Electron Paramagnetic Resonance signal ratio of Alanine Pellets In Nuclear Power Plants

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Introduction

As a dosimeter for ESR dosimetry, alanine has many useful features including relatively long endurance time of radicals and almost no difference with the radiation dose rate and radiation quality.[1,2] Alanine dosimeters have been accepted as transfer dosimeters for their good precision at high radiation range.[3,4] For alanine/ESR spectra, it was reported that the peaks of the spectra are due to the three kinds of radicals induced by radiation.

The ratio of the weak "satellite line" and the cnetral peak of the threemanin alanine specta(in this study "x/y ratio") are changed on the LET value of radiation. In case of lithium formate monohydrate was recently identified as a promising dosimetric material. in addition, it was reported the the peak height in the signal spectra is not easily saturated when power is irradiated with relatively high LET radiation such as neutron rays. The difference in the peak height ratio was reproted to be caused by increased local radical density following the radiation of high LET.

Experiment

1. Dosiemter and Spectrometry System

Pallet type alanine dosimeters from BioMax (Germany) were purchased and stored in darkness for this experiment. Experiment was done by "e-scan" and "EMX" spectrometers. All spectrometers were calibrated by standard alanine dosimeters irradiated in NPL(National Physical Laboratory) using Co-60 at a range of 25 to 5 kGy.

2. Installation and measurement

To prevent accidental shock, plastic capsules that contained the dosimeters were carefully fastened to the power and instrument calbes. After one or two operating cycles, the installed capsule were returned from nuclear power plants.

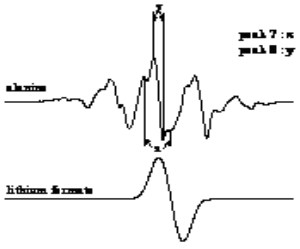

Fig. 1 Typical ESR spectra of alanine dosimeters and lithium formate powder irradiated with cobalt-60 at 500 Gy. The satellite peak and main resonance peak of alanine ared indicated as

"x" and "y" lettters in the figure and used in the calculation of the "x/y ratio" As in figure 2, The "x/y ratio" of alanine pallets that were irradted at NPL and returned from NPPs after one or two fuel cycles were different each other. It means apparently these pellets which were installed in containment vessel was exposed to mixed rays composed of gamma rays and neutron particles.

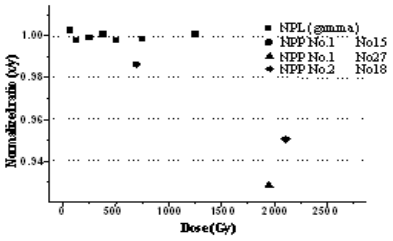

Figure 1. The"x/y ratio" of the alanine pallets in nuclear power plants

Experiment and Result

The ratio of signal intensity at two different powers was evaluated on a daily basis . This difference in saturation powers can be observed. The power level is changed from 0.5 mW to 50 mW and the signal intenstity ratio changed according to radiaton qualtity. The measured difference was very subtle and in most cases it could be accounted for by the movement of the quartz tube inside cavity. As we can from figure 1, the difference is very apparent in some samples.

Conclusion

The spectrum shape of some alanine dosimeter installed in the containment buildings of NPPs showed differences in comparison with dosimeters exposed only to gamma rays. There was apparent change of spectra, expressed as the "x/y ratio". As noted in other papers, high LET radiation such as neutron rays causes shape changes of the spectrum of alanine dosimeters. Thus, the unanticipated high dose level and low "x/y ratio" of some alanine dosimeters from the containment building could be explained b exposure to mixed radiation with high LET. Generally, the locations evaluated in this study are regarded as being exposed only to gamma rays, because the positions are blocked from direct neturon rays, because the positions are blocked from direct neutron rays from reactor by thick cement barriers and heavy instruments.

Reference

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