Measurements of Tritium Concentration in Solid and Liquid by X-ray Detection with Imaging Plates

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Imaging plates (IPs) are simple and sensitive two-dimensional radiation sensors, and those for β-ray detection (IP-β) without protection layers are widely used to examine tritium distributions on/near surfaces of solids. Due to small escape depth of β-rays, however, measurement of bulk tritium concentration is difficult if surface concentration is much higher than that in bulk as often observed for ferrous materials [1,2]. In addition, this type of IPs is unsuitable to measure tritium concentration in aqueous liquids because photo-stimulated luminescence (PSL) material (Eu-doped BaFBr) is soluble in water. From these viewpoints, the applicability of IPs for X-ray detection (IP-X) with protection layers of polyethylene terephthalate (PET) was examined in the present study. Because of larger escape depth, X-rays can provide information on bulk. Tritium concentration in water can be measured from outside of container. Immersion of IP-X in water is also possible because PSL material is protected by the PET layer.

Disks of ferritic steel exposed to tritium gas were used as specimens. The specimens had uniform tritium distribution at ca. 50 kBq/cc in the bulk, and thin surface layers with strong tritium segregation. The radiation from the specimens was measured with IP-β and IP-X with and without surface polishing to remove segregation layer of tritium. In the case of IP-β, the PSL intensity obtained for unpolished specimen was larger than that for polished one by a factor of 15; surface treatment was indispensable to measure bulk tritium concentration. On the other hand, PSL intensity obtained with IP-X for unpolished specimen was only double of the value observed for polished one. These observations confirmed that IP-X is more suitable for the evaluation of bulk tritium concentrations. It was also possible to detect X-rays from tritiated water (500 kBq/cc) through walls of polyethylene vials (1 mm thickness). Results of measurements by immersing IP-X in tritiated water will be also given in the presentation.

This study has been supported in part by KAKENHI on Priority Areas, 476, Tritium for Fusion, from MEXT.

[1] T. Hirabayashi and M. Saeki, J. Nucl. Mater., 120(1984)309.
[2] Y.Torikai et al., Fusion Sci. Technol, 48(2005)177.