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Time dependence of ESR signal of irradiated alanine dosimeter

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1. Introduction

It is very important to assess the cable which generally depending on environment conditions like temperature and radiation dose rate. Radiation level has been assessed by RHRI in cooperation with Wolsong Unit 1. and Youngkwang Unit 1. The assessment method of radiation level is that First, install alanine dosimeter at the location of interest in times of pre-scheduled maintenance period then, after one or two fuel cycles, retrieve and analyze the dosimeters by use of ESR dosimetric system. The Alanine dosimeter were installed 38 place at the Wolsong Unit 1 and 30 place and the Youngkwang Unit 1. Measurements of the ESR signal amplitude of γ-irradiated alanine has signal variations in the signal amplitude within days after irradiation.
The characteristics of ESR signal, especially signal decreasing time and pattern, would be different on the ranges of dose quantity[1], but the range we are interested in is low dose range less then about 5Gy. In most case of dose assessing for measurement of cable aging, the dose range is very low, this study give us good information about proper measurement time after alanine dosimeter was taken out from NPP.

2. Methods and Results

2.1 Characteristic of alanine dosimeters

The used dosimeters were BioMax alanine dosimeter which contain α-amino acid alanine, NH_2-C_α H(CH_3)-COOH and Teflon as binder material to form dosimeter as pallet(ratio>9/1). The alanine dosimeter pellets was 5mm in diameter and 3mm in height and weighed 64.5±0.5mg.
ESR/alanine dosimetry of absorbed dose range is 1 – 100kGy. And alanine dosimetry are not significantly affected by temperature and also fading rate at moderate temperatures is limited to 1% per year.[2]. But the quantity of radical is influenced by temperature and humidity of environment. It means before and after environment could be the key factor to assess the dose quantity.[3]. The dosimeters were stored in the dark space at ambient temperature under controlled humidity conditions and temperature. After irradiation, for several days, the signal intensity change of alanine signal could observed and get the data about the stabilization time for radicals in alanine dosimeter.

2.2 ESR System

The system for detection of radicals in alaine pallet is X band EMX EPR spectrometer of Bruker.
Figure 1. is dual cavity of EMX spectrometer system.
The dual cavity was also installed in the case of scanning simultaneously standard marker for compensating Q factor change during scanning time.

Figure 1. Dual cavity measures reference sample and and alanine pellet simultaneously.

Can use put in the reference sample at rear cavity and the alanine pellet at front cavity. Then each cavity sample signal have not influence when the sample measurement.

2.3 Experimental

Can be evaluated absorbed dose is using the prior exposed alanine dosimeter about 50Gy. also after irradiated pasted for long time such more then 4 month as time then alanine radical was stabilized.
It added 5Gy exposed to the prepared 50Gy exposed 5 alanine pellets.
With under the range 5Gy, relatively big modulation amplitude has advantage to detect very weak radicals signals but it also give us inaccuracy by over modulation. When it adds the about 50Gy dose first, there is a possibility of ESR signal measurement of accuracy improvement. [4]
It used 5 alanine pellets and it observation the difference of each alanine sample time dependence of alanine signal amplitude.
Alanine pellets is Gamma ray irradiation was done by blood irradiator with Cs-137 source.
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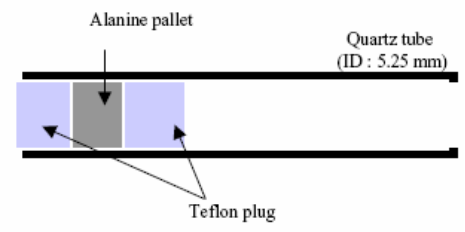
To hold dosimeter properly inside the cavity of spectrometer, quartz tube(ID:5.25mm, open end type) and specially designed Teflon plug(holder) was prepared to fitted well with alanine dosimeter pellet in quartz tube as seen in Figure 2. The pallet between Teflon plugs was fixed firmly inside quartz tube to avoid signal deviation by trembling or some movement.



Figuer.2 Alanine pallet and Teflon plug in quart tube

3. Conclusion

Time dependencies of the amplitude of the central line in the irradiated alanine spectrum normalized by the intensity of the Mn^{++} reference signal are presented in Figure 3. The plot shows that the intensity of the signal varies with time.

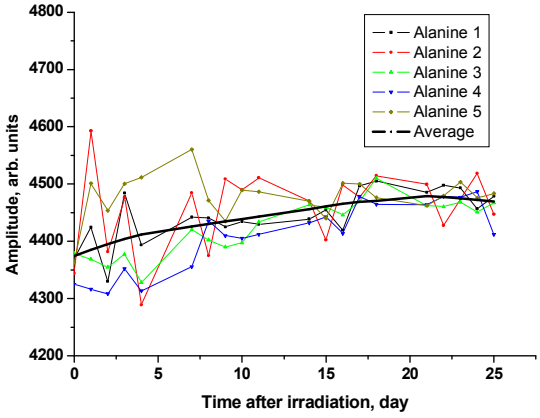


Figure 3. Time dependence of the amplitude of the 5 pellets ESR spectrum amplitude of 5Gy irradiated alanine dosimetry.

10 days after the irradiation, the alanine signal amplitude was changed so deeply as fig 3.

Figure 4 also show standard deviation of alanine signal amplitude. The signal came to be 2.5% higher than the intensity gotten immediately after irradiation.

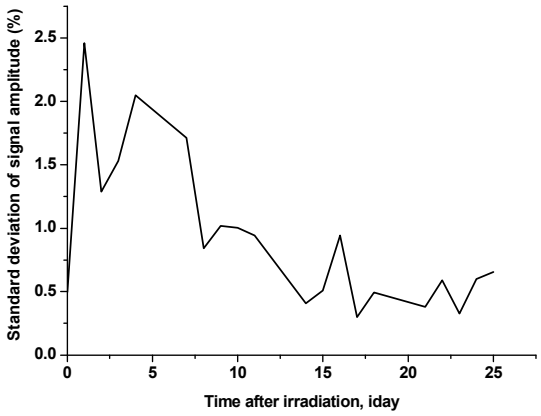


Figure 4. standard deviation of ESR signal amplitude of 5 alanine pellets.

For assessment of alanine pellets signal amplitude , at least 20 days would be needed.

This research result is useful and could be used when we measure alanine signal amplitude for dosimetry.

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