§ 17. Development of Au^- Ion Source for a Heavy Ion Beam Probe of LHD

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For the purpose of understanding of plasma behaviors it is essential to measure the potential profile and density fluctuation in a fusion device. A heavy ion beam probe(HIBP) system is a candidate and has been built to diagnose LHD plasmas. The development of a gold negative ion source, which is one of main components of LHD-HIBP system, becomes a key issue to realize the system. We adopted the sputter type multicusp ion source with cesium added in argon plasma. The ion source for diagnostic beams requires the following conditions. If the potential in plasma is assumed to be a few percent of the plasma temperature of a few keV, the energy spread of diagnostic beam should be less than 10 eV. Taking into consideration the attenuation by passing through the LHD plasma, we require at least 100 μA of gold negative ion beam current.

The size of the cylindrical ion source is 8 cm in diameter and 9 cm in length. The electrostatic extraction system consists of an electrode with the 5-mm-diam. hole. The source body is connected to a potential of the acceleration power supply, V_{acc}, which varies over 0 – 20 kV, while the voltage of the Einzel lens electrode, V_L, is adjusted to the optimum beam current, measured by a Faraday cup located at the beam down stream.

The beam current is measured at about 50 cm down stream from the plasma electrode by using a Faraday cup Full beam enters into the Faraday cup. After adding the cesium vapor into the ion source, the ion source was operated for a few hours.

The Au^- beam current is plotted in Fig. 2 as a function of the target voltage, Vt. The Au- beam current of 12 μA(61 μA/cm^2) is yielded at Vt=500V at beam energy of 2 keV. As the target voltage is increased, Au^- beam current monotonically goes up.

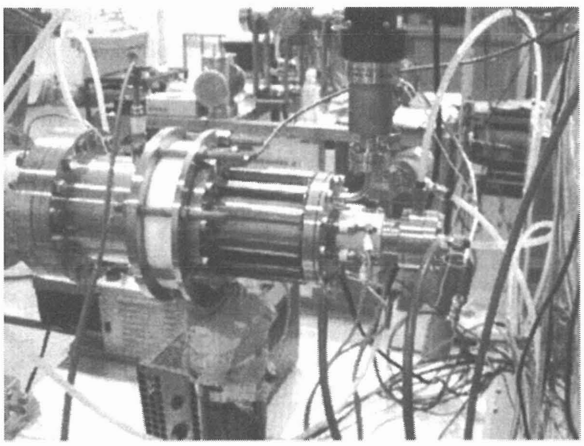

Fig. 1 Photograph of sputter type gold negative ion source for LHD-HIBP system.

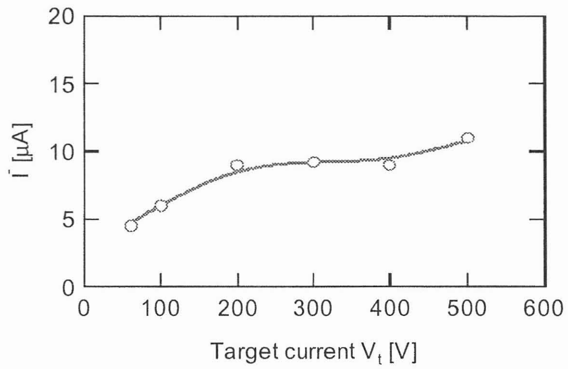

Fig. 2 Dependence of Au^- beam current as a function of target voltage.

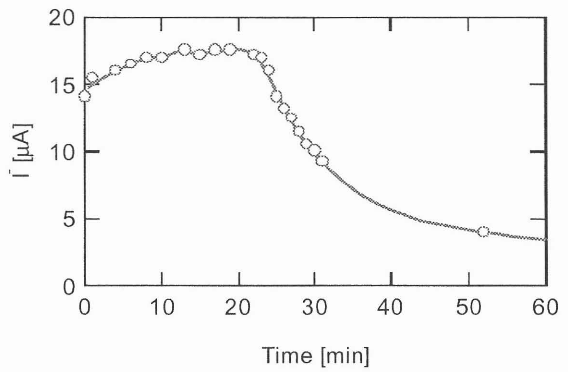

Fig. 3 Temporal Au^- beam current by use of residual cesium. The ion source is operated under the conditions that the discharge voltage is 60 V, the discharge current is 5 A, the target voltage is –400V, and the beam energy is 10 keV.

Next day the residual cesium was made use of without heating the cesium oven. At 10 minute operation the Au^- beam current reached at the maximum of 17.5 μA. After 22 minute operation the Au^- beam current was suddenly decreased. This is considered that the residual cesium inside the ion source was consumed beyond the optimum thickness of cesium layer on the gold target. The filaments were broken after a several hours operation.

In order to obtain more Au^- beam current stably, the input power should be increased by use of a LaB6 or bigger diameter of Re-W filament. The ion species, energy spread, and emittance should be measured for the optimization of the ion source.