§22. The Production Mechanism of Negative Hydrogen Ion in the Uramoto-type Sheet Plasma Experiment

Jimbo, K., Yamamoto, M., Nagasaki, K.
(Institute of Advanced Energy, Kyoto Univ.)

There are mainly three processes to produce negative hydrogen ions: the double charge exchange process, the surface conversion process, and the volume production process. [1] In the volume production process, negative ions are produced uniformly in a bulk plasma. We are, however, skeptical about the mechanism of the volume production process: electrons in a cold plasma are dissociatively attached to vibrationally excited hydrogen molecules generated in a hot plasma. Non-Boltzmann populating of the vibrational levels of hydrogen molecules was predicted in the volume production process [2] but a plateau in the spectrum of vibrationally excited molecules was not confirmed. [3] On the other hand, they reported a high concentration of hydrogen atoms in a cold ion source plasma. We proved indirectly that negative hydrogen ions were formed from hydrogen atoms, and emphasized the importance of hydrogen atom production channel of the volume production process. In this sheet plasma experiments (Fig.1), plasma potentials decreased but negative hydrogen ion currents increased toward the outside. The negative hydrogen ions are pushed inside by the electric field and are not coming out from the plasma unless an equilibrium exists somehow. A relation between negative hydrogen ion currents and plasma potentials (Fig.2) is well explained by the one-dimensional Saha equation, from which the electron temperature 1.3eV is obtained. This value is very close to the electron temperature 1eV of the Langmuir method. A reasonable negative hydrogen ion density is also calculated from the equation. We conclude that electrons, hydrogen atoms and negative hydrogen ions are in equilibrium. Our experimental results suggest that the hydrogen negative ions are formed directly from atomic hydrogen.

References
1) J.R.Hiskes et al.: J.Appl.Phys. 53 (1982) 3469.
2) J.R.Hiskes: J.Appl.Phys. 70 (1991) 3409.
3) G.C.Stutzin et al.: Rev.Sci.Instrum.61 (1990) 619.

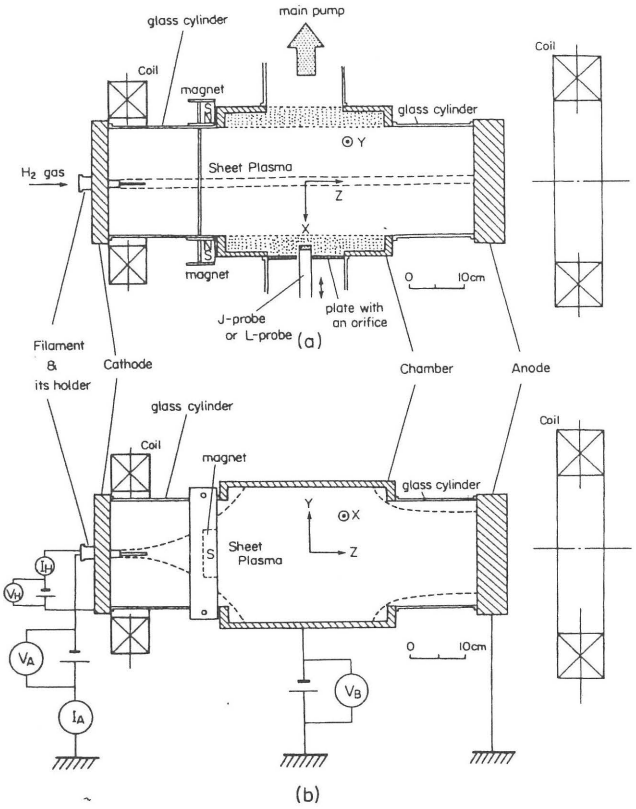

Fig.1: Simplified sectional views of the sheet plasma experiment.

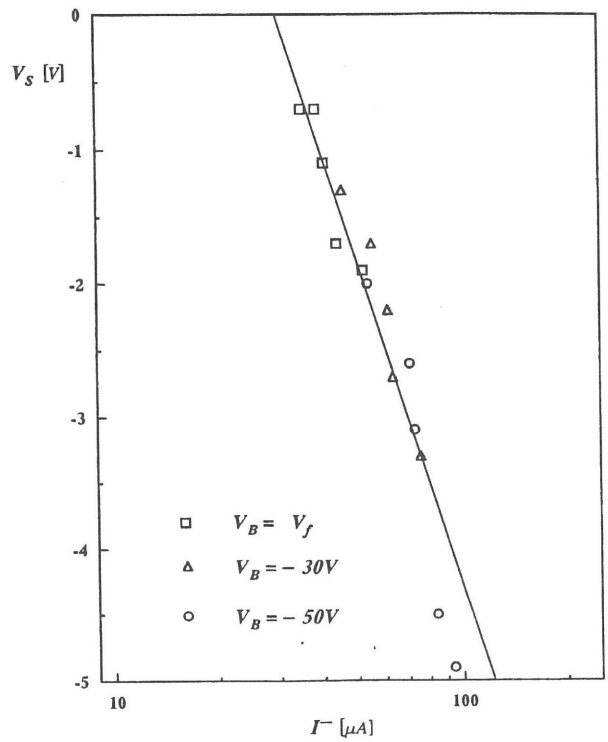

Fig.2 The relation between V_s (the plasma potential) and I^- (the extractable negative ion current).