§19. Development of Compact Divertor Plasma Simulator for Hot Laboratory

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We have developed a compact divertor plasma simulator(CDPS), being able to be operated in a limited radiation control area, to investigate plasma-material interaction using neutron-irradiated materials. The schematic of the CDPS is shown in Fig. 1. The CDPS has smaller space requirement and lower electric power consumption than conventional ones. The CDPS consists of two magnetic coils, dc plasma source, sample holder, and sample carrier system. The dc plasma source is composed of a zigzag-shaped LaB_6 cathode and a water-cooled hollow copper anode. High density steady-state plasma can be generated by the Phillips Ionization Gauge (PIG) discharge. The sample holder equipped with an air-cooling system makes sample temperature almost constant during plasma exposure. The sample temperature during plasma exposure is controlled within uncertainty of 5K by changing the airflow rate. Further the plasma-irradiated sample can be transported to the infrared heater for thermal desorption spectroscopy (TDS) analysis without air exposure.

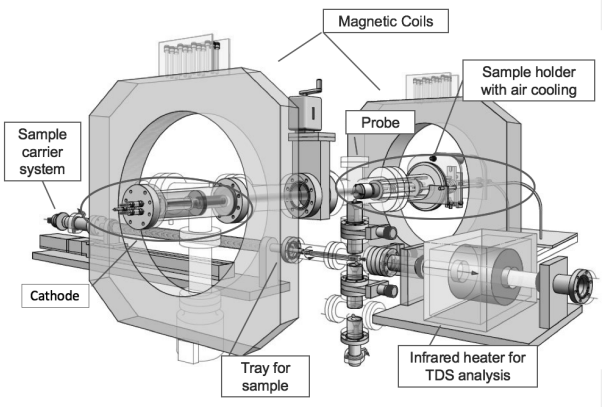

Fig. 1: A Schematic of the compact divertor plasma simulator (CDPS).

After construction in Nagoya University, the CDPS was moved and successfully installed in the radiation controlled room in International Research Center for Nuclear Materials Science (Oarai Center), IMR, Tohoku University. Fig. 2 shows the photo of the CDPS installed in the Oarai Center. The CDPS is connected to the existing TDS system equipped with ion beam gun.

Fig. 3 shows first TDS data obtained by using the CDPS. Recrystallized tungsten (W) sample (ϕ10mm $\times$ 3mm) was exposed to a deuterium plasma. The incident ion energy was 20 eV. The ion fluence was $4 \times 10^{24}\mathrm{m}^{-2}$. After plasma exposure, , the W sample was released from the sample holder. The dropped sample was received by a tray made of tantalum, which is mounted in the head of the sample carrier system. The W sample was transferred to the infrared heater of the TDS system. These processes are operated in vacuum. The TDS spectrum shows two peaks which would be due to processing dislocation (lower temperature side) and intrinsic vacancies (higher temperature side).

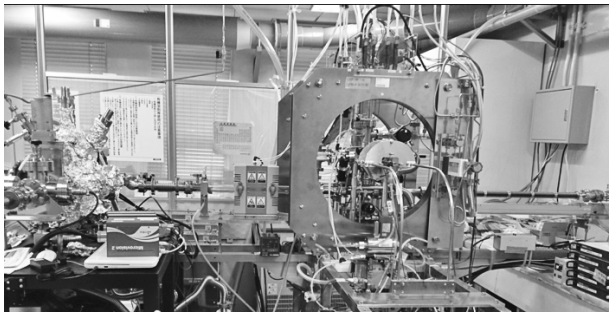

Fig. 2: Photo of the CDPS installed in the radiation controlled room of the Oarai Center.

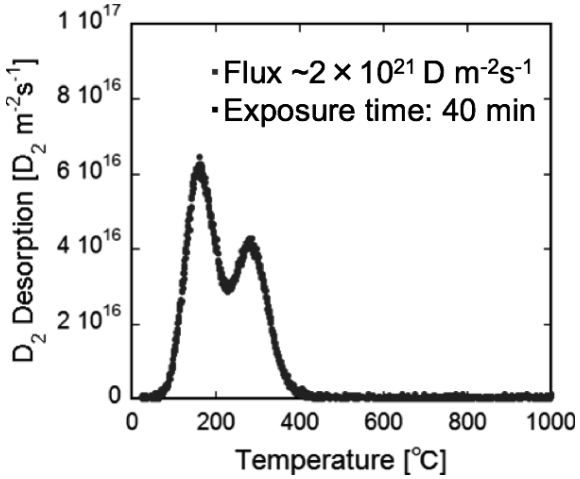

Fig. 3: First TDS spectrum of W sample exposed to deuterium plasma by using the CDPS.

1) N.Ohno, 26th IEEE Symposium on Fusion Engineering(SOFE2015), 2015.5.31-6.4, Austin, USA (invited).

2) N.Ohno, T.Kuwabara, M.Takagi, *et al.*, 5th International Workshop on Plasma Material Interaction Facilities for Fusion Research, 2015.10.7-9, Juelich, Germany.