Tritium Measurement in High Gamma-ray Radiation Fields by Using an Imaging Plate

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Tritium measurement is important from both viewpoint of tritium accountancy of fusion reactors and studies on tritium behavior in plasma facing materials. However, gamma radiation deriving from components activated by neutron would seriously affect tritium measurement. Separation measurement method of tritium from gamma ray is, therefore, required. The main nuclides produced by neutron activation from Mo, Ni, Fe, and Cu contained in vacuum vessel (SS316) and superconducting magnet are ^{99}Mo, ^{58}Co, ^{57}Co, ^{54}Mn, and ^{60}Co in Large Helical Device facility [1]. It was assumed that the same nuclides are produced by neutron activation in fusion reactors as well. Because of its long half-life (5.27 y) and high gamma emission energy (1.173 and 1.333 MeV), ^{60}Co would be a main issue for tritium measurement.

In the present study, an imaging plate (IP) was applied to measure tritium detecting the bremsstrahlung X-rays induced by tritium beta rays. The IP made of europium-doped BaFBr (I), a photostimulated luminescence (PSL) material, is a two-dimensional radiation sensor. The PSL response of the IP has a peak at 20-50 keV and steeply decreases towards higher energy, falling by one hundredth at around 1 MeV. Measurements were conducted by using four small borosilicate glass tubes, filled with pure tritium gas of 12.5, 25, 50, and 100 MBq, respectively as the tritium source that generates bremsstrahlung X-rays. The IP was irradiated for 1h with the tritium source and ^{60}Co, varying its dose rate in the range from 0.0013 to 9.22 μ Gy/m, simultaneously. It was found that the effect of ^{60}Co irradiation to PSL value, obtained by irradiated with tritium of 12.5 MBq, was negligible by dose rate of 4.380 μ Gy/m and there was only 7.0% difference of PSL value, obtained by irradiated with tritium of 100 MBq, between dose rate of 0.0013 and 9.22 μ Gy/m. The IP tritium measurement method can be a promising candidate to measure tritium in high gamma-ray radiation fields.

[1] H. Handa, K. Hayashi, Fusion Eng. Des. 17 (1991) 335-342.