§ 16. Temporal Change of Extracted H^- Current by Injecting Pulse Laser Light into the Extraction Region of an H^- Ion Source

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To measure the density of hydrogen negative ions (H^-) in hydrogen plasma, photodetachment technique assisted with a Langmuir probe is mainly used.1). In this method, a pulse laser beam is injected into a hydrogen plasma along a probe tip and all H^- on the laser path are converted into electrons and atoms by laser photon energy. Then, the excess electrons due to photodetachment reaction are collected with a probe biased positively with respect to the plasma to show a temporal increase of probe current. Density and velocity of H^- can be determined from the temporal change of the photodetachment current indirectly. This method can yield local information of H^- at a probe location. However, how the H^- ions in plasma are extracted from an ion source cannot be measure with this photodetachment method.

A new photodetachment method utilizing the H^- beam modulation by pulse laser beam is being developed. While a H^- ion beam is extracted, a pulse laser beam is injected parallel to a plasma grid (PG) surface and destructs H^- on laser path near a PG. Then the temporal decrease of ion beam current is detected due to destruction of H^- in the ion source. This photodetachment signal contains information how H^- on laser path are transported and extracted from the ion source.

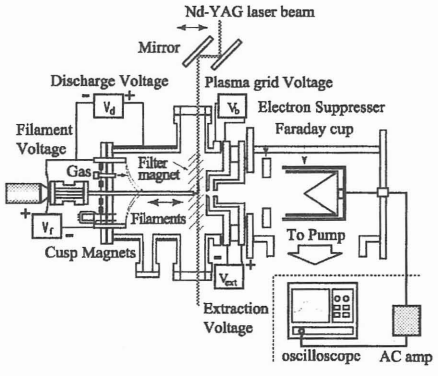

Fig.1 Schematic diagram of the experimental apparatus

The experimental apparatus is shown in Fig.1. Ion source chamber is 9cm diameter and 11cm height. Magnets are attached on sidewall to confine plasma with cusp magnetic field. A PG is made of Mo and has 4mm diameter beam extraction hole. Two 0.35mm-diameter and 7.5cm-long W filaments are installed on the end plate.

The Nd-YAG pulse laser beam used to accomplish photodetachment reaction has 4 mm diameter and 3.3 ns pulse length. It is injected through a window installed on the chamber sidewall and passes plasma near a PG. The distance between PG surface and laser axis(D) can be changed by a pair of movable mirrors. Plasma parameter, H^- density and velocity are measured with Langmuir probe installed on end plate.

Fig.2 shows a typical photodetachment signals for different values of D. In measurement with D=5 mm (minimum), the photodetachment signals showed the peak height about 20% of the H^- ion beam current, and 30 μsec duration. When laser axis was moved away from the PG, H^- on the laser path decrease and showed longer duration to the original H^- current. Therefore, peak height was low in large D measurement. Integrals of these photodetachment signals(ΔQ) are defined as quantity of H^- on laser path extracted from ion source. Fig.3 shows D dependence of ΔQ. In Fig.3, ΔQ is different value in small D condition with different gas pressure and beam current measurement. H^- near a PG are important for decision of H^- beam current from this measurement.

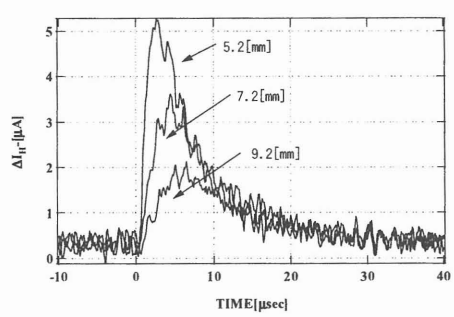

Fig.2 Photodetachment signals three different distances (D) between laser axis and PG.

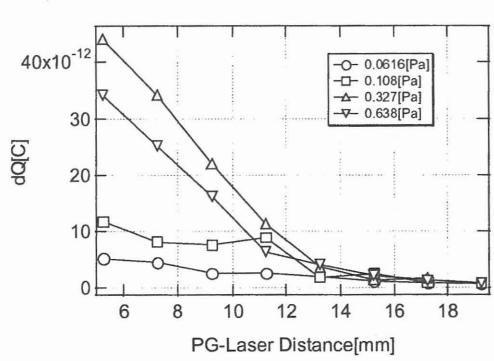

Fig.3 Contribution of H^- on laser path (ΔQ) dependence on distance between laser axis and PG surface (D).

References

[1] M.Bacal, Rev. Sci. Instrum., **71**, 3981(2000).