§17. Dynamic Behavior of Tritium Release from Stainless Steel for LHD

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A given amount of tritium shall be produced by D-D fusion experiments by the Large Helical Device (LHD), depending on the conditions of plasma confinement. A part of the produced tritium species is charged and trapped in the plasma-facing materials. From viewpoints of not only control of fuel particle balance but also reduction of exposure to tritium, it is of a great importance to evaluate dynamic behavior of trapping and release of tritium in/from stainless steel (SS316L) being used as the protection plates of LHD.

The small samples cut from a SS316L plate were exposed to the glow discharge of hydrogen isotopes. After glow discharge under the given conditions, the sample was heated in vacuum vessel. Desorption species and partial pressure of them were monitored by a conventional mass spectrometer.

The schematic diagram of a glow discharge device constructed newly in this study was shown in Fig. 1. Major point of this device is to enable to examine the trapping and release behavior of hydrogen isotopes charged by glow discharge without exposure to the atmosphere. Glow discharge conditions are as follows: atmosphere was hydrogen or deuterium, pressure was 130 Pa, discharge current was 20 mA, and discharge time was changes from 1 to 4 hours.

Figure 2 shows the hydrogen pressure changes during a glow discharge in Glow-2. Hydrogen pressure decreased with time, indicating that ionic hydrogen molecules were

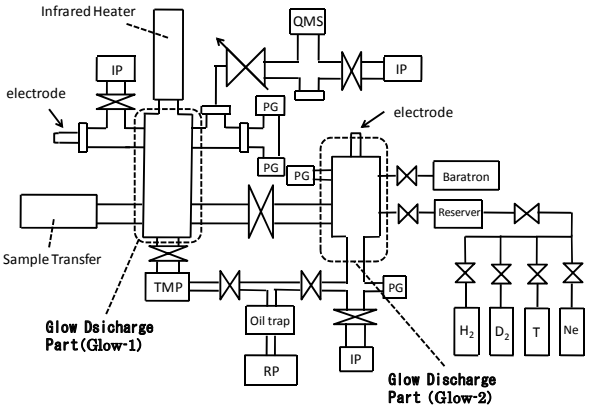

Fig. 1 Schematic diagram of the glow discharge device.

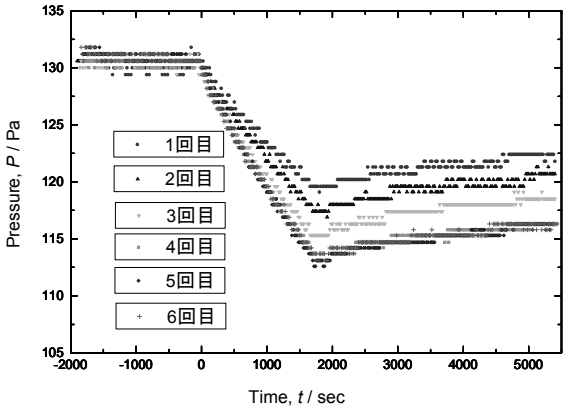

Fig. 2 Pressure changes during a glow discharge.

impinged into the wall of the discharge part. Pressure change became large with the number of glow discharge, and it reached almost constant after five discharges. Decreasing behavior of pressure was similarly observed for deuterium atmosphere. The number of hydrogen and deuterium atoms implanted into the wall was estimated to be 3.5×10^{18} and 3.0×10^{18} atoms, respectively. On the other hand, the number of atoms struck on the surface was evaluated as 2.3×10^{20} atoms from the discharge current. Namely, it was seen that only a few percent of atoms was implanted into the wall.

An example of desorption spectra was described in Fig. 3, which was observed after exposing small SS316L samples to deuterium glow discharge. Most of deuterium species was desorbed at a temperature lower than about 120°C. Main desorption species was D_2, and a little fraction was HD. Hydrogen species was contained in deuterium gas as an impurity. No desorption peaks of HDO and D_2O were observed, although the temperature was raised to 450°C. However, if water molecules exist on the surface of materials, HDO and D_2O species shall be observed at low temperatures. This indicates that surface state of materials plays an important role for the desorption behavior of hydrogen isotopes implanted.

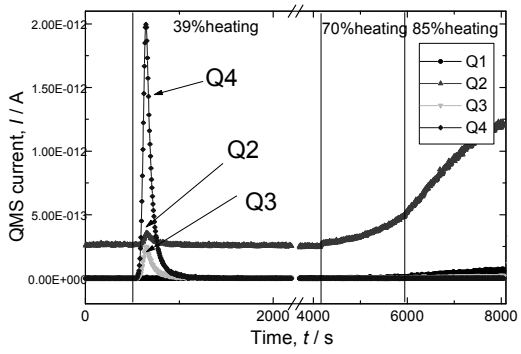

Fig. 3 An example of thermal desorption spectra after deuterium glow discharge.