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Progress of Experimental Study on Negative Hydrogen Ion Production and Extraction

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Development of the high performance negative hydrogen ion source is a fundamental demand in realizing fusion reactor. In order to clarify the extraction mechanism of Hˆ-, temporal and spatial variations of the negative ions and electrons in the extraction region are intensively surveyed at NIFS. In addition, the beam acceleration experiments have been performed by changing the accelerator configuration in order to improve the voltage holding capability and to study the negative ion beam optics.
In a cesiated hydrogen plasma, it was observed that the negative hydrogen ion density (n_H-) becomes one order higher in magnitude than the electron density (n_e) in the vicinity of the plasma grid (PG). The response of negative-ion rich plasmas to the extraction field was investigated by measuring the plasma potential (V_p) profiles in the axis perpendicular to the PG before and during beam extraction. The V_p increases with applying the extraction field, and the influence of the extraction field on the V_p was observed at 30 mm from the PG. As for the n_H-, it was also observed that the extraction field affects on the n_H- at 30 mm from the PG, where the n_H- decreases simultaneously with the beam extraction. These observations indicate that the extraction field affects the particle dynamics in the wide region extending over 30 mm from the PG. This feature is completely different from that of electron-ion plasmas.
We also found that the negative ion production efficiency becomes twice higher by changing the shape of grounded grid holes without any modification on the plasma chamber. We assumed that the behavior of the back-streaming ion was affected by changing the GG. The back-streaming ion trajectory was analyzed with the beam trajectory simulation, and it was found that the back-streaming ion distributes in the larger area on the back plate with the slot GG. This implies that some part of condensed Cs on the back plate was more effectively evaporated by the back-streaming ion with the slot GG and that Cs flux onto the PG surface increased, which resulted in the enhancement of the negative ion production. This result suggests that the accelerator configuration is one of the key factors to determine the negative ion production efficiency and that the Cs consumption can be reduced by the Cs recycling from the wall of the ion source chamber.

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