§66. Study of Tritium Distribution in Tungsten Exposed with Plasma

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Tungsten (W) is planned to use as a plasma facing material in a fusion reactor due to its high melting point, low sputtering yield and low hydrogen inventory. In this study, the tritium distribution on W surface exposed with D plasma and that on as received W surface were measured with the Imaging Plate (IP) method to make comparison with the hydrogen inventory and the surface morphology.

Two kinds of W materials were prepared for this study. One is a recrystallized W, another is a ITER grade W that was manufactured according with the ITER specifications. D plasma exposure was carried out for only recrystallized W at three different temperature, 495K, 545K and 550K. The energy and the fluences of D plasma exposure were 38eV/D and 1×10^{26} D/m^2, respectively. Recrystallized W exposed with plasma and as received samples, recrystallized W and ITER grade W, were placed into a tritium gas exposure apparatus equipped with high vacuum pumping system. Before a tritium gas exposure, all samples were degassed at 573K until the pressure of apparatus was reached below 10^{-6} Pa. After that, the tritium gas exposure was carried out at 573K in 5 hours. Tritium gas consisted of 7.8% tritium and deuterium. During tritium gas exposure, some amounts of deuterium or protium in W were exchanged to tritium by isotopic exchange reaction. At the end of gas exposure, temperature of samples was cooled immediately and tritium gas was restored into ZrNi bed. After the pressure was reached below 10^{-6} Pa, samples were taken out from the gas exposure apparatus. IP, that can record β-ray emitted by tritium, were putted on the surface of samples in light tight box. After 72 hours exposure at room temperature, the tritium distribution recorded in IP was measured with imaging analyzer.

Fig. 1 shows the results of IP measurements. The level of darkness corresponds with the concentration of tritium. The images of Fig.1 (1) to (3) were the results of recrystallized W exposed with plasma and the inner region of a broken circle corresponds to the area exposed with plasma. Fig. 1 (4) and (5) were the results of as received recrystallized W and ITER grade W, respectively. The distribution of hydrogen isotopes on W surface could be measured successfully by using tritium and IP method. In Fig.1 (1) to (3), tritium was concentrated on the area exposed with plasma. It was found that plasma exposure obviously increases the hydrogen inventory of W surface. In the area exposed with plasma, the inner region of broken circles, the tritium distribution was not uniform. Tritium seems to be concentrated on the outer periphery of exposure area. The tritium concentration of W exposed at 550K was highest in all results and W at 550K has a different tritium distribution comparing with that of W at 495K, although the difference of exposure temperature was only 5K. These differences suggested that not only temperature but also plasma condition strongly effect the tritium distribution on W. On the other hand, there is also a difference in both as received Ws in Fig.1. Although ITER grade W has a uniform tritium distribution, as received recrystallized W has some slightly tritium concentrated areas. To identify the reason of tritium distribution in recrystallized W, the surface observation with SEM is planned. The intensities of luminescence indicated in Fig.1, were estimated and shown in Table I. The ratio between highest intensity and lowest one (b/a, d/c, f/e) in a same sample were within 4 to 6 times. This ratio indicated that there was no extremely highly tritium concentrated region in IP resolution. In addition to the IP measurement, the BIXS method will be carried out to evaluate the qualitative tritium distribution and the observation of W surface with SEM also will be carried out to reveal the correlation between the tritium distribution and the surface morphology. And more high resolution observation of tritium distribution with micro autoradiography is planed to be carried out.

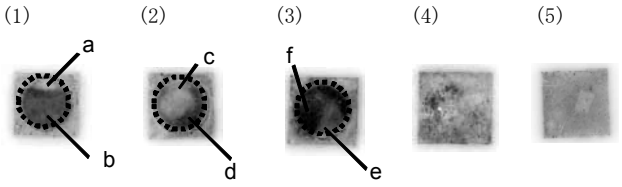

Fig. 1. The images of IP measurements for different 5 samples
(1) W exposed with D plasma at 495K
(2) W exposed with D plasma at 545K
(3) W exposed with D plasma at 550K
(4) As received recrystallized W
(5) As received ITER grade W

Table I Luminescence intensities of each point

Point	a	b	c	d	e	f
PSL/mm^2	320	1800	500	2100	560	3200