

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

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A given amount of tritium is generated by depending on the conditions of plasma confinement, when the D-D fusion experiments are conducted in LHD (Large Helical Device). A part of the tritium is charged and trapped in the plasma-facing materials, and the others are pumped out from the reactor core. A part of tritium trapped in the surface layers of those materials will be chronically released from the materials based on a concentration gradient of tritium. Such release behavior is of a serious problem when an operation of the device is stopped and an atmospheric gas is introduced into the device for maintenance of the device.

From viewpoints of tritium safety and control of fuel particle balance, it is of a great importance to evaluate dynamic behavior of trapping and release of tritium in stainless steel (SS316L) being used as the first wall materials of LHD.

The small samples cut off a SS316L plate, which are used as a protection plate in LHD, were exposed to tritium gas diluted with deuterium under the given conditions of temperature, pressure and time. After thermally exposed, the tritium amount retained in the surface layers of a sample was evaluated by  $\beta$ -ray-induced X-ray spectrometry (BIXS). Size of the samples is  $10 \times 10 \times 0.5 \text{ mm}^3$ . In this examination, three kinds of samples exposed to plasmas of 9<sup>th</sup>, 10<sup>th</sup>, and 11<sup>th</sup> experimental cycle were prepared. Location of samples

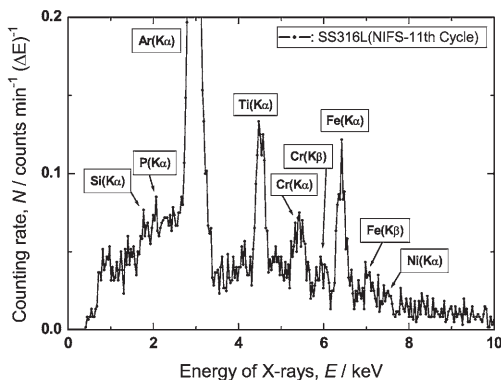


Fig. 1 X-ray spectrum observed for a small SS316L sample set at the 9.5U port.

in LHD was 5.5U port for 9<sup>th</sup> cycle, 1.5U port for 10<sup>th</sup> cycle, and 9.5U port for 11<sup>th</sup> cycle. To compare with these materials, buff-polished SS316L samples were also prepared and those were similarly exposed to tritium gas.

As shown in Fig. 1, deposition of titanium on the sample surface was clearly observed in the spectrum of BIXS, which is consistent with the results of pre-experiments in the last year. On the other hand, no titanium peak was observed for the samples of 1.5U port and the 5.5U port, although the experimental cycle was different. Namely, it is considered that the deposition of titanium is strongly dependent on the location of a protection plate. The present observation indicates that the tritium retention in LHD may be affected by deposition of titanium, because titanium is well known as one of materials that interactions with hydrogen are very strong.

Figure 2 shows the result examined changes in intensity of X-ray peaks after tritium exposure of buff-polished samples, when the sample was immersed into water for a given time (5 minutes in each immersion run). Initial amount of tritium before immersion was evaluated as  $8.2 \text{ GBq/m}^2$  from the intensity of an Ar(Kα) peak, when the concentration of tritium gas used to exposure was taken into account. In addition, it was found from the intensity ratio of Cr(Kα) to Fe(Kα) that chromium concentration of the surface was enriched than that of the bulk.

Intensity of Ar(Kα), Cr(Kα) and Fe(Kα) peaks decreased with an immersion time as shown in Fig. 2. Change in the intensity of a Cr(Kα) peak was larger than that of an Fe(Kα) peak. In addition to this, the intensity ratio of Cr(Kα) to Fe(Kα) decreased with an immersion time. From these results, it is suggested that tritium was mainly trapped by chromium with a chemical form of hydroxyl group and released through exchange reaction with a water molecule.

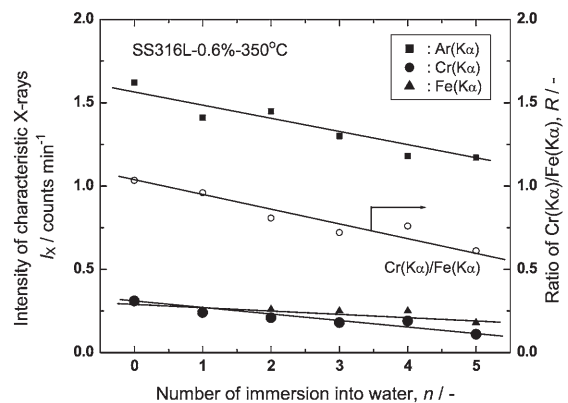


Fig. 2 Changes in X-ray peak intensity and the ratio of Cr(Kα) to Fe(Kα) by immersion into water.