogen-ion (H^-) source is one of the main components of neutral beam injector. In the H^- source, most H^- ions extracted as beam are produced on a surface of boundary electrode between plasma and beam, as it is called plasma grid (PG). To understand H^- dynamics from production to extraction, we measured electron density and temperature, space potential, H^- density and optical emission spectrum in the vicinity of the PG. For a measurement of H^- density, Cavity Ring-Down method (CRD) was applied. The CRD is a kind of laser absorption spectroscopy and line-integrated density can be evaluated. In our CRD system, Nd-YAG laser with the wavelength of 1064 nm and the diameter of 7 mm was utilized for the CRD system. A main absorption process is photo-detachment of negative hydrogen ion [1].

Figure 1 shows time evolutions of the H^- density ($n(H^-)$) with input arc power (P_{arc}) and acceleration power-supply drain-current I_{acc}. Finite I_{acc} means that beam is extracted. The absolute value of $n(H^-)$ in the P_{arc} is different for bias voltage which is applied between arc chamber and PG. However, the $n(H^-)$ changes with the P_{arc} regardless of bias voltage. A relation between the $n(H^-)$ and the P_{arc} maintains even during beam extraction in high bias voltage (6 V) case. However in low bias voltage (2 V) case, a drop of $n(H^-)$ as the same time of beam extraction start was observed.

The $n(H^-)$ normalized by the P_{arc} just before and after the beam extraction, and $n(H^-)$ difference between them are shown in Fig. 2. The $n(H^-)$ just before the beam extraction decreases gradually with the P_{arc}. The $n(H^-)$ just after beam extraction is almost constant in low bias voltage range (from 0 V to ~6 V), and decrease with the P_{arc} as the same as that just before the beam extraction. As a result, the difference decreases with the P_{arc} in the low bias voltage range, and vanishes over ~6 V. We show some candidates of interpretations for these dependences. A bias voltage dependence of the $n(H^-)$ just before beam extraction could indicate that surface produced H^- is attracted to PG, and/or mean free path of H^- shortens due to decrease release speed of the H^- form PG. The dependence just after the beam extraction means extraction field influence H^- dynamics more than bias field and/or voltage. The value of 6 V is near the plasma potential which is ~4 V in this experiment. Quantity of the $n(H^-)$ drop could relate to the plasma potential.

1) Nakano, H. et al: AIP Conf. Proc. 1390, pp. 359-366.
2) Nakano, H. et al: 14th International Conference on Ion Source, Giardini Naxos, Italy, 12-16 September 2011, C28.

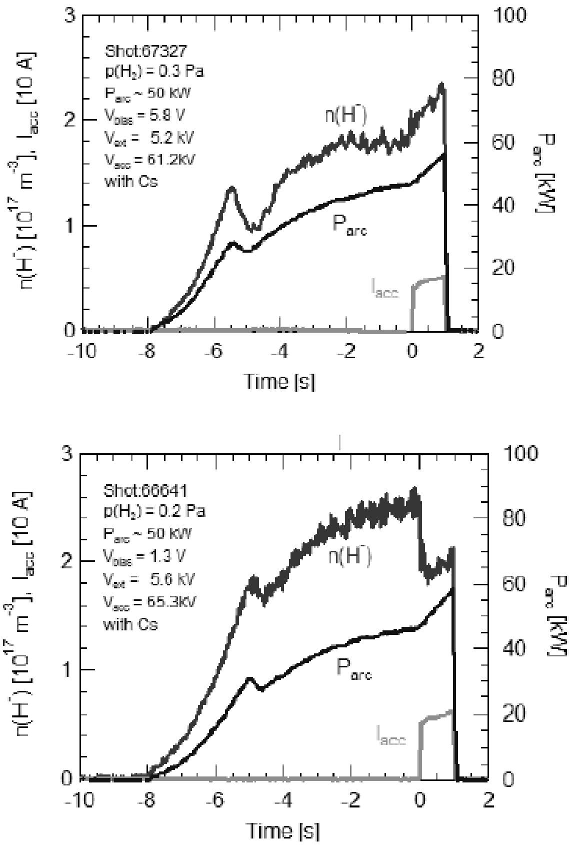

Fig. 1. Time evolutions of H^- density ($n(H^-)$) with input arc power (P_{arc}) and acceleration-power-supply drain current (I_{acc}) in (a) 5.8 V and (b) 1.3 V of bias voltages.

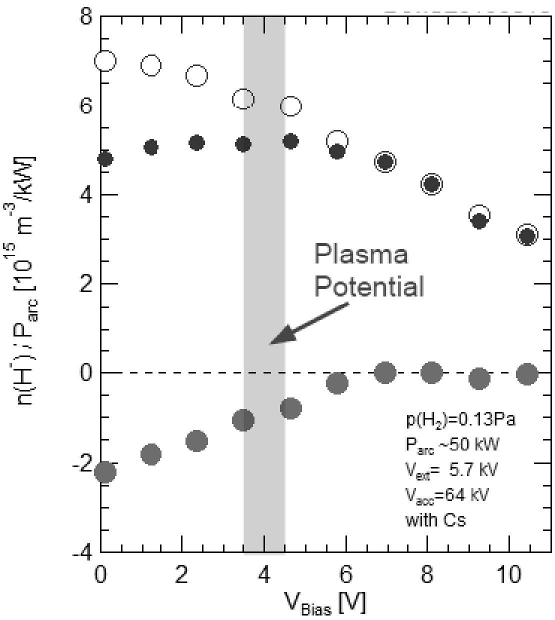

Fig. 2. The H^- densities normalized by the input arc power just before (open circle) and after (filled circle in positive density) the beam extraction, and H^- density difference between them (filled circle in negative density).