§3. Gas Flow Analysis in a Vacuum-Immersed Negative Ion Source

Takeiri, Y., Oka, Y., Ando, A., Kaneko, O., Tsumori, K., Akiyama, R., Kawamoto, T., Kuroda, T.

The gas flow analysis along a beam axis has been performed for the estimation of the stripping loss of the H^- ions during the beam acceleration in a vacuum-immersed negative ion source. The 1/3-scaled vacuum-immersed negative ion source was constructed as a prototype of the LHD-NBI ion source with the negative ion beam test-stand[1]. Since the ion source is immersed in the vacuum vessel and the grids are supported by post insulators, gas pumping of gaps between grids could be enhanced, resulting in reduction of the beam stripping loss in the acceleration region.

The gas pressure distribution between grids were calculated by the conductance method, and the stripping loss of H^- ions was estimated[2]. The results show that the vacuum-immersed structure is effective for the reduction of the stripping loss of H^- ions in the accelerator configuration with long extraction and acceleration gaps and short grid edge distances.

A Monte-Carlo calculation code was developed for the gas flow analysis along a beam axis. Figure 1 (a) shows an example of a gas molecule trajectory and the grid arrangement. The resultant gas pressure distribution along the beam axis is shown in Fig. 1 (b) under the conditions where the gas temperature is constant, 300 K, and the gas flow rate is 2.5×10^{-3} Pa m^3/sec. The stripping loss along the beam axis is estimated and the survival negative ion current ratio is also shown in Fig. 1 (b). The gas temperature effect can be also considered in this Monte-Carlo code. The results of the Monte-Carlo calculation including gas temperature effect are shown in Fig. 2. The flow rate is the same as that in Fig. 1 and the temperatures of the arc chamber and all the grids are 1000 K and 300 K, respectively. The gas temperature and the gas molecule density are shown in Fig. 2 (a), and the gas pressure and the survival negative ion current ratio are shown in Fig. 2 (b). For the same flow rate, the gas molecule density is lower in the case of higher gas temperature. Thus, the stripping loss is estimated lower when the gas temperature effect is considered.

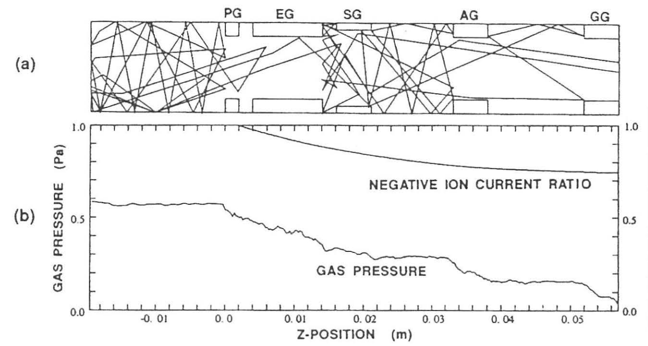

Fig. 1. (a) Example of a gas molecule trajectory, and (b) the gas pressure distribution and the survival negative ion current ratio.

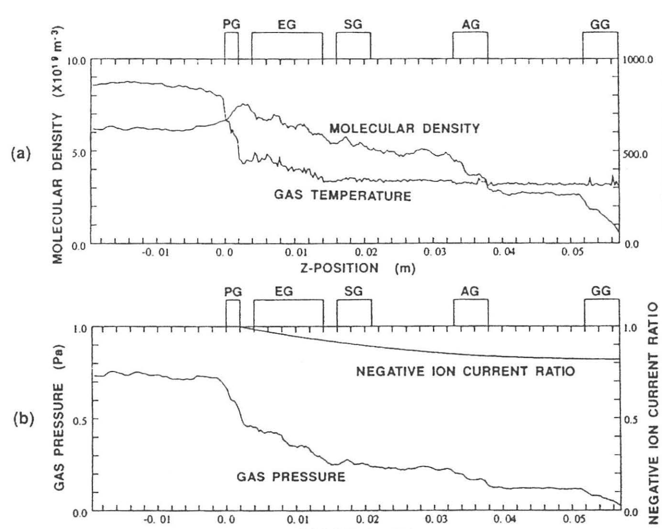

Fig. 2. Results of the Monte-Carlo calculation including gas temperature effect. (a) The gas temperature and the gas molecule density, and (b) the gas pressure distribution and the survival negative ion current ratio.

References

1) Y. Takeiri, *et al., Proc. of the 6th Int. Symp. on the Production and Neutralization of Negative Ions and Beams, Upton, 1992,* p.869.
2) Y. Takeiri, et al., Rev. Sci. Instrum. 65 (1994) 1198.