

§66. Tritium Concentration of Co-deposited Carbon Films after Tritium Gas Absorption

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Carbon material is a candidate as a divertor target in helical reactor because of its high thermal shock resistivity and low atomic number. Carbon material is easily eroded by incident hydrogen and the sputtered carbon atom co-deposits with hydrogen isotopes on plasma facing walls. Hydrogen isotopes retention in carbon films produced by co-deposition and implantation processes has been investigated so far. However, the hydrogen retention owing to the tritium gas absorption process has not been investigated. In the previous study, tritium (T) gas absorption experiment was conducted for co-deposited carbon film, tungsten and graphite. It was seen that the amount of absorbed T in co-deposited carbon film was much larger than that for graphite and tungsten¹⁾. Therefore, it was recognized that the co-deposited carbon film is responsible for tritium absorption. In the present study, the tritium concentration (atomic ratio of tritium to carbon, T/C), after T gas absorption, was measured for numerous co-deposited carbon films. It is noted that the value of T/C is essential for estimation of in-vessel tritium inventory.

The co-deposited carbon films used in the present study were produced by a deuterium arc discharge with two carbon electrodes. The prepared carbon films initially contained deuterium (D) with different deuterium concentration. The tritium absorption experiments were conducted by using a special chamber for tritium gas exposure apparatus in University of Toyama. The carbon films were placed on the sample holder and then the chamber was evacuated. After the evacuation, the samples were degassed at 423 K in order to remove adsorbed molecules, such as H₂O. Then, the tritium gas was introduced into the sample chamber. During the tritium exposure, the sample temperature and partial pressure of tritium gas were kept at 423 K and 10 Pa, respectively. The duration of tritium exposure was changed from 1 to 10 hours. The amounts of absorbed tritium were measured by using β -ray-induced X-ray spectrometry (BIXS). The crystal structure of the carbon film was analyzed with Raman spectroscopy.

Figure 1 shows the Raman spectra before the tritium gas absorption for the carbon films with different deuterium concentrations in atomic ratio, D/C. For all the films, two main peaks appeared at 1360 cm⁻¹ (D-band) and 1580 cm⁻¹ (G-band). These peaks became broader with an increase of the deuterium concentration. This result indicates that the carbon film with a higher D/C value has more amorphous structure.

Figure 2 shows the tritium concentration of the carbon films with different D/C values as a function of absorption time duration. The T/C value increased with decrease of

D/C. In the carbon film, the absorbed tritium may preferentially bond with a dangling bond of carbon atom. The carbon film with a lower D/C value has more dangling bonds, which means that the number of trap site for tritium is larger in the film with a lower D/C. This is one of the possible reasons for the difference of the T/C value. The T/C almost saturated at the exposure time of 10 hours and the saturation value was about 10⁻⁴ in the case of the absorption temperature of 423 K. This value is 3-4 orders of magnitude smaller than that of co-deposition case. From these results, it is clearly concluded that the main process of tritium accumulation in the carbon film is co-deposition process due to the tritium atom and/or tritium ion, not absorption process of tritium gas.

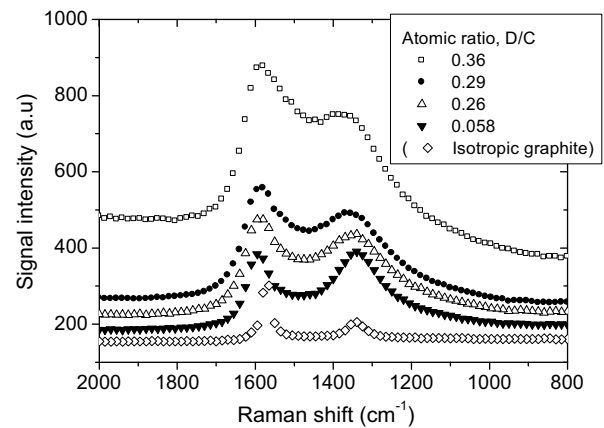


Fig.1 Raman spectra for carbon films before tritium absorption.

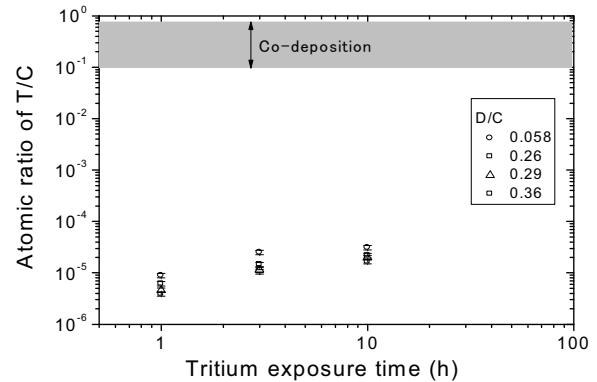


Fig.2 T/C of the carbon films as a function of absorption duration.

1) Y. Nobuta, T. Hino et al., Fusion Science and Technology, **60** (2011) 1535-1538,