Production of sub MeV positive gold ion beams with various gas targets for improvement on the tandem accelerator of LHD-HIBP

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It is important to increase the probing beam current, in order to improve the heavy ion beam probe on LHD (LHD-HIBP). One of the methods of increasing the current is to improve charge exchange efficiency at a gas cell in the tandem accelerator of LHD-HIBP [1]. An objective of this study is to research physics of atomic collisions between Au^- ion and atoms introduced into a gas cell at a high voltage terminal. It is difficult to carry out a charge exchange experiment with various gas species and gas pressures in a gas cell in the accelerator of LHD-HIBP [2]. The experiments were carried out on a tandem accelerator at Kobe University, 5SDH-2, because we can easily change gas species, gas pressure, and beam energy. Unfortunately, a momentum of MeV Au ion is too large to be bent to a detection chamber by the bending magnet on the 5SDH-2 system. Therefore, the terminal voltage is limited to about 150 kV, but the ion energy is smaller than LHD-HIBP system whose energy is up to 6 MeV. A theoretical model with cross sections of collisions in a wide range of the ion beam energy is needed. Applying the experimental results on 5SDH-2 to the experiment on LHD-HIBP using the model, an Au^+ beam of LHD-HIBP can be optimized for plasma diagnostics.

A 150 keV Au^- ion interacts with atoms introduced into a gas cell at high voltage terminal in 5SDH-2. Various gases such as He, Ar, N_2, H_2, and Xe were introduced into the gas cell. A beam current was measured by a Faraday cup at a chamber on a M15 beam line. The beam energy was 280 keV for Au^+ and 410 keV for Au^{++}. Gas pressure was measured by ionization gas gauges at both the ends of the accelerator tank. The absolute value of gas thickness is needed for a beam fraction calculation, and this value is one of the most important parameters. Fig. 1 shows the dependences of a beam current on gas pressure introduced into gas cell. H_2, He, N_2, and Ar gases were used as target gas in these experiments. Gas pressure of the horizontal axis is corrected by the sensitivity coefficients of the gas gauge, but the gas thickness is not calculated. An Au^+ beam current was normalized by an Au^- beam current measured by a Faraday cup at the low energy beam line of 5SDH-2. It can be seen that Au^+ beam current peaks exist to the order of 10^7 and 10^6 Torr for all targets. In the poster presentation, an atomic collision process including scattering and ionization will be discussed, and these cross sections will be estimated. By adapting these values to a high energy beam system, gas species and gas pressure dependence in a gas cell of LHD-HIBP will be discussed.

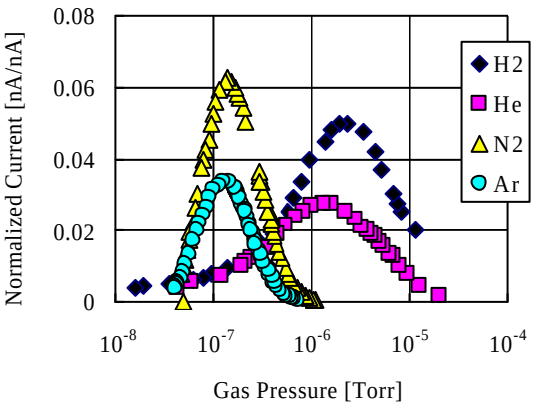

Fig. 1. Dependence of Au^+ beam current on gas pressure.

[1] T. Ido, et al., Rev. Sci. Instrum. **77** (2006) 10F523.
[2] M. Nishiura, et al., Rev. Sci. Instrum. **79** (2008) 02C713.