§27. 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 been investigating; (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 (i) cryogenic recovery of hydrogen isotopes from evacuated gases and (ii) separation of tritium localized on the surface and absorbed in the bulk to control surface contamination and de-contamination. Some of other results are given in published papers[1-6].

(i) 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 was built last year. Two sets of experiments were done. (a) After H_2 and He mixed gas was absorbed on the cryo-panel, the panel temperature was heated and desorbed H_2 and H_2 were measured as given in Fig.1 for different initial gas mixing ratios of H_2 and He. As clearly seen in the figure, He was desorbed at lower temperature than H_2, and the H_2 release started after the completion of the He release. (b) Gas mixture of H_2 and CH_4 were also examined and it was found that CH_4 was desorbed much higher temperature than H_2, indicating easy separation of H_2 and CH_4. Thus cryogenic separation is very much promising and the separation will be qualified next year.

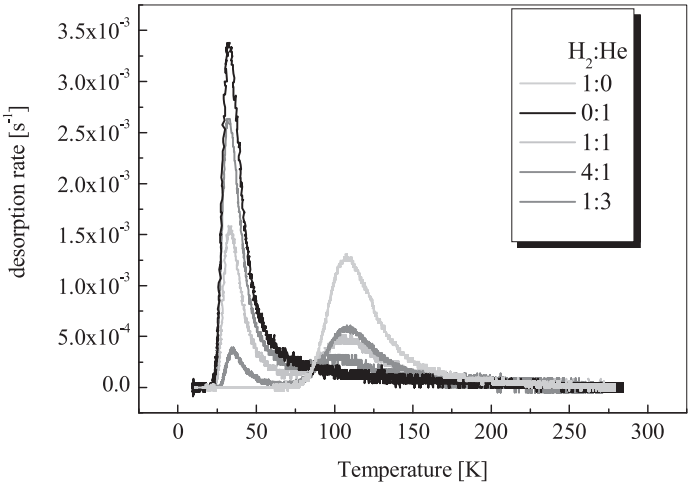

Fig.1 Cryogenic separation of H_2 and He.

(ii) Separation of tritium localized on the surface and absorbed in the bulk

Figs. 2(a) and 2(b) respectively show tritium distribution localized on the surface and tritium penetration profile into the bulk by diffusion, observed by an imaging plate technique. Although, the surface profile is quite inhomogeneous, the penetration profile indicates simple diffusion of tritium into the bulk. An apparent diffusion coefficient assuming the simple diffusion written in the figure agrees well with literature data. However, the calculated profile given in the dotted line at very near surface did not well represent the experimental profile. This indicates that tritium localized on the surface is likely behaves differently from hydrogen in solution but is not likely influence T diffusion (penetration) into bulk. Removal or decontamination of surface T will be studied in the next year.

Published papers
1) T. Otsuka et al. J. Fusion Technol. **54** (2008).541-544.
2) C. H. Skinner, et al. Fusion Science & Technology, **54** (2008) 891-945.
3) N. Bekris, et al. Fusion Eng. and Design, **83** (2008) 1137–1141.
4) Y. Uchida, et al., J. Fusion Technol. **54** (2008) 545-548.
5) K. Katayama, et al. Fusion Science and Technology, **54** (2008) 549-552.
6) T. Otsuka, et al. J. Nucl. Mater. **386-388**(2009)884-887.

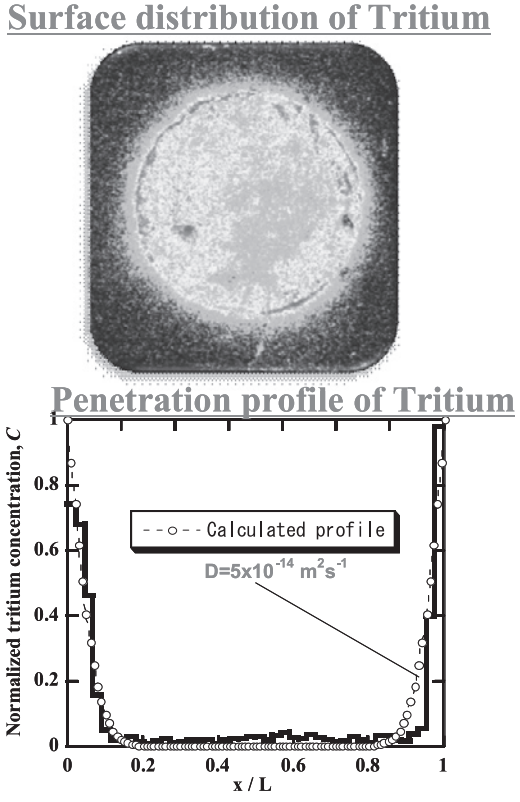

Fig.2 (a) Surface distribution and (b) diffusion profile by tritium for stainless steel exposed to gaseous T/H.