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Environmental factors of Alanine/ESR dosimetry in NPP

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1. Introduction

Dosimetry of Alanine/ESR has already been known that could be affected by some the environmental factors like temperature, humidity and neutron dose. Generally these effects are not so severe needed to be corrected. Among above factors, relative humidity besides dosimeters can be overcomed by hermetic sealing dosimeter capsule, and neutron factors, during normal plant operation period, can also be regarded as trivial value. But, the temperature factor should be considered seriously in two ways, temperature in irradiation and storage. Normally, consideration of storage temperature in alanine dosimetry has not been the important problem, because the time interval between irradiation and scanning at the lab condition is not so long that need intensity correction by temperature factor. Even if above the factors are generally regarded as trivial and neglected in radiation dosimetry, some factors is need to be studied for getting accurate dose estimation values in dosimetry program in NPP.

2. Methods and Results

.1 Alanine dosimeters

L-α-alanine has attracted considerable interest for use in radiation dosimetry and has been formally accepted as a secondary standard for high-dose and transfer dosimetry. In this experiment, used dosimeters were BioMax alanine dosimeter which contain α-amino acid alanine, CH_3-$CH(NH_2)$-$COOH$ and Teflon as binder material to form dosimeter as pallet. The alanine dosimeter pellets was 5mm in diameter and 3mm in height and weighed 64.5±0.5mg.

2.2 ESR system

ESR measurements were performed at normal atmospheric conditions using Bruker EMX spectrometer equipped with an X-band bridge and dual cavity. The dual cavity was installed in the case of using standard marker for compensating Q factor change during scanning time. ESR spectrometer were recorded with a mircrowave power sweep of 0.633mW to 200.2mW, a modulation frequency and amplitude of 100kHz and 0.2mT, a time constant of 10ms. The magnetic field sweep width was 12.0mT, while the number of sampling points was 1024. the microwave frequency was about 9.73GHz. Signal intensity could be corrected by putting the reference sample at the rear cavity and alanine sample at front cavity.

2.3 Neutron effect

In Figure 1, We can see the spectrum of alanine samples irradiated with only gamma ray and both gamma and neutron rays scanned by EMS system. The ratio of signal peaks(x/y) can be regarded as indicator of exposure to the neutron rays[4]. The shape changing after exposure to the mixed radiation field is like these.
1) The ratio between spectrum peaks(especially central peaks used for absorbed dose estimation)
2) The spectrum width showed as x and y in Figure 1.

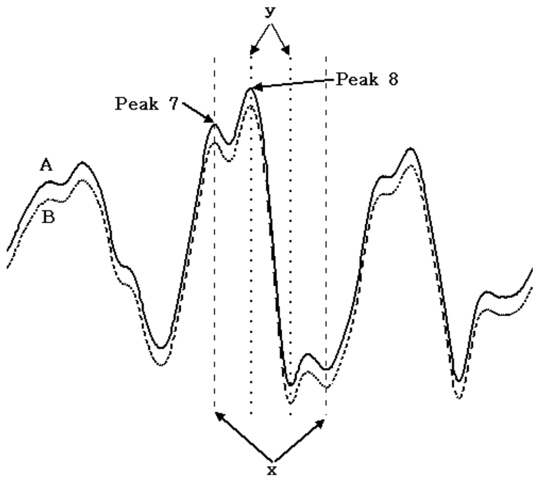

Figure 1. x/y ratio of γ-ray irradiated alanine and exposure alanine in mixed field(CV Wolsung Unit 1.)

2.4 Thermal effect

Normal alanine pallet(1000Gy) is compared to the heated alanine pallet(120℃, 23hours, 1000Gy) for pursuit of thermal heat transferring effect. It is natural that signal intensity of heated alanine pallet is lower than that of normal pallet by annealing process. If we call the two peaks in central spectrum as P_7 and P_8 from left to right, the fading movement of 7 and 8 peaks show apparent difference on heating time. The ratio of P_8 and P_7(P_7/P_8) is slightly changed from 0.5455 to 0.5425. Each dose quantity is 500Gy ~ 3kGy of gamma rays. This value seems to be regarded as fixed value on wide range of dose. if we scanned the alanine sample recovered from Wolsung unit 1, the result may be regarded as indicator for deciding whether the sample was stored in different thermal environment in NPP .

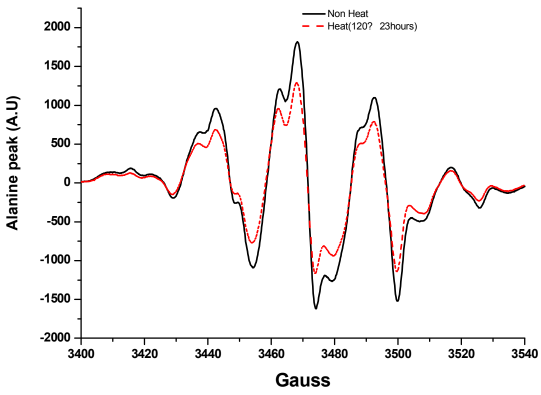

Figure 2. Black line is unheated Alanine of NPL(γ-ray 1000Gy). Red dot line is heating(120℃, 23 hours) alanine sample.

From Figure 3, Signal intensity of peak 7 and 8 is actually the combination of radical R_1(stable, normally regarded as produced in room temperature) , R_2 and R_3. As we know that the each activation energy of these radicals is different, so it means that, if some heat energy is transferred to alanine sample, the faded quantity of each radicals are different with each other. Hence, the signal intensity of the P_7 and P_8 shows different ratio after alanine sample is exposed to heat.

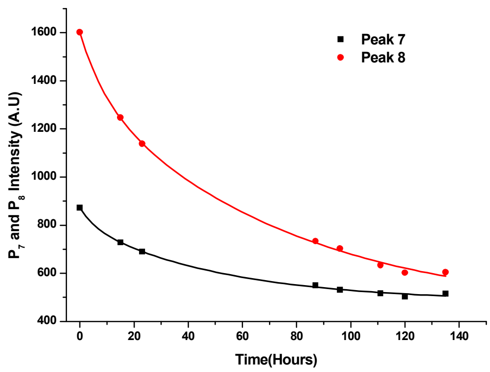

Figure 3. fading effect of each peak per time. (alanine-120℃)

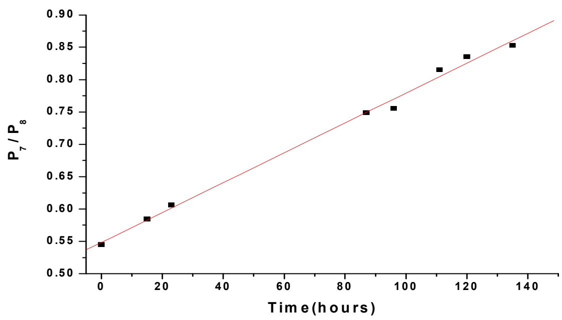

Figure 4. values per time of P_7/P_8 ratio is higher about 0.55 times than heating alanine.(storing 120℃).

3. Conclusion

Normally, the effect of neutron is less than that of other environmental factors in general operation of NPP. But in the case of this, the sample is stored for extremely long time, the dose quantity of neutron should be checked for accurate dose estimation. Though the sensitivity of alanine to the neutron ray is not so high as gamma ray, the actually accumulated dose quantity is not to be neglected to the shape of spectrum. Also, the different contribution and activation energy of three alanine radicals(R_1,R_2,R_3) gives different peak(P_7,P_8) ratio after exposed to the different thermal environment.

REFERENCES

[1] H.P Nette, S. Onori, P. Fattribene, D. F. Regulla and A. Wieser, Coordinated research efforts for establishing an international radiotherapy dose intercomparison service based on the alanine/ESR system. Appl. Radiat. Isot. 44, 7-12(1993)

[2] IAEA, Assessment and Management of ageing of major nuclear power plant components important to safety : Incontainment instrumentation and control cable technical document(2000)

[3] J.M. Dolo, V.Feaugas, Analysis of parameters that amplitude of the ESR/alanine signal after irradiation. Appl. Radiat. Isot. 62.273-279(2005)

[4] B. Ciesieelski, L.Wielopolski, The effects of bron on the electron paramagnetic resonance spectra of alanine irradiated with thermal neutrons. Radiation research 144, 59-63(1995)