§33. Development of High Heat Plasma Generator with Ion Beam Analysis and In-situ Measurement of Hydrogen Isotope Retention

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Particle control on a plasma-facing wall is a key issue for long operation; therefore, it is necessary to establish the appropriate wall conditioning techniques. In the LHD, wall conditioning by helium and/or neon glow discharge is performed regularly, and it is reported that neon glow discharge is particularly useful for wall conditioning. However, on the other hand, the surface damage by the glow discharge is also observed and it is not clear yet that it has an influence on dynamic and static hydrogen isotope retention in the wall.

Then, we are developing the high heat plasma generator with ion beam analysis device (Rutherford Back Scattering spectroscopy (RBS), Nuclear Reaction Analysis(NRA), Elastic Recoil Deflection(ERD)), which can be the in-situ surface analysis under plasma irradiation as shown in Fig. 1.

Fig. 2(a) shows a photo of a target chamber, equipped with two magnetic coils to confine the plasma, DC plasma source, and target holder with three axis drive mechanism. Fig. 2(b) shows the newly developed DC plasma source, which is very compact to be connected to ICF114 conflat flange. Cathode is made of zigzag shape LaB_6, which is heated up to 1500 K by direct-current Joule heating. Anode is made of a copper tube cooled by water. Deuterium plasma with $2 \times 10^{18} m^{-3}$ of electron density and 4 eV of electron temperature can be generated at 1.5 kW of discharge power.

Fig. 3 shows the preliminary experimental result of the time evolution of deuterium retention of W and SUS316 after deuterium plasma exposure with a fluence of $7.5 \times 10^{21} m^{-2}$ and surface temperature of 600 K. The deuterium retention in SUS316 is almost constant in time, on the other hand, the deuterium retention in W drops dramatically by atmospheric exposure. This result suggests that we should take care of the treatment of W sample after its plasma exposure to measure the deuterium retention in W precisely.

We will examine the surface damage of metal materials irradiated to plasma and a change of a hydrogen isotope retention with it systematically and clarify physics of wall conditioning from a microscopic point of view, and are aimed at establishing a base of sciences of wall conditioning method to contribute to deuterium experiment in the future LHD.

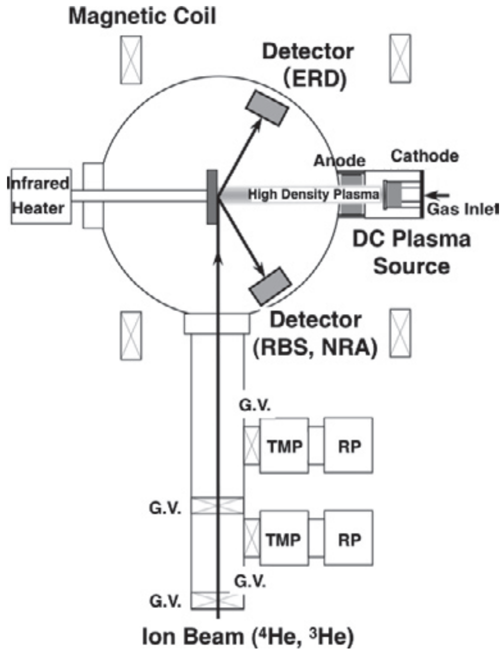

Fig. 1: Schematics of experimental device.

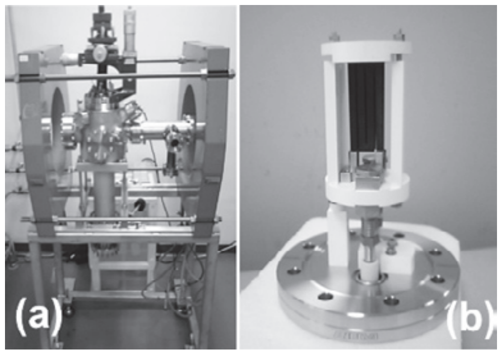

Fig. 2: Photos of (a): target chamber and (b): newly developed DC plasma source.

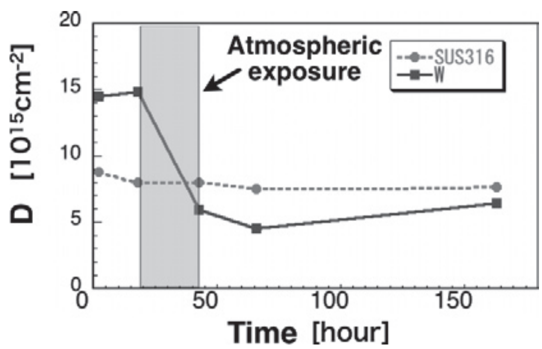

Fig. 3: Time evolution of deuterium retention in W and SUS316.