

§65. Studies on Improvement of Tritium Safe-Handling Techniques and Material Interactions with Tritium

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Reduction of tritium retention in the plasma-facing materials (PFM's) of a future fusion reactor as well as ITER is one of great important issues from viewpoints of not only controlling the fuel particle balance in the reactor core but also safety and economy of tritium, since a huge amount of tritium is used in a future thermonuclear fusion reactor. However, the trapping and release behavior of tritium in/from the PFM's will be changed by exposure to fusion plasmas during a long period, because PFM's are always bombarded by neutrons, fuel particles, and the impurity particles. In addition to this, surface of PFM's is eroded by chemical and physical sputtering due to bombardments of various particles, and consequently results in formation of deposition layers on different surface of PFM's. Namely, it is important to study the effects of exposure to plasmas for tritium retention.

In this study, stainless steel exposed to plasmas of the 14th cycle in the Large Helical Device (LHD) was used as a model material, and the effects of plasma exposure for trapping and release of tritium have been studied. Sample plates of stainless steel type 316 (SS316: 10x10 mm²) were preliminarily fixed at four locations (1.5U, 5.5U, 6.5L and 9.5L) in the LHD prior to experimental campaign of the 14th cycle. After being exposed to plasmas, sample plates were separated from each wall, and those were loaded in a conventional tritium exposure device equipped a quartz tube. The samples were evacuated in it at 296 or 673 K in order to examine the effects of heat treatment, and then they were exposed to tritium gas at 296 K. Exposure time was 4 hours, and the total pressure of tritium gas was 2.66 kPa. After tritium exposure under the given conditions, the samples were analyzed by β -ray-induced X-ray spectrometry (BIXS) and an imaging plate (IP) technique.

Figure 1 shows the results obtained by BIXS measurements for different pumping conditions: namely, tritium exposure temperature is the same, while evacuation temperature is different. It is clearly seen that the amount of tritium

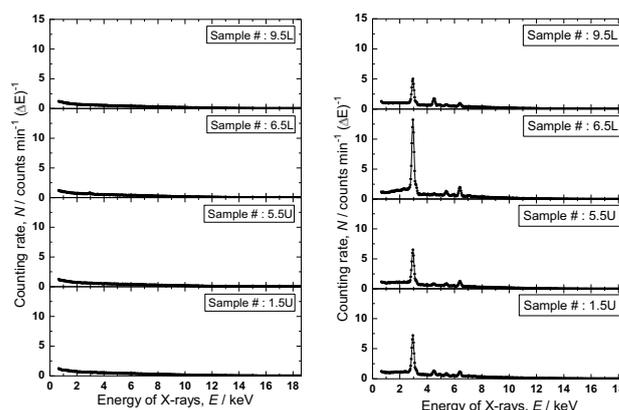


Fig. 1 X-ray spectra observed by BIXS: left spectra were observed for evacuation at 296 K, while right spectra were done for evacuation at 673 K.

retained in surface layers increased more than 100 times with increasing an evacuation temperature. Contaminants adsorbed on the surface of the sample can be removed by evacuating at 673 K. It is considered that this is a major reason for large tritium retention.

Figure 2 shows a tritium distribution on the sample surface of 6.5L measured by IP technique. A large difference in tritium retention appeared in both samples as mentioned above. In addition, a little non-uniformity of tritium distribution was also observed. It was suggested from the analyses by an X-ray photoelectron spectroscopy that the non-uniformity of tritium retention on the surface was caused by the metallic species deposited on the surface.

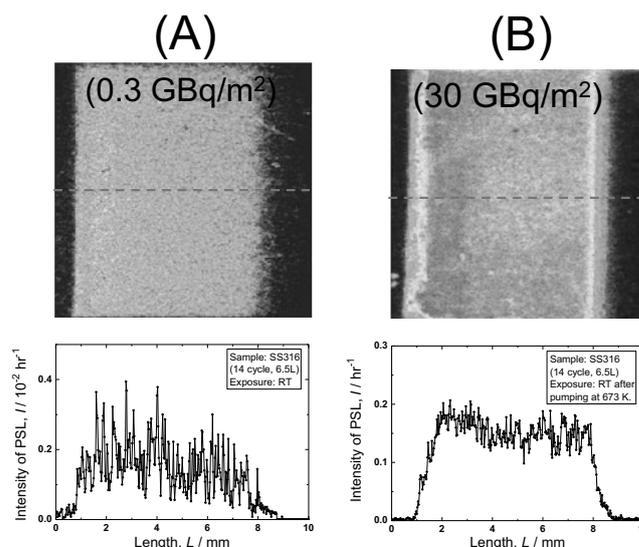


Fig. 2 Tritium distribution measured by an imaging plate technique. Image of (A) was observed by evacuating at 296 K, while the (B) was done by evacuating at 673 K. Red dotted lines show a line analysis of tritium.