§27. Cs Effect on Negative Hydrogen Ion Production in a Large Negative Hydrogen Ion Source

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It is generally known that H^- beam current increases by several times after Cs vapor is injected into an arc chamber of a volume-production-type negative ion source. In order to investigate how this Cs injection affects H^- production in the ion source, we observed H^- density characteristics in the extraction region in front of the plasma grid, in cases without and with Cs addition, and compared with H^- beam extraction characteristics. The modified 1/6-size ion source is used for the measurement [1]. H^- beam current extracted from the ion source is measured by 7 channel multi-Faraday-cup-array. The photodetachment method is used for H^- density measurement in the extraction region. A pulse operated Nd-YAG laser (wave length of 1064 nm) is employed as a laser beam for the photodetachment method. In our case, H^- beam current increases twice at a maximum value after Cs is seeded (Fig. 1). However, increment of H^- density in the extraction region is much more than that of H^- beam, as seen in Fig. 2.

Figure 3 shows the correlation between extracted H^- beam current and H^- density in a plasma at the same discharge condition. It can be seen that coefficient of H^- beam current against H^- density becomes low after Cs is injected. This decrease of coefficient is explained by degradation of H^- temperature. If we assume that thermal H^- flux is conserved from the extraction region to the extraction aperture on the plasma grid, H^- temperature; T_{H^-} can be estimated as following expression using H^- density; N_{H^-} , H^- beam current density; J_{H^-} and H^- mass; M [2].

$$J_{H^-} = \frac{1}{4} N_{H^-} e \left(\frac{8eT_{H^-}}{\pi M}\right)^{\frac{1}{2}} \quad (T_{H^-} \text{ in eV}), \qquad (1)$$

When T_{H^-} are calculated from gradient of lines in Fig. 3, they result in 0.3 eV and in 0.07 eV without and with Cs injection, respectively. It is suggested that Cs ions in a plasma make H^- temperature lower due to their large mass. It is generally known that H^- beam divergence does not increase after the injection of Cs vapor, although current density of H^- beam remarkably increases. Our result that H^- temperature becomes low in operating with Cs is a good reason of the reduction of beam divergence.

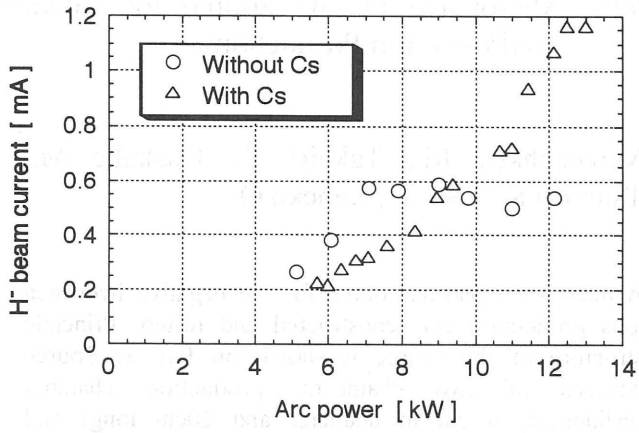

Fig. 1 Arc power dependence of extracted H^- beam current at filling gas pressure of 1.5 Pa

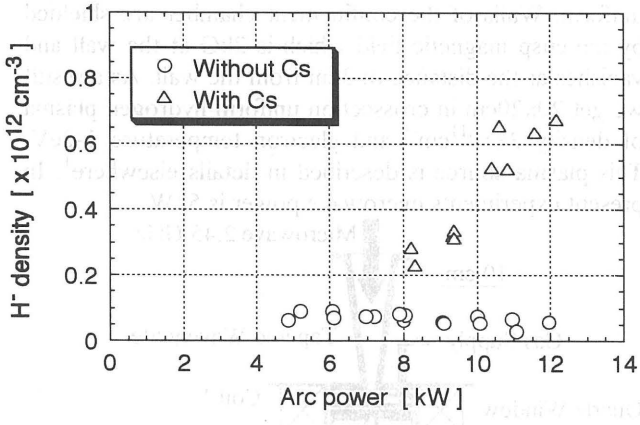

Fig. 2 Arc power dependence of H^- density in the extraction region at filling gas pressure of 1.5 Pa

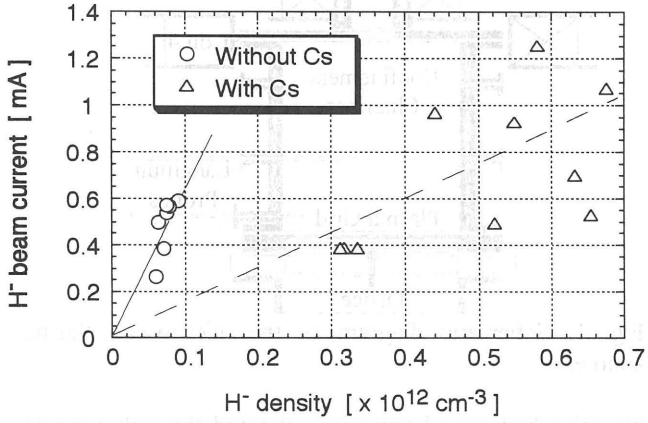

Fig. 3 H^- beam current plotted as a function of H^- density in the extraction region under the same arc discharge condition at filling gas pressure of 1.5 Pa

Reference
1) Hamabe, M. et al., Rev. Sci. Instrum. 69, (1998) 944
2) Bacal, M. et al., Rev. Sci. Instrum, 56 (1985) 2274.