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プラズマ電極近傍での水素負イオン生成過程
Negative Ion Production Process near the Plasma Grid of a Negative Ion Source

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Introduction

Extractable amount of negative hydrogen (H^-) ion current is enhanced by Cs injection into the ion source discharge. The reason for observing this enhancement is believed to be negative ionization of hydrogen atoms leaving the low work function plasma grid surface. Two mechanisms are considered responsible in forming particle flux of atomic hydrogen leaving the surface. One is reflection of hydrogen ions striking the surface of the plasma grid, and the other is ion induced desorption of hydrogen adatoms on the surface. Yields of these atomic hydrogen components have been studied and reported for normal incidence of primary hydrogen ions [1]. Atomic hydrogen emission due to an impact of a hydrogen ion of grazing incident angle is studied using the ACAT code.

Surface model

Surface structure of the plasma grid has been assumed to be a Cs monolayer covering a monolayer hydrogen adsorbed bulk Mo. The ACAT (Atomic Collisions in Amorphous Target) code has been modified to make the simulation with the adsobed layer possible. There can be more hydrogen layer adorbed on the top layer of the plasma electrode surface, but all results introduced in this abstract have been obtained without any hydrogen over layer.

Results and discussion

Figure 1 shows the calculated particle reflection coefficient plotted as a function of incident angle measured from the surface normal. Species of the ion flux has been assumed to be 100% proton at the energy of 45 eV. This value had been assumed from the 60 eV plasma potential in a 2 MHz driven RF ion source, and 15 eV positive bias to the plasma grid. As shown in the figure, the particle reflection coefficient begins to increase as the incident angle exceeds 10 degree. Then it tends to saturate above 40 degree until it reaches to about 0.7 at 80 degree.

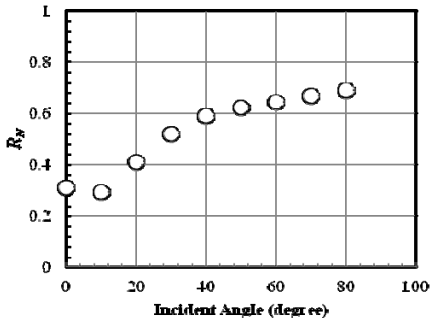

Fig. 1. Particle refelction coefficient R_N plotted as a function of incident energy of hydrogen ions (H^+). Energy of incident H^+ has been set to 45 eV.

The sputtering yield of Cs exhibits a similar trend. As shown in Fig. 2, the yield is nearly 0 at normal incidence. For incident angle more than 30 degree, the sputtering yield exceeds 0.1% and can cause substantial impact on Cs recycling at the plasma grid surface.

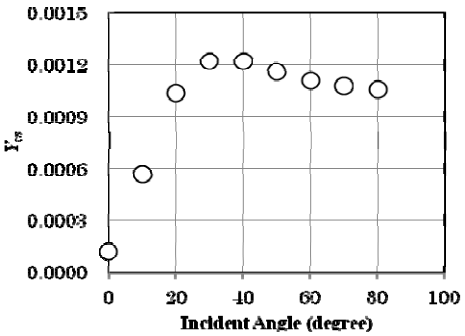

Fig. 2. Sputtering yield for Cs adsorbates (Y_{Cs}) plotted as a function of incident energy of hydrogen ions (H^+). Energy of incident H^+ has been set to 45 eV.

References

[1] M. Wada, M. Bacal, T. Kasuya, T. Kenmotsu and M. Sasao, Presented at the 3rd International Conference on Negative Ions, Beams and Sources, Yüvaskyüla, Finland, September (2012).