§19. Microwave Plasma Source for the Negative Hydrogen Ion Production

Mozjetchkov Michael, Takanashi Toshihiko, Oka Yoshihide, Tsumori Katsuyoshi, Osakabe Masaki, Kaneko Osamu, Takeiri Yasuhiko, Kuroda Tsutomu

A microwave plasma source shown on Figure 1 was designed and constructed to study the possibility of it's application as a source of negative ions for the neutral beam injector (NBI). This microwave tandem type[1] plasma source consists of two chambers: plasma production chamber (cylindrical shape, 6 cm in diameter) and confinement chamber (rectangular shape, 26x26cm square crossection). Microwave is completely absorbed in the plasma production chamber and produced plasma drifts to the confinement chamber along the magnetic field lines, where it gets uniform. Strong axial magnetic field is applied to the plasma production chamber by coils 1-3 and is eliminated in the plasma grid region by the magnetic field of coil 4. Coils 1-3 were designed using hollow conductors and are able to carry a current of 200A in the CW mode and create the magnetic field up to 2000 G on the axis.
Cusp magnetic field created between coils 1-3 and 4 serves to make plasma uniform and to cool down the electrons through diffusion and reflection from the magnetically shielded walls, before plasma reaches the plasma grid region, where the negative ion production is expected due to the following two-step process:

$H_2 + e(high) \rightarrow H_2(v) + e$
in the plasma production chamber, and

$H_2(v) + e(low) \rightarrow H^- + H$
in the confinement chamber. [2, 3]

Preliminary experiments were held with argon and hydrogen. Plasma parameters were measured using Langmuir probe in the field-free vicinity of the plasma grid. A new window with an intensive cooling for the introduction of the microwave generator power of 5kW was designed. By changing the magnetic field configuration and eliminating the conducting surface on the end side of the production chamber, plasma potential was reduced from 40 to 15 volts and plasma density increased 2 times resulting in formation of the uniform plasma 20x20cm in crossection with the following density:
Argon: for the pressure of 3mTorr
$N_e=3\times10^{12}cm^{-3}$, $T_e=2eV$;
Hydrogen: for the pressure of 5mTorr,
$N_e=3\times10^{11}cm^{-3}$, $T_e=2eV$.

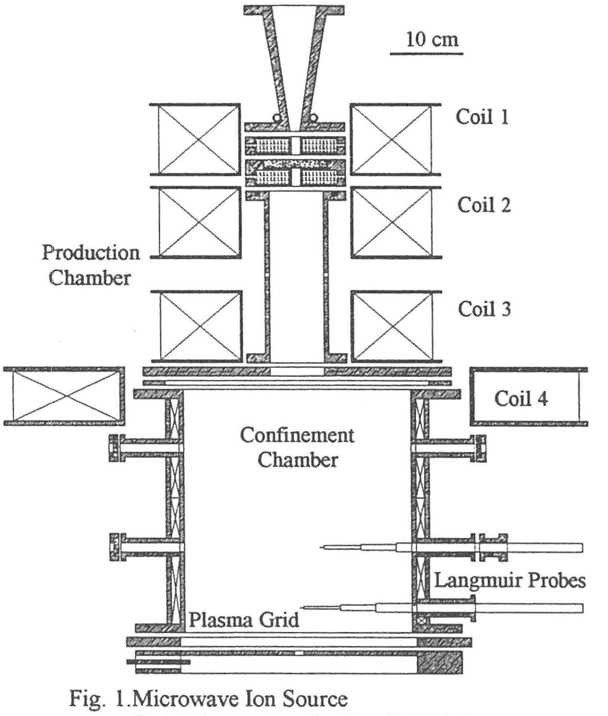

Fig. 1.Microwave Ion Source for Hydrogen Application (MISHA)

References
1) H. Nihei, J. Morikawa, D. Nagahara, H. Enomoto and N. Inoue, Rev. Sci. Instrum. 63(3) (1992)
2)J.R. Hiskes J. Appl. Phys. 56(7) (1984)
3)J.R. Hiskes, A.M. Karo, M. Bakal, A.M. Bruneteau , W.G. Graham, J. Appl. Phys. 53(5) (1982)