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

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In order to establish steady state plasma discharge in fusion devices, particle control in plasma-facing components is a one of the most important issues; therefore, it is necessary to establish the appropriate wall conditioning techniques. In the LHD, wall conditioning by using helium and/or neon glow discharges has been performed regularly, and it is reported that neon glow discharge is particularly useful for wall conditioning. However, underlying physics in the wall conditioning has not been fully understood yet. Especially, it is quite important to understand static and dynamic hydrogen retention in the plasma-facing components.

Therefore, we have developed the high heat flux plasma generator with an ion beam analysis including Rutherford Back Scattering spectroscopy (RBS), Nuclear Reaction Analysis(NRA), Elastic Recoil Deflection (ERD) as shown in Fig. 1[1)], which makes it possible to conduct the in-situ surface analysis under plasma irradiation. The target chamber is equipped with two magnetic coils to confine a plasma, a DC plasma source, and a sample holder with a three axis drive mechanism. The DC plasma source is 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. Figure 2(a) shows a discharge power dependence of electron density n_e and temperature T_e at a center of deuterium plasma column generated by the DC plasma source. T_e is around 5 eV. n_e is proportional to a discharge power to reach $1.3\times10^{18}\mathrm{m}^{-3}$ at 1.3 kW. Diameter of plasma column, defined by a full width at half maximum of the electron density profile shown in Fig. 2(b) is about 20 mm.

We made a postmortem analysis of deuterium retention in W exposed by a deuterium plasma by using NRA. Figure 3 shows NRA spectrum without a Mylar film in a inset of Fig. 1. Alpha particles generated by a nuclear reaction between ^{3}He and D were detected. The D retention was estimated to be about $3\times10^{16}\mathrm{m}^{-2}$.

We continue to study a change of hydrogen isotope retention in W systematically with the Mylar film as well as an aluminum film to be used for a protection of SSD during plasma exposure.

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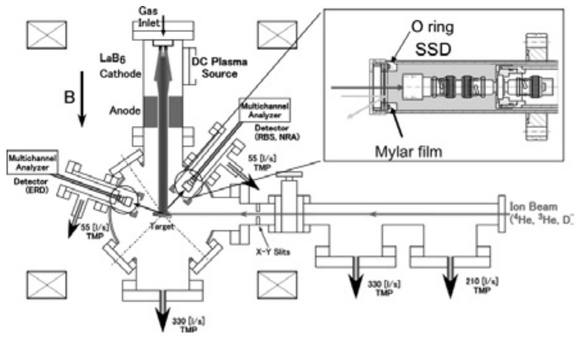

Fig. 1: Schematics of experimental device.

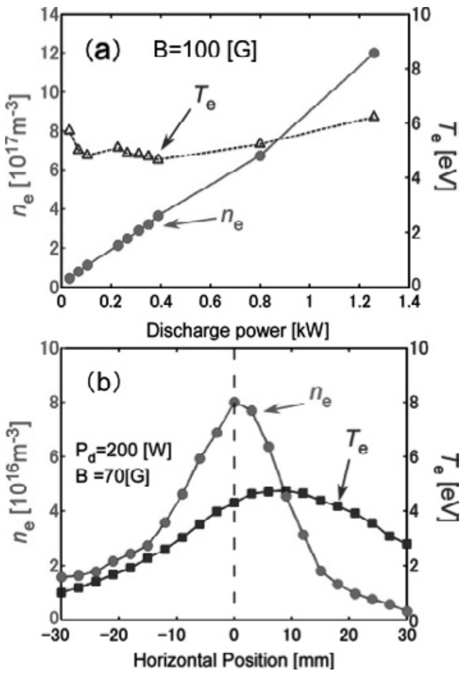

Fig. 2: (a) discharge power dependence of electron density and temperature, (b) profiles of electron density and temperature.

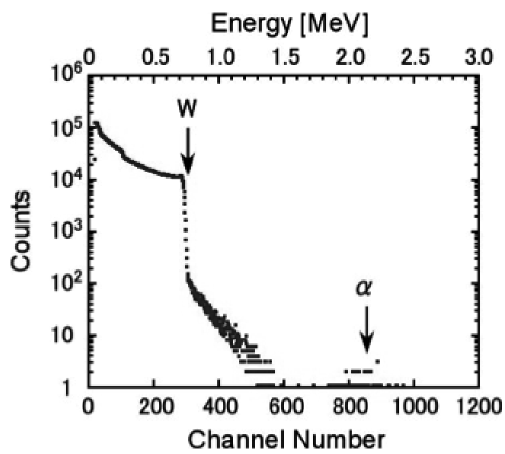

Fig. 3: NRA spectrum of W exposed by a deuterium plasma.