§108. Change of Trapping Behavior Due to Neutron Irradiation in Plasma-facing Material

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Tungsten material has advantages of low sputtering rate and high melting point and is a primary plasma-facing material. Low activated ferrtic steel, F82H, is a candidate structural material for test blanket module in ITER. Plasma-facing materials are exposed to fuel hydrogen during plasma operation and part of implanted hydrogen is accumulated in the materials. In addition, neutron produced by D-T reaction is also implanted into plasma-facing materials, which produce irradiation damages in the materials and should influence the hydrogen retention properties. In terms of estimation of tritium inventory and fuel hydrogen recycling, hydrogen retention behavior of neutron-irradiated materials needs to be investigated. The purpose of this study is to understand the effect of neutron irradiation on hydrogen retention behavior in tungsten and F82H.

Early in FY 2013, disk-shaped samples of ITER grade tungsten and F82H with 5 mm in diameter and 0.2 mm in thickness were prepared and these samples were sent to Belgium for neutron irradiation. These samples will be sent back to Japan after the neutron irradiation and be used for deuterium (D) irradiation experiments in Tohoku University.

In order to investigate the hydrogen retention behavior of these materials with no neutron irradiation, D_3^+ ion irradiation with energy of 5 keV (1.7 keV for D) were performed for these samples. After the D irradiation, the desorption behavior of retained deuterium were investigated with thermal desorption spectrometry (TDS). In order to evaluate the relationship between the desorption behavior and impurity existing on the top surface, the depth profile of atomic composition was also analyzed with Auger electron spectroscopy (AES).

The depth profiles of atomic composition before D irradiation are shown in Fig.1. Little amount of impurities were found on the tungsten surface (Fig.1 (a)). On the other hand, impurities (carbon and oxygen) were observed on the F82H surface. Thermal desorption spectra of D_2 in tungsten and F82H were shown in Fig.2. For tungsten (Fig.2 (a)), D_2 desorption spectra showed two main peaks at around 420 K and 570 K, which would be responsible for D trapped in naturally exiting trap sites (point defect, grain boundary, etc.) and ion-induced defects, respectively [1,2]. For F82H (Fig.2 (b)), the trapped D was released at higher temperatures and the spectra had a main peak at around 970 K. As seen in Fig.1 (b), carbon and oxygen existed on the surface of F82H. D trapped by such impurities might be released at higher temperatures. These data on D desorption behavior for tungsten and F82H will be compared to those of neutron-irradiated material in the next fiscal year.

[1] J.P. Roszell et. al., J. Nucl. Mater., 415 (2011) S641-S644.
[2] A.A.Haasz et.al., J. Nucl. Mater., 241-243 (1997) 1076-1081.

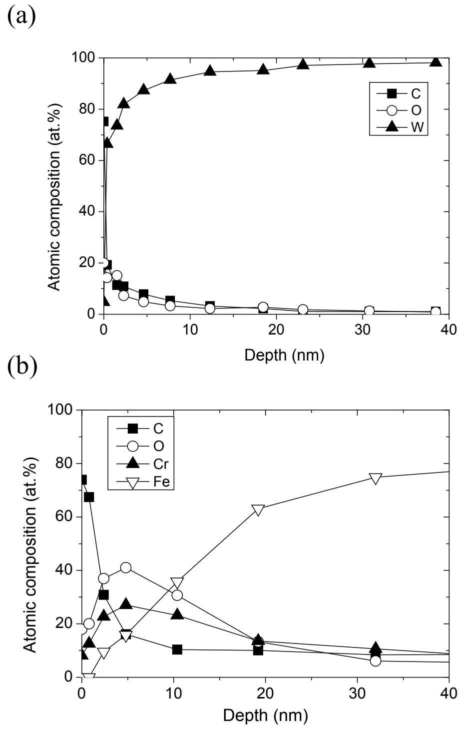

Figure 1 Depth profile of atomic composition before D ion irradiation for (a) W and (b) F82H

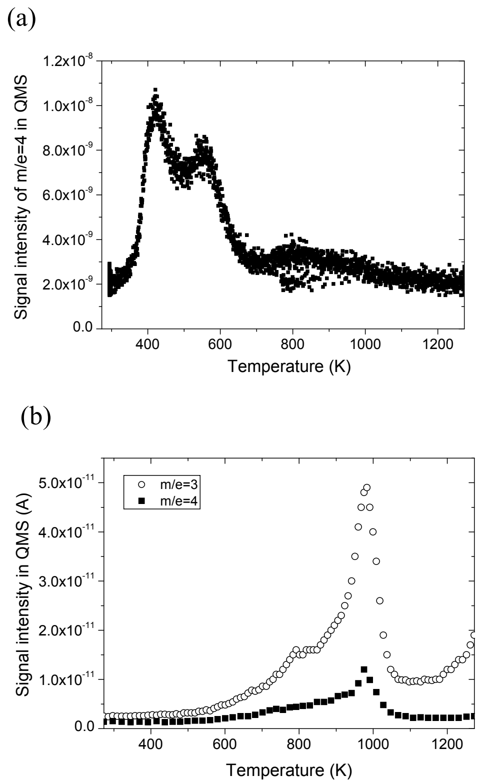

Figure 2 Thermal desorption spectra of trapped deuterium in(a) W and (b) F82H.