Testing the effect of packaging materials on activity measurement using 4πβ-γ coincidence counting

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1. Introduction

An activity measurement system developed in HANARO utilization division of the Korea atomic energy research institute (KAERI) is measuring the activity of samples irradiated in the neutron irradiation facility of research reactor HANARO [1]. In this system, an aqueous sample is mixed into a liquid scintillator (LS) to ensure uniform distribution, and then beta- and gamma-rays emitted from the sample are measured to evaluate activity. However, among the radioactive samples, there are not only aqueous samples but also solid samples. And since these solid samples cannot be uniformly distributed in the LS, the position dependence of the activity measurement was tested and the appropriate sample location where the activity is measured without loss was found [2].

Meanwhile, in order to measure the activity of a powdered sample, an auxiliary method is required to fix the powdered sample to a specific location. As one such method, a method of fixing a solid sample by packaging it using tape or a sealing film was tested. At this time, a rectangular solid sample that can measure activity without a packaging material was used to determine the effect of the packaging material on the activity measurement. Through this test, it was confirmed whether it is appropriate to use a packaging material when measuring the activity of a powdered sample.

2. Methods and Results

2.1 Materials

The sample used in this test is a rectangular neutron transmutation doped germanium (NTD-Ge) sample. This sample was doped with Ga, As, and Se by neutron irradiation to high-purity germanium. The doping concentration of this sample is 1.8×10^{16} /cm^3 and the weight is 0.585 g. The size of the sample is 1.1×1.1 cm^2 in area and 1 mm in thickness, and the measured activity value is 8.3 kBq.

Sealing filme, transparent tape, and opaque tape were used as packaging materials. And a plastic stand was made using a 3-D printer to measure the activity of solid samples. Fig. 1 shows the sample before and after using the packaging material, and Fig. 2 shows the positioning of the sample during measurement.

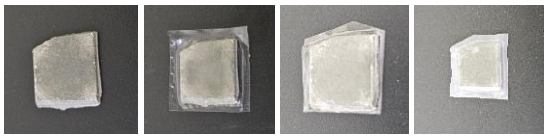

Fig. 1. NTD-Ge samples w/o and w/ packaging materials (sealing film, transparent tape, and opaque tape, from left).

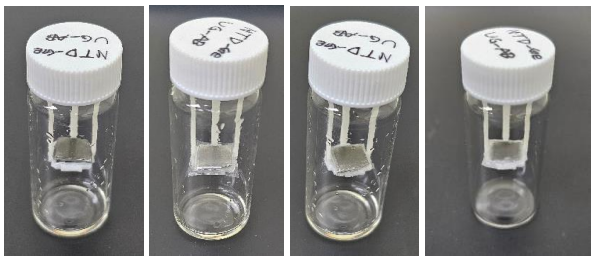

Fig. 2. Positioning of NTD-Ge samples. (from left, w/o packaging material, w/ sealing film, w/ transparent tape, and w/ opaque tape)

2.2 Measurements

NTD-Ge sample was measured under four conditions in total, depending on the type of packaging material used. For each measurement, the background was measured before and after the sample measurement, and the beta- and gamma-rays emitted from the sample were measured using detectors in the system. Then, the number of measured beta- and gamma-rays and their coincidence counting were used to evaluate the activity of the sample, as shown in Fig. 3.

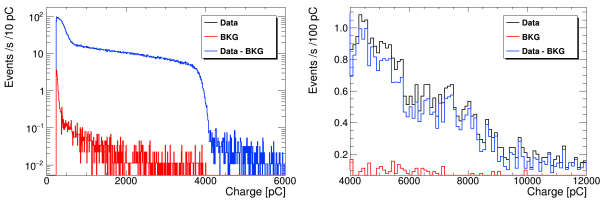

Fig. 3. Beta (left) and gamma (right) spectra for NTD-Ge sample.

2.3 Results

Fig. 4 compares how much each packaging material affects the activity measurement. Specifically, the ratio of the measured activity value when each packaging material is used is compared with the activity value when no packaging material is used. Regardless of the packaging material used, the measured activity value was lower than the activity value when no packaging material was used. The activity reduction ratio was 5.3% when using the sealing film, 9.4% when using the transparent tape, and 13.3% when using the opaque tape.

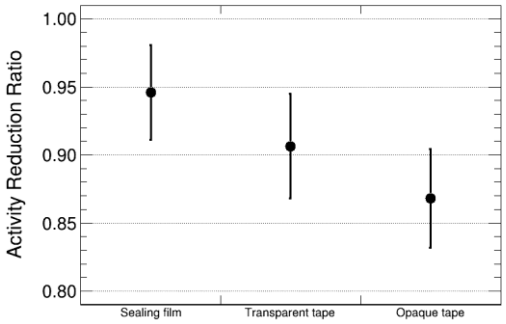

Fig. 4. Activity reduction ratios for three packaging materials. The correction for activity decrease over time is applied.

3. Conclusions

The use of packaging materials as the method for measuring the activity of powdered samples in the activity measurement system using LS was proposed and tested. Three packaging materials were tested, and it was found that the activity of the sample was measured lower than the original value regardless of the packaging material used. Future studies will be conducted to determine whether the activity reduction ratio is consistent when using a specific material, and the activity of the sample can be measured without reduction using different packaging materials.

REFERENCES

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