§1. Effect of H^- Enhancement on Cs and Rb Vapor in a Volume Negative Ion Source

Nishiura, M.(The Grad. Univ. for Advanced Studies)
Sasao, M.
Wada, M. (Doshisha Univ.)

In order to extract a high current beam of H^- ion from an ion source, cesium injection has been considered as an effective method experimentally for N-NBI ion sources. However the enhancement mechanism of H^- production in a source due to cesium has not been well understood.

A compact multicusp ion source has 12 Sm-Co magnets for plasma confinement, which are attached to the surface of the cylindrical copper vessel (8.5cm in diameter and 10cm in length). In the extraction region, the stainless steel vessel has three ports, where diagnostic tools and a nozzle for the injection of alkali metal vapor are installed.

A cylindrical Langmuir probe located in the center of the vessel and a laser photodetachment technique 1) are used to measure the densities of electron and negative ion in front of the plasma electrode. The spectrum lines integrated in the radial direction of the cylindrical vessel are also measured to monitor the amount of Cs or Rb metal vapor. The work function change of the plasma electrode is obtained by measuring the photoelectron current.2)

Figure 1 shows the correlation of the n_-/n_e ratio and the work function of the plasma electrode. The n_-/n_e ratio goes up immediately as the intensity of Rb spectrum line is increased. At I_{Rb}=1200, the n_-/n_e ratio reaches a maximum value, and then the work function of Rb/Mo surface becomes a minimum value. This surface is considered to adsorb a half-mono layer of rubidium on the molybdenum. Introducing the rubidium vapor more by heating the reservoir, the n_-/n_e ratio decreases as the work function goes up slightly and reaches the work function of pure rubidium. When I_{Rb} goes up more than 6000, the n_-/n_e ratio decreases gradually. This may indicate the loss reaction by mutual neutralization of H^- and Rb^+.

In case of cesium seeding, the maximum value of the n_-/n_e ratio agrees with the point of the minimum work function, while the difference of H^- enhancement due to mass of Rb(M=85.5) and Cs(M=132.9) does not appear clearly in these experiments.

As an estimated mean free path 3) between H^- ion and hydrogen molecule, λ, is larger than the distance of the extraction region, produced H^- ions from the surface do not collide with any other particle in the extraction region. It is found that the influence from the alkali adsorbed metallic surface in the extraction region surrounding the plasma electrode is considerably large for H^- enhancement by means of alkali vapor injection to hydrogen plasma.

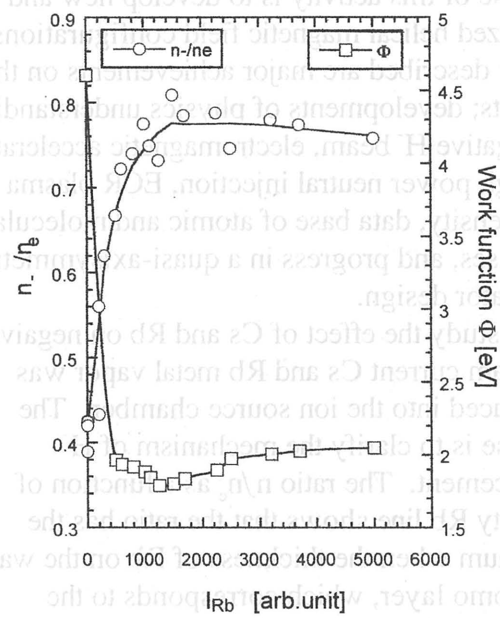

Fig. 1 The work function of the Rb/Mo surface and the n_-/n_e ratio as a function of the intensity of rubidium D line(780nm RbI($5p^2P_{3/2}$-$5s^2S_{1/2}$)). Then the intensity of Hα is kept a constant about 2200. The discharge condition is Vd=100V, Id=2A, Pg=3.5mTorr, and the temperature of the plasma electrode, $T_{p.e}$=330°C.

References
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