

## §100. Tritium Behavior on First Wall Materials in High Temperature Plasma Confinement Device

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It is of importance to clarify phenomena of implantation, retention, diffusion and permeation of tritium on surface of the armor materials of the first wall/blanket and the divertor from a viewpoint of precise control of fuel particles, reduction of tritium inventory and safe waste management of materials contaminated with tritium. In addition, it is well known that re-deposited layer, which includes the first wall components emitted by sputtering and residual gases such as oxygen, is formed. On the other hand, tungsten would be used as the armor material of the first wall and divertor in demo reactor. Therefore, clarification of behavior of tritium on surface exposed by plasma in all metallic first wall and divertor needs to be made. In the present work, tritium exposure experiments have been carried out for long term installed samples on first wall in spherical tokamak QUEST, which is an all metallic first wall device.

Samples have been installed on vacuum chamber of spherical tokamak QUEST at Kyushu University. The vacuum vessel, and an armor of divertor and center stack of QUEST are made of SUS316L and tungsten, respectively. After the plasma discharge experiments, the samples have been examined using XPS, RBS and ERD. In addition, tritium exposure experiments have been carried out using a tritium (T) exposure device at University of Toyama. Pressure of the T gas was 1.3 kPa and T exposure was kept for 4 h in all examinations. T concentration in the gas was about 5 %. After thermal exposure to T gas, T amount retained in surface layers of the sample was evaluated by  $\beta$ -ray-induced X-ray spectrometry (BIXS) and imaging plate (IP) measurements. In this fiscal year, T exposure experiments on sample which was exposed by 7th cycle under the condition which temperatures of pre-heating and T exposures were 400 °C and 350 °C, respectively has been carried out. In addition, T exposure experiments on sample which was exposed by 9th cycle under the condition which temperatures of pre-heating and T exposures were 100 °C and 100 °C, respectively have been also performed.

Figure 1 shows result from XPS analyses on the SUS316L sample which was installed in the 9th cycle (from 2012/11 to 2013/3). Re-deposited layer which main composition are Fe, O, W, C and Cr, was formed on the SUS316L surface. The composition is different from that of the past samples and a thickness of deposited layer was 6 times larger than that of the sample, exposed at 7th cycles,

which main composition of re-deposited layer was Fe. Re-deposited layer on W sample was also formed, however, depth profile and composition were different from that of the SUS316L. This is considered to indicate that deposition and reflection of atom on the sample surface is depend on the composition of the sample surface. In addition, thickness and composition of these re-deposited layers are considered to be different in a strong refection of plasma parameters, components inside the vacuum vessel and the surface of the vacuum vessel depending on the cycles of plasma confinement experiment.

Figure 2 shows result of IP measurement of the SUS316L and W which were installed in the 9th cycle (from 2012/11 to 2013/3). IP measurement indicated that amount of T on the SUS316L installed in the 9th cycle (from 2012/11 to 2013/3) which temperatures of pre-heating and T exposures were both 100 °C (same temperature of wall during plasma discharge experiment in QUEST) was 4.4 times higher than that of non-exposure sample. On the other hand, in the case of W, amount of T on the re-deposited sample measured by IP method was 1.1 times higher than that of non-exposure sample in QUEST. This indicates that amount of T of surface layer of the W before and after the plasma exposure is almost same. Distribution of T from IP on the non-exposed W was not uniform and large T amount area exists spotty, however, distribution of T on the exposed W was almost uniform. In the case of W used, W was strongly rolled because a thickness of W used was 0.1mm. This resulted in slightly uneven surface. As a result, non-uniform T distribution is considered to be formed. On the other hand, in the case of the W sample which re-deposited layer was formed, T is considered to be retained uniformly in the re-deposited layer.

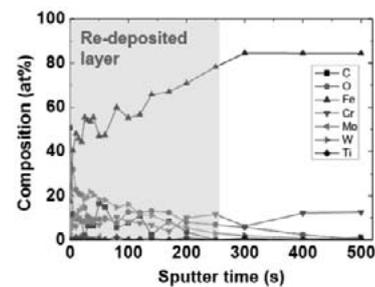


Fig. 1. Depth profile of SUS316L installed in 9 cycle in QUEST

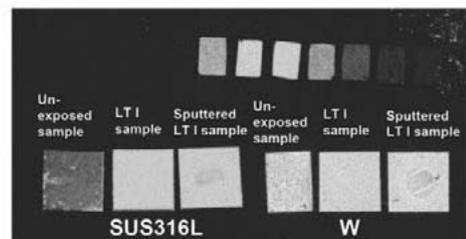


Fig. 2. Tritium images of samples exposed to T gas at 100 °C.