§39. Basic Studies for Reduction of Tritium Retention, and for Recovering and Recycling of H, D and T under LHD-DD Operations

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Tritium (T) produced by D-D reactions is a safety concern in deuterium discharges planned in LHD. We have started a new three years research program for investigations of (1) where and how much tritium is retained at particular locations in plasma facing surfaces and remote areas. (2) reduction and/or removal of the retained tritium in the vacuum vessel, and (3) recovery and separation of hydrogen isotopes from evacuated gases.

Because of the limited space, this report focus two results (1) difference of hydrogen isotope retention in retention characteristics and (2) cryogenic recovery of hydrogen isotopes from evacuated gases. Some of other results are given in published papers[1-7].

(1) Different characteristics of retention of hydrogen isotopes and their impact on tritium removal

Carbon tiles used in JT-60U were exposed to DD (Discharges with Deuterium puffing + Deuterium NBI) discharges. In addition, HH discharges were made before the vacuum ventilation to remove T produced by DD reactions. Hence all hydrogen isotopes retained in the carbon tiles showed different depth profiles, reflecting discharge history and isotopic exchanges. Based on our recent studies on retention of hydrogen isotopes (H, D, and T) in plasma facing carbon tiles used in JT-60U[1,2], retention of hydrogen isotopes are illustrated in Fig.1 with separation of eroded area and deposited area.

Hydrogen retention at the eroded area is very likely saturated and would not linearly increase with time. Furthermore, the isotopic ratios of retained hydrogen near surface layers are always equilibrated with in coming hydrogen fluxes (H/D/T). This is also true even for the redeposited carbon layers on the inner divertor. And the depth attaining this equilibrium is quite large owing to their porous nature and temperature increase over 800 K. Hence tritium retention in plasma facing surfaces (both eroded and redeposited) would be significantly reduced by isotopic replacement by DD discharges subsequently made after DT discharges. The efficiency of the isotopic replacement is higher and deeper for higher temperatures.

At the deposited area, on the other hand, continuous carbon redeposition would pile up tritium retention with little isotopic replacement. Nevertheless, the location of the deposited area is mostly limited to the divertor area of a tokamak, indicating that one can concentrate to tritium removal at only limited areas. Hence the deposition profiles in LHD should be examined urgently.

(2) Cryogenic recovery of hydrogen isotopes from evacuated gases.

Since the evacuation system of LHD is consisted of cryogenic pumps, hydrogen isotopes could be separated from other impurity gases, like He, hydro-carbons and water vapors, by temperature controlled heating of the cryo-panels. To do this, basic data for gas release characteristics during the heating are required and an experimental apparatus shown in Fig. 2 is newly produced. Preliminary results are promising and the experiments are continued

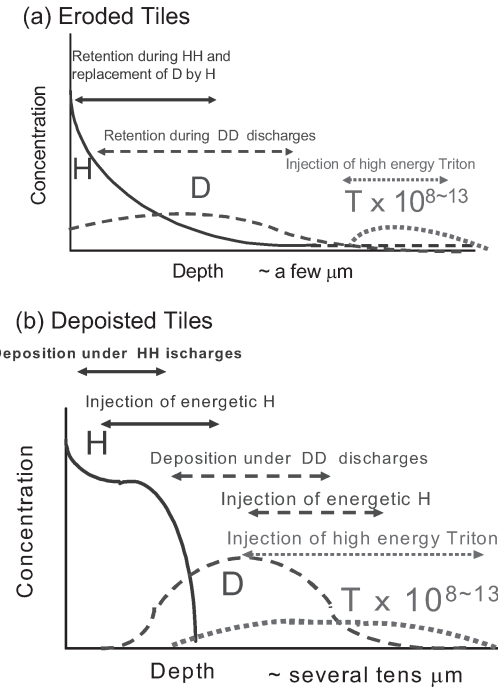

Fig. 1 Schematics of hydrogen retention characteristics in plasma facing materials (a) eroded and (b) depositited areas

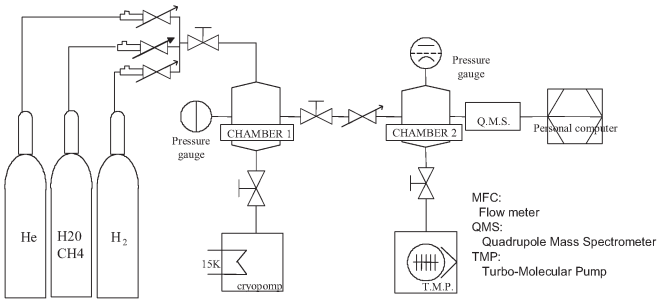

Fig.2 Experimental apparatus for cryogenic recovery and separation of hydrogen isotopes.

Published papers
1) M. Yoshida et al. presented at 18th PSI, to be published in J. Nucl. Mater.
2) T. Tanabe, et al., presented at 18th PSI, to be published in J. Nucl. Mater.
3) K. Sugiyama, et al. J. Nucl. Mater. **363-365** (2007) pp.949-954.
4) D. Watanabe, et al. J. Nucl. Mater. **363-365**(2007) pp.972-976
5) T. Otsuka, et al., J. Alloy. Compd. **446-447** (2007) pp. 655-659
6) T. Otsuka and T. Tanabe, , J. Fusion Technol. in press.
7) Y. Uchida, et al., J. Fusion Technol. in press.