§15. Studies on Contamination and Decontamination Processes of Tritium by BIXS Considering DD Plasma Experiments in LHD

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In a thermonuclear fusion reactor, the plasma facing components and construction materials are exposed to ionic and/or molecular tritium having a variety of kinetic energy. A part of such energetic tritium species adsorbs on the surfaces of those materials and diffuses into the bulk. Those tritium species will affect not only the recycling efficiency of fuel in a reactor core but also the safe waste management. From viewpoints of decrease of tritium contamination and effective decontamination of the contaminated materials, it is of great importance to understand basic tritium behavior such as adsorption, desorption, dissolution and diffusion on the surface and/or in the bulk of materials.

Although there are several methods for evaluation of the adsorption amount of tritium on the surface and of a depth profile of tritium in the bulk, those are not still enough for nondestructive and quantitative evaluation of tritium behavior in contamination and decontamination processes. This is a reason why development of a new tritium measuring method is required. From this viewpoint we have proposed a new measuring method for nondestructive determination of tritium on the surface and/or in the bulk: i.e., β-ray-induced X-ray spectrometry (BIXS). BIXS has been employed for determination of the considerably small amount of tritium on an ALT-II limiter tile exposed to D-plasmas in TEXTOR, and also for evaluation of diffusion behavior of tritium in bulk of Pd and Zr.

In this study, the present measuring technique was applied to evaluate contamination level of tritium by ion irradiation and molecular tritium exposure to some kinds of materials. In addition, after tritium charges into the materials to examine decontamination behavior, changes in the X-ray spectra at room and elevated temperatures were also observed, and the tritium depth profiles in the bulk were evaluated by analyzing the X-ray spectra by means of computer simulation.

The β-ray-induced X-ray spectrometry was applied to examine contamination and decontamination behavior of tritium for four kinds of metallic materials. Two charging methods of tritium were employed for contamination of the materials, and the decontamination process was examined at room temperature and elevated temperatures, i.e., isothermal and isochronal heating. From these examinations, the following results were mainly obtained:

(1) Almost same amount of tritium ions was irradiated at room temperature, but the amount of tritium retained in the materials significantly differed. The order of the retained amount was as follows.

$$\text{Hastelloy} < \text{SS-316} \fallingdotseq \text{Tungsten} < \text{B/SS-316}$$

(2) Exposure of molecular tritium to SS-316 was conducted at 523 K for 3 hours, and a uniform depth profile in the bulk was established, although a considerably high concentration region existed near surface.

(3) From the decontamination test of B/SS-316 in the ambient air, it was suggested that moisture in the air play an important role for decontamination efficiency. In addition, decontamination at elevated temperatures indicated that it is possible to remove tritium relatively low temperatures.

(4) An interesting change in the tritium depth profiles appeared in a decontamination process at 473 K for SS-316. Further investigations are needed to elucidate the decontamination mechanism in detail.

These results will be helpful to consider the further DD plasma experiments in LHD.