§38. Development of a Miniature Ion Gun for Fast-ion Orbit Loss Study in LHD

Morimoto, S., Kitamura, T. (Kanazawa Inst. of Technology), Shoji, M., Yanagi, N., Komori, A., Yamazaki, K., Motojima, O.

Confinement of alpha particles and removal of helium ashes are very important for realizing D-T fusion reactors. To simulate experimentally behavior of alpha particles in helical fusion reactors, we have developed a miniature ion gun, which can emit potassium ions with the energies of E~1keV and the beam currents of I_B=(10~50) μA. The ions are launched from defined positions in the vacuum vessel of the LHD under the toroidal magnetic field of B~1.5T. Thus we can simulate the alpha particle motions in helical fusion reactors.

Figure 1 shows a schematic drawing of the newly developed ion gun. A commercially available ion source (Heat Wave Inc, Model-1139) is used as an ion emitter. The ion source is 6.4mm in diameter and is contained rigidly in a boron-nitride container. The emitter consists of a porous tungsten disk into which the emitter material (potassium) is fused. It is indirectly heated (heating power<13W) with a non-inductively wound molybdenum filament. A mesh cathode (tungsten, transparency 92%) is placed in front of the emitter and an extraction voltage V_B is applied between the cathode and the emitter. The cathode and the aluminum case are kept at the earth potential.

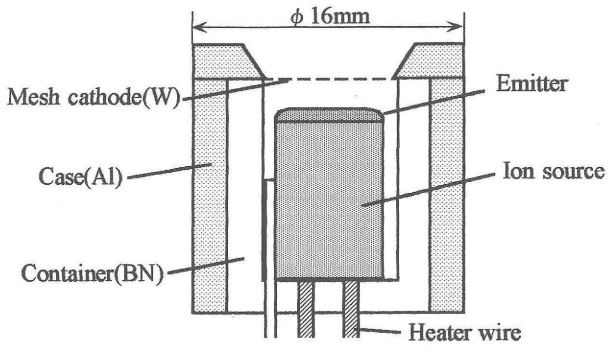

Fig.1. Schematic drawing of the K^+ miniature ion gun.

In this fiscal year, we conducted performance tests of this ion gun. Figure 2 shows a typical dependence of the extracted ion beam current (I_B) on the ion emitter temperature (T_E). The emitter temperature was measured with an optical pyrometer. The ion beam current starts to grow at T_E~750°C and reaches to ~30μA at T_E=950°C (the heating power for the emitter P_E ~ 12W at this temperature).

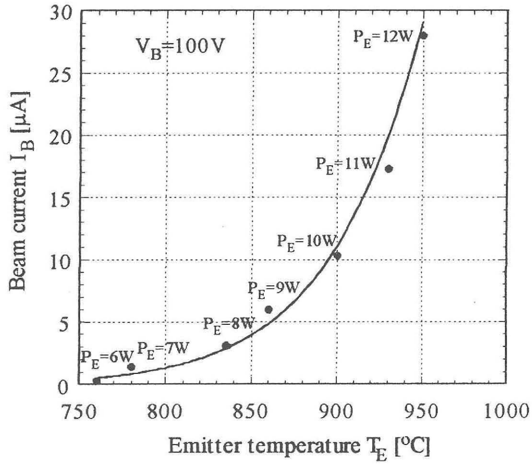

Fig.2. Beam current versus emitter temperature

We measured the energy distribution of the ion beam by using an electrostatic grided analyzer. Figure 3 shows the collected beam current (I_B) as a function of the retarding grid voltage (V_G) at V_B =800V. We have found that the ion beam has a fairly sharp energy distribution. The half width of dI_B/dV_G is ~7% that might be attributed to the instrument resolution of the energy analyzer.

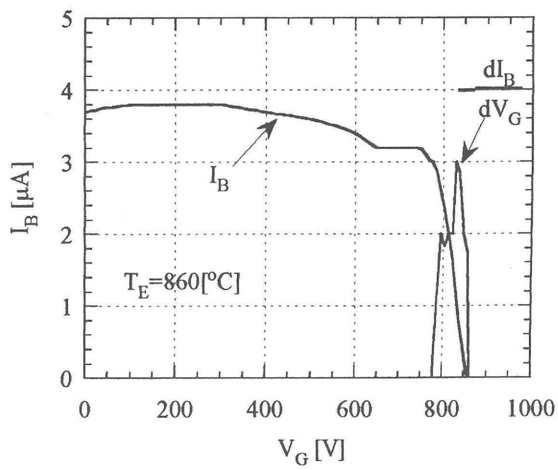

Fig.3. Collected beam current versus grid voltage.

We have also investigated mass spectrum of the ion beam by using a quadrupole type electrostatic mass analyzer that is used usually for vacuum measurement. We have observed an increase of K^+ peak without any increase of other alkali metals after the turn-on of the beam extracting voltage.

We will test this ion gun in high magnetic field of B~1.5T in the next year.