§7. Tritium Measurement with High Measurement Efficiency by Plastic Scintillator-2

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In our environment, tritium is naturally produced by cosmic rays. On the nuclear fusion reactor research, the measurement of tritium concentration is an important issue. Generally, a liquid scintillation counter (LSC) is used for the measurement. It is considered that liquid scintillator of a mixture of organic solvent and surfactant is indispensable for the LSC measurement. However, the liquid scintillator becomes the radioactive waste after the measurement by LSC and the treatment of radioactive waste is time consuming and needs big budgets. On the other hand, the measurement method with plastic scintillator (PS), which is alternative material of liquid scintillator, is superior method because of no radioactive waste[1]. The purpose of this study is to develop a new measurement method for tritium with high efficiency that the waste does not produce. A characteristic of the tritiated water to the PS was examined as preliminary experiments in 2011. As the results, the measurement efficiencies for tritiated water with the PS were low because of hydrophobicity of the PS. So, we tried many methods to get the PS of hydrophilicity.

Tritiated water (HTO; MT-924C) was measured by using plastic scintillator of BC-400 (Saint-Gobain). The sheet of the PS used was 50mm×15mm×0.5mm. The PS surface was treated with an atmospheric pressure glow plasma processing (the plasma method)[2]. The conditions of plasma method were as follows: Ar gas of 4 L min^{-1}, the high pressure of 10 kV, glass tube of Si was 60 mm in length and the PS was put below 5 mm from the edge of the tube. Also, tritiated water was dissolved in commercial liquid scintillator and measured the radioactivity to calculate measurement efficiencies.

Figure 1 shows the difference of the contact area of tritiated water to the PS with the plasma treatment. The (a) was treated example and the (b) was untreated one. It is clearly shown that the contact area was widened with the plasma treatment.

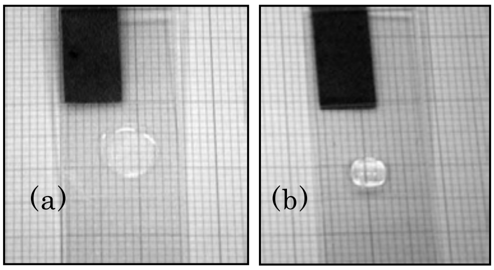

Figure1 The effect of plasma treatment on the PS.

Figure 2 shows the measurement efficiencies of tritiated water of 20 μL by following 9 methods:1) liquid scintillator, 2) untreated 1 PS sheet, 3) untreated 2 PS sheets (put the tritiated water between the 2 PS sheets),4)~6) treated 1 PS sheet for 1 min, 2min,3min, respectively, 7)~9) put treated 2 PS sheets for 1 min, 2min, 3min, respectively. As the result, the 2 min treatment by the plasma method; No.8) showed the highest measurement efficiency and it was same as that of the liquid scintillator used, which was considered the best measurement efficiency with LSC.

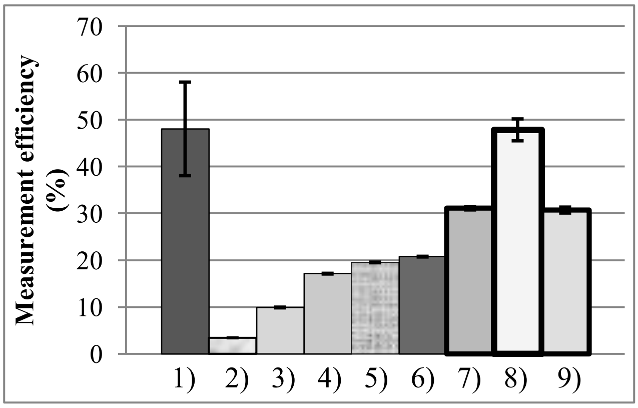

Figure2 The measurement efficiencies with different methods.

Because the plasma method has many factors, we need more experiments to get the best condition for measurement of tritiated water.

1) E.Furuta et.al.: Radiocarbon (2011) 283.
2) Ohyama et.al.: *J. Phys. D: Appl. Phys.* 42(2009) 105203.