§12. Investigation of Deuterium Retention in Dust and Redeposited Layers by Using Divertor Plasma Simulator

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Dust particles generated in fusion devices have a strong influence on safety and operational issues. For example, dust accumulation inside the vacuum vessel could lead to huge tritium inventory. Therefore, quantitative evaluation of hydrogen isotope retention in dust particles is one of the most important problem.

Many kinds of metal and carbon dust particles including deposits have been collected in large fusion devices to investigate shape and size distribution of dust particles. Further, gas retention in collected dust particles were analyzed by using thermal desorption spectroscopy (TDS). However, it is quite difficult to discuss gas retention mechanism inside the dust particles quantitatively, because dust particles in the large fusion devices are grown under many different main discharges and glow discharges for wall-conditioning.

In this study, we will investigate characteristics of deuterium gas retention in tungsten dust particles and deposits produced in high density deuterium plasmas, which were generated by using a linear divertor plasma simulator, NAGDIS-II.

Figure 1 shows newly developed TDS system, which can heat up specimens up to 1900 K by using infrared light heating. Two quadrupole mass spectrometers (QMS) with different resolution are installed in the TDS system. High resolution QMS can detect deuterium molecule and helium atom separately. We can set the specimen without breaking vacuum in QMS region.

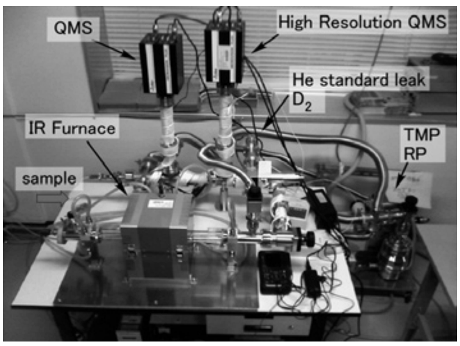

Fig. 1: Photo of developed TDS system.

First, in order to check the performance of the developed TDS system, we have analyzed a divertor tile, which was used in the LHD. SEM-EDX analysis shows that the region A in Fig. 2 is eroded by sputtering, and in the region B, there is co-deposits of metal and carbon. In the region C, carbon deposition is mainly observed. In the TDS spectra as shown in Fig. 3, the specimen B has a strong He peak in comparison with those of specimens A and C, probably because He is trapped in defects, such as bubbles of metal layers. The specimen B also shows double peaks of hydrogen. A peak at lower temperature corresponds to hydrogen retained in voids between deposited layers as molecule, and another peak at higher temperature means chemically bonded hydrogen at voids and defects.

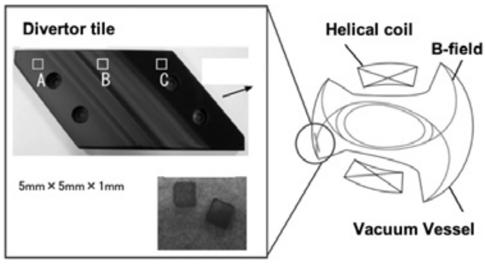

Fig. 2: Divertor tile used in LHD.

We made deposition layer of W on Mo substrate under high density deuterium plasma in the NAGIS-II device. W was ablated by Nd:YAG laser. SEM photograph in Fig . 4 shows deposited W surface on the Mo substrate. Spherical dust particles were also observed on the surface. Now, we are analyzing deuterium retention of W deposited layer by using the TDS system.

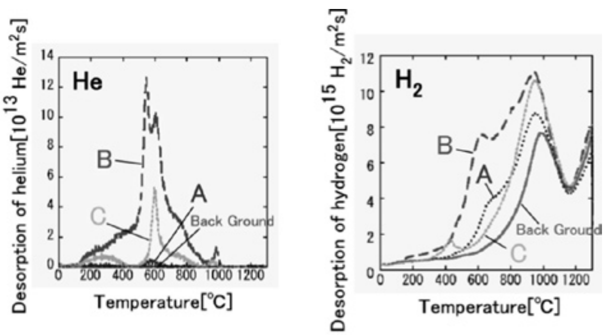

Fig. 3: TDS spectra for helium and hydrogen.

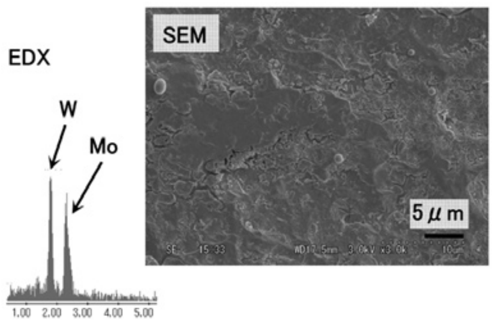

Fig. 4: SEM photograph showing deposited W on Mo substrate.