

## §16. Evaluation of Tritium in Materials Available for LHD

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### 1. Examination of a new nondestructive measurement technique for surface tritium on materials

Evaluation of tritium retained on the surface layers of the wall materials in a fusion reactor is one of the most important subjects from viewpoint of tritium safety and economy. Although a variety of techniques for measurements of surface tritium on the wall materials have been utilized so far, the detectable depth of them is limited to a region shallower than the escape depth of  $\beta$ -rays from tritium in the materials: namely, there are no techniques applicable to nondestructive measurements of tritium distributed into a region rather deeper than the escape depth of  $\beta$ -rays. From this viewpoint, applicability of a newly developed nondestructive technique, that is,  $\beta$ -ray induced x-ray spectrometry (BIXS) has been examined for this purpose. The observed conversion efficiency was determined to be  $2.6 \times 10^{-5}$  photons/ $\beta$ -particle, and the lower detection limit of the present technique was evaluated to be about 30 Bq/cm<sup>2</sup>. Applying this technique to a practical graphite tile used to D-plasma experiments, a very small amount of tritium could be detected. It was concluded, therefore, that the present method is valuable for nondestructive measurements of tritium retained on/in the wall materials in LHD as well as a fusion reactor.

### 2. Sorption and active removal of tritium from various materials in fusion reactor

Adsorption and desorption of water on oxide formed on the iron surface were studied by XPS. Electronic state of O1s was observed after the sample was exposed to distilled water. Several peaks appeared. The peak at 529.7eV was assigned to iron oxide, 531.2eV to hydroxyl of FeOOH, and wide peaks at 532~533eV to molecularly or dissociatively adsorbed water and /or impurities on the surface. Moreover we had constructed an experimental apparatus for tritium active removal, which can conduct thermal desorption (TD), electron stimulated desorption (ESD) and photon stimulated desorption (PSD). Various desorbed species by TD, ESD or PSD from the iron oxide after exposed to water are analyzed with QMS. TD is carried out at 5K/min from

298K to 773K. Electron energy of ESD can be changed from 10eV to 100eV. For PSD, two deuterium lamps and one Hg-Xe lamp can be used, and can irradiate by the photon range of 115~400nm, 185~400nm and 300~1000nm respectively. Preliminary results by TD showed that water was desorbed at 400 and 600K, and that the desorption behavior was considered to be affected by oxide properties observed by XRD, AFM and XPS.

### 3. Tritium Trapping Capacity on Various Materials

It is well known by experience that tritium is apt to stick to the surface of various materials. If the amount of tritium trapped to the surface is not small enough compared to the amount of tritium introduced to the tritium handling system, interaction of tritium with the system materials affect the behavior of tritium in a manner peculiar to the system. This phenomenon has been named as the system effect of tritium by the present authors and the way to quantify this effect using the serial reactors model has been also proposed. The tritium trapping capacity on the surface of isotropic graphite, stainless steel, copper or aluminum is quantified in this study considering that the surface water consists of physically adsorbed water, chemically adsorbed water and structural water. It is observed in this study that the amount of surface water on each material in this study gives non-negligible tritium trapping capacity and that the structural water controls the tritium trapping capacity when the vapor pressure is low or when temperature is high.

### 4. Chemical existing states of energetic deuterium implanted into Boron film coated on graphite

In this physical year, the chemical existing states of energetic deuterium ions implanted into boron (B) films coated on graphite have been mainly investigated by the X-ray photo electron spectroscopy (XPS). In X-ray Photoelectron Spectroscopy (XPS) experiments, chemical peak shift of B-1s orbital electron after D<sub>2</sub><sup>+</sup> implantation was measured. The D<sub>2</sub><sup>+</sup> implantation was carried out by the ion gun at room temperature with ion energy of 3 keV, and ion fluence up to  $1.2 \times 10^{22}$  m<sup>-2</sup>. The XPS spectra of B-1s orbital electron were analyzed to consist of four peaks of 188.9 (Peak 1), 190.4 (Peak 2), 192.2 (Peak 3), and 194.2 eV (Peak 4). The each peak of Peak 1, 2, and 4 was identified to correspond to amorphous B, crystalline B, and boron oxides, respectively. The relative peak area of the Peak 3 was found to increase with the amount of the implanted D increasing, while that of the Peak 1 decreased. This suggested that the implanted D could interacted with amorphous B to generate B-D bonds.