Particle Reflections at the Extraction Electrode Surface of an Ion Source

イオン源引出電極面での粒子反射

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Effects upon ion beam characteristics due to particle reflections at the plasma electrode surface are being investigated both experimentally and theoretically. Based on the results recently reported by Bacal *et al.* [1], negative hydrogen ion (H^-) yields at the plasma electrode surface have been reexamined. The negative ionization efficiency at the surface depends upon the H^- velocity component perpendicular to the surface. The strength of the filter magnetic field had turn out to play a decisive role in H^- extraction, as it determines the incident angle for incoming hydrogen ions onto the plasma grid surface.

1. Introduction

Highly positive plasma potential was observed in an RF driven ion source for negative hydrogen ion (H^-) production [1]. The measured plasma potential as high as 60 V accelerates hydrogen plasma ions toward the plasma electrode surface biased at 15 V. Thus, 45 eV H^+, H_2^+ and H_3^+ ions are back scattered at the surface as 45 eV, 22.5 eV and 15 eV H atoms, as the mean free paths for these ions can be comparable to the ion source dimension [2]. Bacal had assumed the negative ionization fraction based on the normal incidence of these ions at full energy [3]. However, the velocity distribution function of surface produced H atoms should determine the negative ionization of H atoms leaving the surface, and a study to estimate the velocity distribution function has been started

2. ACAT calculation

The energy distribution functions of hydrogen atoms reflected from Cs-H-Mo surface, together with those of hydrogen atoms desorbed from the surface have been calculated with a Monte-Carlo Simulation code ACAT [4]. The result is shown in Fig. 1, which indicates broader energy distributions for higher energy hydrogen ions. The change in energy distribution functions due to coverage of hydrogen and Cs did not largely affect the particle reflection coefficient, but the Cs over layer on hydrogen saturated Mo had enhanced the high energy component in the distributions.

3. Effect due to Filter Field

More precise information on velocity distributions on incident hydrogen ions are necessary to accurately compute the negative ion yield due to surface production, as the incoming ions should be largely bent by strong magnetic field of the filter magnets [5]. Sheath structure of the extraction electrode also affects the H^- current, and the extraction model must include all these aspects.

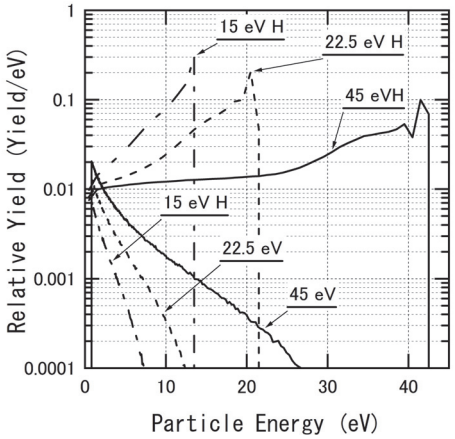

Fig.1. Energy resolved H atom yield for reflection (broader distribution) and fro ion induced desorption (sharp peak) due to impact of hydrogen ions at shown energies.

References

[1] Martha Bacal, "Effect of fast positive ions incident on cesiated plasma grid of negative ion source": Book of Abstracts for 14th International Conference on Ion Sources, (2011) 160.

[2] M. Bacal, R. McAdams and B. Lepetit, AIP Conference Proceedings Volume 1390, (2011) 13.

[3] M. Seidl, H. L. Cui, J.D. Isenberg, H.J. Kwon, B.S. Lee, S.T. Melnychuk, J. Appl. Phys. 79 (6), (1996) 2896.

[4] Y. Yamamura, Y. Mizuno, Plasma Physics, IIPJ-AM-40, Inst, Nagoya Univ., 1985.

[5] W. Kraus, U. Fantz , D. Wunderlich and the NNBI team, AIP Conference Proceedings Volume 1390, (2011) 303.