# §20. Improvement of $H^-$ Extraction Efficiency by Controlling the Plasma Potential Structure

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i) Introduction

Negative ion sources have been used to deliver neutral beams into fusion experimental plasmas. Efficient sources are desired for International Thermonuclear Experimental Reactor and future reactors. One important issue to increase the ion source efficiency is to improve the $H^-$ extraction probability by which we mean the probability for a $H^-$ in plasma near the extractor to be extracted as $H^-$ beam. The probability strongly depends on plasma potential structure near a beam extraction hole of the ion source. In this study, we control the plasma potential structure by supplying additional electrons with a secondary filament and investigated the effects improve the $H^-$ extraction probability.

ii) Experimental results

Schematic view of the experimental setup is shown in Fig. 1. Our ion source is 11 cm in height and 9 cm in diameter. It has a single aperture 4mm diameter extraction system. Plasma parameters are measured with a movable Langmuir probe along the beam extraction direction. We can estimate local $H^-$ extraction probability with two kinds of photodetachment techniques which we devised and have improved[1]. The secondary filament is installed at beam extraction region to control the plasma potential. Previously, we reported that additional electron supply with the filament made plasma potential more negative, and decreased the $H^-$ beam current. However, in order to clarify the correlation between the plasma potential and the extracted $H^-$ current, we should modify the filament system to get much better Signal-to-Noise (S/N) ratio of photodetachment signal.

Experimental results with the new filament system are shown in Fig. 2. Discharge voltage and current are 70.0 V and 0.5 A, respectively. Beam extraction voltage is 1 kV. Bias voltage of a plasma electrode (PE) is set to 0 V. A Langmuir probe is located at 0.7 cm from the PE surface. Plasma potential gradually has decreased from 2.65 to 2.05 V as increasing input power of the secondary filament. Then, we can confirm that the local $H^-$ extraction probability enhances as a function of plasma potential. However, the extracted total $H^-$ beam current has decreased by the electron supply. Probably, high energy additional electrons from the secondary filament destruct $H^-$ ions, so that we should introduce some ideas to avoid decrease of $H^-$ density. We will make further improvement of the system in the near future.

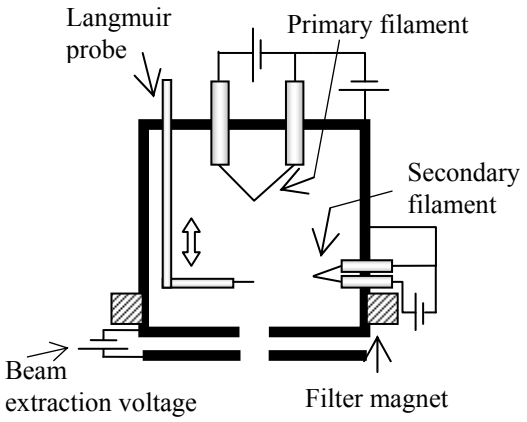


Fig. 1 Experimental setup

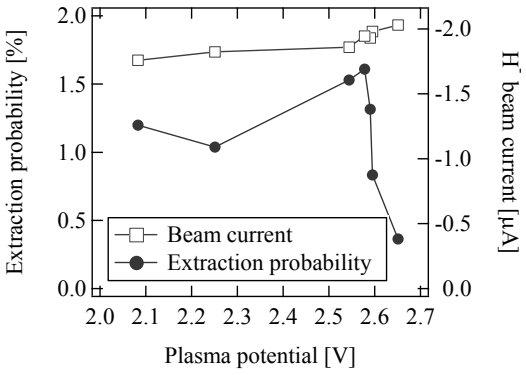


Fig. 2 Dependence of extraction probability and that of beam current upon plasma potential.

1) Matsumoto, Y., Nishiura, M., Matsuoka, K., Sasao, M., Wada, M. and Yamaoka, H.: Thin Solid Films Vol.506-507, 522-526 (2006)