§62. Behavior of Tritium Retention on Metallic Surfaces Exposed to Plasmas in QUEST

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From viewpoints of not only controlling the fuel particle balance in the reactor core but also safety and economy of tritium, 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. However, the trapping and release behavior of tritium in/from the PFM's will be changed by exposure to fusion plasmas, 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 order to clarify such effects, many investigations have been so far carried out by using deuterium and/or tritium. However, most of these studies have been done using samples exposed to atmosphere after exposing to plasmas. Exposure to atmosphere makes unclear interesting properties of plasma-exposed surface owing to adsorption of oxygen, water vapor, carbon dioxide and so on. Therefore, to expose to tritium without air exposure after plasma exposure experiments we have constructed a specially designed apparatus, which can be connected with QUEST, as shown schematically in Fig. 1.

Requirements of the new apparatus are as follows:

(1) Maximum moving distance of a linear motion is longer than 90 cm in order to introduce a sample into the plasma experimental device.

(2) Leak rate of a sample moving part is within 5x10^{-10} Pa m^3/s.

(3) Rotational function is required to expose a sample to plasma with an optimum angel.

(4) Transportation of a sample should be kept in vacuum state.

(5) The transportation is separable from the linear motion after exposure to plasmas.

(6) Leak rate of the transportation is within 5x10^{-10} Pa m^3/s.

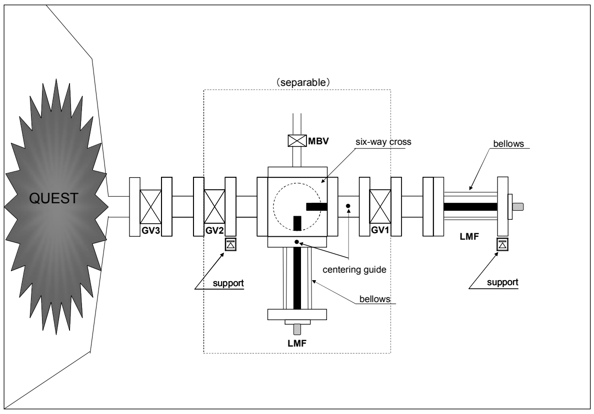

Fig. 1 Schematic diagram of a plasma exposure system equipped with the transportation of a sample.

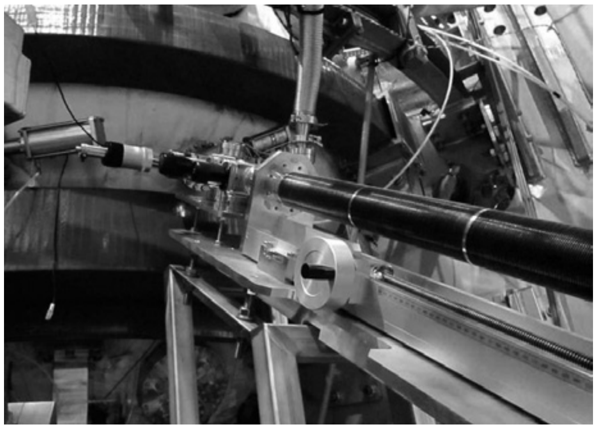

Fig. 2 Photograph of the transfer system of a sample to expose to plasmas in QUEST.

(7) The transportation is durable for a long transfer from Kyushu University to University of Toyama.

Figure 2 shows the photograph of the moving system of a sample in order to expose to plasmas in QUEST. In the first experiment, a sample of type 316L stainless steel was kept in the upper part of the present system as a model sample. It was exposed to plasmas from Dec. 2012 to March 2013. After exposure to plasmas in QUEST, the sample was transported to Hydrogen Isotope Research Center, University of Toyama, and then it was exposed to tritium gas at 373 K under the given conditions. In comparison, plasma non-exposed sample was simultaneously exposed to tritium. After tritium exposure, tritium retention was measured by β-ray-induced X-ray spectrometry and imaging plate technique.

The amount of tritium retained on the plasma-exposed surface was about 2.5 times larger than that on the non-exposed sample. It is considered that the increase is due to effects of irradiation of plasmas.