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

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When the D-D fusion experiments by the Large Helical Device (LHD) are conducted, a given amount of tritium will be produced in the device, although tritium amount depends on the conditions of plasma confinement. A part of the tritium is impinged and trapped in the plasma-facing materials. From viewpoints of reduction of exposure dose by tritium species, 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 the SS316L protection plate were exposed to the glow discharge of hydrogen isotopes at ambient temperature. After glow discharge under the given conditions, the sample was heated in the vacuum vessel. Desorption species and partial pressure of them were monitored by a conventional mass spectrometer. In this experiment, precise temperature measurement is one of key issues for evaluating release behavior of hydrogen isotopes by linear heating. From this viewpoint, a temperature control device which consists of a movable thermocouple has been newly attached as shown in Fig. 1.

A typical desorption spectrum is shown in Fig. 2, which was observed by heating at 15 K/min after exposure to deuterium glow discharge for 60 min. A trace amount of m/e=3 (HD) was detected with a major amount of m/e=4 (D_2). No other species such as HDO, D_2O and $C_nH_xD_y$ were observed. In this run, peak temperature appeared at 123°C, which is consistent with the desorption temperature reported by Wilson et al. In addition, peak temperature shifted to the lower temperature side with increasing in discharge time, and to the higher temperature side with increasing a heating rate. Shape of the desorption peak observed was asymmetric and extended to the higher temperature side. These tendencies indicate that the desorption rate of hydrogen isotope impinged into the sample is limited by the diffusion rate.

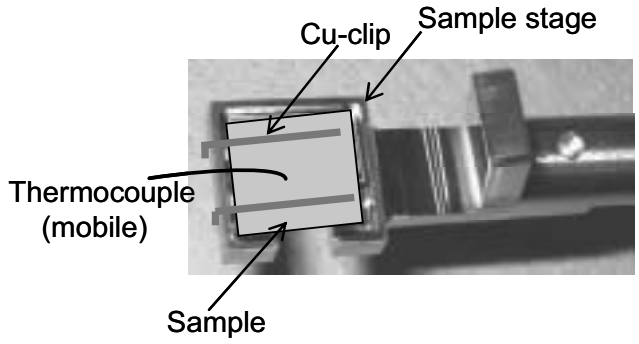

Fig. 1 View of a new temperature measurement device.

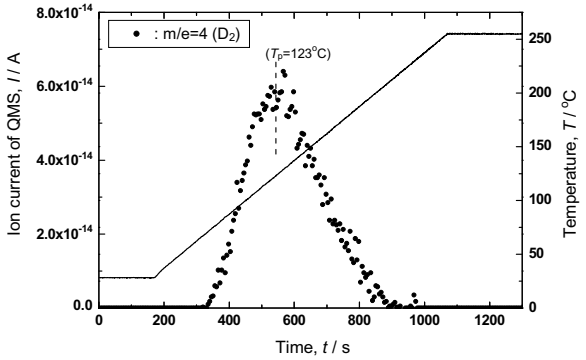

Fig. 2 An example of desorption spectra of deuterium.

After glow discharge of deuterium, the sample was exposed to the ambient atmosphere for 3 hours. After that, it was evacuated again below $3x10^{-5}$ Pa at room temperature. Subsequently, the sample was heated up to 473 K. During heating, desorption species was followed by mass spectrometer, and the results are shown in Fig. 3. In this run, species such as HD and D_2 were below the detection limit of the present mass spectrometer and a major desorption species was D_2O as seen from Fig. 3. This indicates that deuterium atoms implanted into bulk by a glow discharge react with oxygen adsorbed on the surface and formed D_2O. Namely, it was seen that a drastic change in desorption behavior was occurred by air exposure.

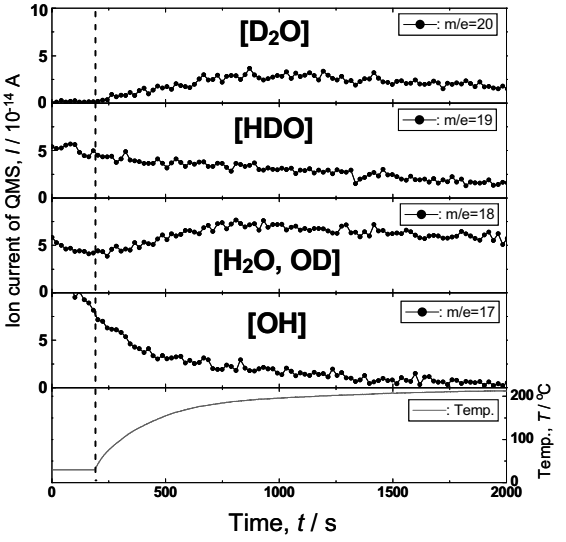

Fig. 3 Change in the peak intensities of each species during heating.