§34. Study on Hydrogen Isotope and Helium Behavior in Reduced Activation Ferritic/ martensitic Steel during Mixed Plasma Irradiations

Nobuta, Y., Yamauchi, Y., Hino, T., Konishi, A., Shinoda, N., Sano, R., Fukayama, K., Shigemura, T. (Hokkaido Univ.),
Ashikawa, N., Nagasaka, T., Hirooka, Y.

Hydrogen isotope and helium retention/desorption in first wall are recognized as one of important issues for plasma density control and reactor safety in fusion reactors. Reduced activation ferritic/martensitic steel is one of candidates of the blanket materials. The first wall of the blanket would receive various particles such as fuel particle, helium ash and impurities. These might lead to surface modification of the first wall, which might result in the change in hydrogen isotope and helium desorption/retention behaviors. In the present study, the hydrogen and helium desorption/retention behaviors for the ferritic/martensitic steel after hydrogen/helium mixed plasma irradiation were evaluated using VEHICLE-1 apparatus in NIFS. The effects of the simultaneous irradiation with hydrogen and helium plasma were investigated.

Reduced activation ferritic/martensitic steel, F82Hm was irradiated to ECR plasma in the VEHICLE-1. We prepared the F82H sample irradiated to hydrogen plasma after helium plasma pre-irradiation, and the F82H irradiated to hydrogen/helium mixed plasma, say, the F82H after simultaneous irradiation with hydrogen and helium plasma. The discharge pressure was 0.3 Pa. The input power of microwave was 100 W. The bias voltage was -100 V, which was related with the maximum energy of implanted ions. For the mixed plasma irradiation, the ratio of helium partial pressure to hydrogen was approximately unity. Total in fluence was estimated to be (1-2)x10^{19} cm^{-2}. After the irradiation, hydrogen and helium desorption/retention behaviors was evaluated by thermal desorption spectroscopy. The sample was linearly heated up to 600°C with a ramp rate of 0.5°C/s. The gas desorption rate during the heating was quantitatively measured by quadrupole mass spectrometer.

Figures 1 and 2 show thermal desorption spectra of H_2/He for the sample irradiated with hydrogen plasma after helium pre-irradiation and the sample irradiated with hydrogen/helium mixed plasma, respectively. For the sample irradiated with hydrogen plasma after helium pre-irradiation, hydrogen desorption with small peak at around 450°C and helium desorption with peaks at around 230 and 480°C were observed. For the mixed plasma irradiation, new peaks for hydrogen desorption appeared at around 300 and 400°C. In addition, the amount of retained hydrogen for the mixed plasma irradiation became large, compared with the case of the hydrogen irradiation after the helium pre-irradiation. It was presumed that the simultaneous plasma irradiation resulted in the formation of new trapping site for implanted hydrogen, and/or the retention in the deep region by radiation-induced diffusion.

The desorption/retention data will be obtained with changing the parameters such as irradiation energy and fluence, then the effect of the simultaneous plasma irradiation on the hydrogen/helium behaviors for the reduced activation ferritic/martensitic steel will be investigated in detail.

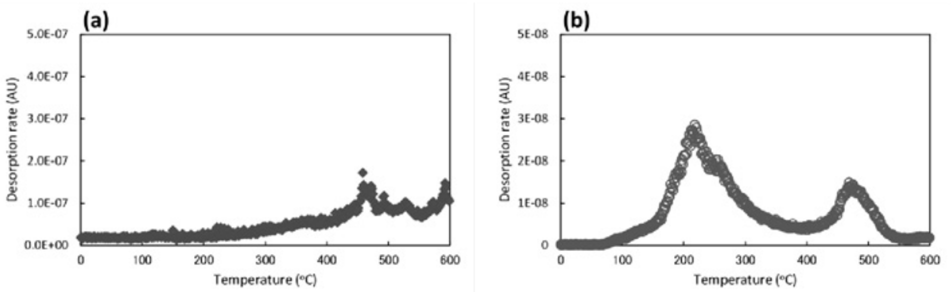

Fig. 1. Thermal desorption spectra of H_2, (a), and He, (b) for F82H irradiated with hydrogen plasma after helium plasma pre-irradiation.

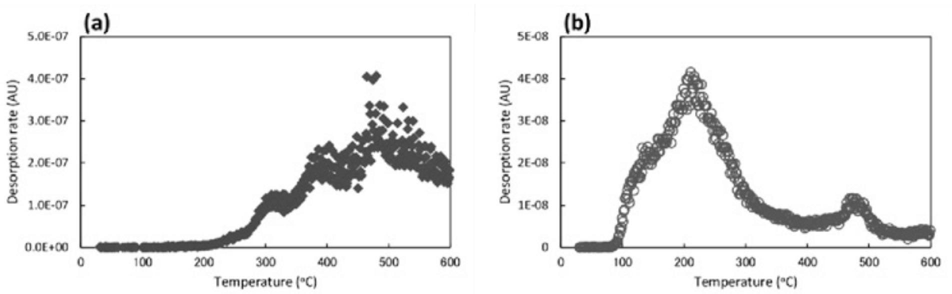

Fig. 2. Thermal desorption spectra of H_2, (a), and He, (b) for F82H irradiated with hydrogen/helium mixed plasma.