§40. Study of Hydrogen Isotope Trapping in a Deposition Layer on Nickel

Torikai, Y. (Hydrogen Isotope Research Center, Univ. Toyama),
Ashikawa, N., Nishimura, K.

In previous work trapping of tritium in a carbon deposit layer generated on stainless steel SS316L by exposure to LHD plasmas and subsequent thermal tritium loading was reported. The amount of trapped tritium in the deposit layer was found to be 40 times higher than that in the base metal SS316L. These measurements may constitute an indirect procedure to estimate carbon deposition buildup during operation of a fusion machine. In this study the release rate of tritium from carbon deposited on Ni was investigated in order to gain more information on the properties of these layers.

Nickel specimens with a dimension of 10×5×0.1 mm^3 and a purity of 99 % were purchased from Nilaco, Co. Ltd., Japan. They were cleaned in an ultrasonic bath first three times in ion-exchanged water and then three times in acetone. One of the cleaned specimens was introduced into the LHD at section 6.5 near of the graphite divertor. There the specimen was subjected to 5,131 H-H shots (numbers #112111 - # 117242). After exposure to LHD plasmas the Ni specimen was covered by a carbon layer.

Most experimental equipment and procedures used for sample loading and thermal release studies have been described in previous publications[1]. A schematic drawing of the experimental apparatus used for loading with tritium is shown in figure 1. To this effect a single specimen was introduced into the quartz reactor attached to the high vacuum system. Before loading, the specimen was heated at 670 K for 3 hours under a vacuum of < 10^{-6} Pa. Then a deuterium-tritium mixture containing 7.2%-T was introduced into the quartz reactor. Loading temperature and pressure were 523 K and 1.2 kPa, respectively.

Figure 2 shows a schematic diagram of the experimental setup used to investigate the release of tritium. The apparatus comprises a gas supply, a specimen tube, two water bubblers and a copper oxide reactor. All tubing and their connections were of stainless steel. During each run they were trace heated at 400 K to minimize condensation and adsorption. The temperature of the specimen was controlled at (298 ± 2) K. With argon as carrier gas the released tritium was first passed through a bubbler in which HTO was retained, then passed through a copper oxide bed maintained at 800 K to oxidize molecular tritium and hydrocarbons into HTO and carbon oxides and finally through a second bubbler. By this procedure it was possible to determine separately tritiated water and elemental tritium. The amount of tritium retained in each bubbler was obtained from liquid scintillation counting.

A comparison between the tritium content of the first bubbler with that retained downstream of the CuO bed in the second bubbler consistently showed that more than 99 % of the liberated tritium consists of water, i.e. HTO. This has been explained by surface reactions between tritium diffused to the surface and traces of moisture present in the carrier gas[2]. Figure 3 compares the release rate of tritium at ambient temperature from pure Ni with that from Ni covered by a thin layer of deposited carbon as function of time after tritium loading. As further noticeable from Fig. 3 the release rate of tritium from clean Ni drops sharply from initially 2×10^5 Bq/h down to 10^3 Bq/h after an ageing period of 24 hours and down to less than 1 Bq/h after elapsing of 40 hours. This behavior could be simulated by a one-dimensional diffusion model[1]. The release of tritium from nickel having a deposited carbon layer, on the other hand, was quite different. In this case, the release rate approached a nearly constant rate of about 7 Bq/h after an ageing period of more than 500 hours. Tritium is evidently released from the carbon deposit on the surface at a much slower rate than from the metal bulk.

This work is supported by NIFS budget NIFS14KEMF056.

1) Saito M. et al., Fusion Sci. and Technol., **60,** (2011) 1459-1462.
2) Torikai Y. et al., Fusion Sci. and Technol., **48**, (2005) 177-181.

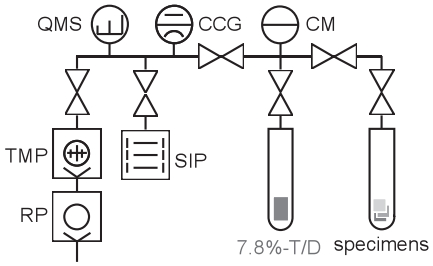

Fig.1. Schematic representation of tritium exposing apparatus.

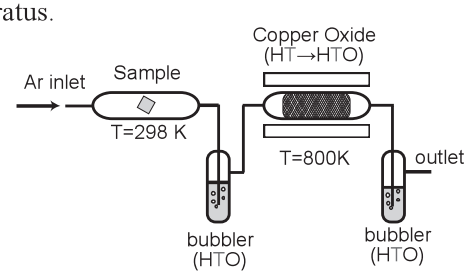

Fig.2. Experimental arrangement for the chronic release studies.

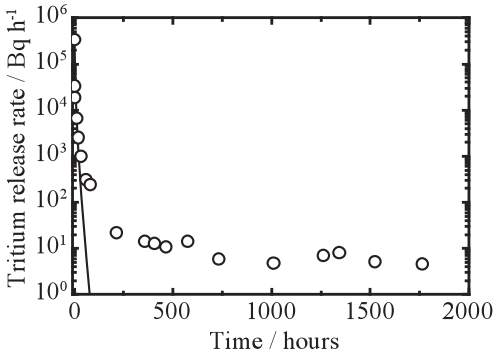

Fig.3. Tritium release from pure Ni (solid line) and carbon deposited Ni(◦).