

§17. Evaluation of Tritium in Materials Available for LHD

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1. In-Situ Measurement of Tritium Retained on Material Surfaces

To evaluate the amount of tritium retained on the surface and/or near surface of materials, we have proposed the newly developed β -ray-induced x-ray spectrometry (BIXS), in which argon is used as an effective working gas. In the present study, to establish a technique for quantitative measurements of surface tritium by the BIXS, correlation between the characteristic x-ray intensity of argon and the amount of tritium was examined by using a graphite plate implanted a given amount of tritium with energy of 1.0 keV. As a result, it was seen that the intensity of characteristic x-rays was proportional to the total amount of tritium retained by graphite. The proportional constant, which corresponds to apparent conversion efficiency of β -rays to characteristic x-rays, was evaluated to be 4.15×10^{-6} counts s^{-1} Bq $^{-1}$. However, this value includes correction factors such as geometrical efficiency, reduction of x-rays, and detection efficiency of an x-ray detector. To determine the intrinsic conversion factor in argon, contribution of those correction factors was examined in detail. Taking into account those factors, the intrinsic conversion factor was finally estimated to be 3.1×10^{-4} photons (β -particle) $^{-1}$, which agreed well with the reported data. Furthermore, both sides of the graphite plate irradiated with tritium were measured to examine a detectable depth by the present method. Although intensity and shape of an x-ray spectrum observed for the rear side were not similar to those for the irradiation side, the shape of the former x-ray spectrum indicated that tritium was trapped in a fairly deep region from the surface. Since the

graphite plate used for the present examination was 500 μ m in thickness, it was revealed that detectable depth for low-Z materials such as graphite is fairly larger than 500 μ m.

2. Water Adsorption on Metal Oxide and Desorption by Photon and Electron Irradiation

Water adsorption on iron oxide was studied by XPS and UPS. Here, thin iron oxide was formed on the surface of pure iron by oxidation with O₂ gas at 400 °C. XPS observation showed that H₂O exists on the oxide surface as FeOOH, surface hydroxyl group (-OH) and H₂O molecule. UPS observation showed -OH (1p) and -OH (3s). This also shows that water exists on the surface as chemically adsorbed surface hydroxyl group.

Desorption experiments were conducted by thermal desorption to 773K and by photon irradiation with deuterium lamp (115-400nm), Hg-Xe lamp (300-1000nm) after energy filtering, and with dye laser (570, 645nm). Desorbed species were observed by QMS. UV irradiation (150-400nm) desorbed D₂O. On the other hand, UV irradiation at higher energy (115-400nm) desorbed D₂ and D₂O. These desorption phenomena were explained by direct breaking of -OD bond to the surface or O-D bond. Irradiation of visible light also stimulated water desorption. The desorption mechanism was tried to be discussed with MGR model or Antoniewicz model. By electron irradiation (10-70eV), stimulated desorption of D₂O and D₂ was observed with the electron energy threshold around 30-40eV. The desorption mechanism was discussed with FK model.

References

- 1) M. Matsuyama, S. Ueda and K. Watanabe, *Fusion Engineering and Design*, **49-50** (2000) 885-891.
- 2) K. Chiba, R. Ohmori, H. Tanigawa, T. Yoneoka, and S. Tanaka, *Fusion Engineering and Design*, **49-50** (2000) 791-797.
- 3) M. Matsuyama, Tetsuo Tanabe, Nobuaki Noda, Volker Philipps, Karl Heinz Finken, and Kuniaki Watanabe, *J. Nucl. Mater.*, **290-293** (2001) 437-442.