SPECTRUM SHAPE CHANGE OF ALANINE/ESR SPECTRUM IN NUCLEAR POWER PLANT

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Introduction

Major elements that affect aging of cable material which had been installed for power and signal transferring in nuclear power plant were already well known as 'temperature', thermal energy accumulated in polymer based cable material, and 'radiation' which caused oxidation by induced radicals. Personal dosimeter like TLD(Thermo Luminiscence Dosimeter) or OSL(Optically Stimulated Luminiscence), is not appropriate for measuring such a long time measurement, at least one or two year period. The strong point of alanine/ESR dosimeter is not only low fading rate(1%/year) but also little environmental temperature effect(0.2%/K) and comparably low humidity effect. Alanine material were formally recognized as secondary standard dosimeter for referential dosimeter in the range of high and medium dose level. Above explained, dozens of alanine dosimeters were installed in nuclear power plant, especially in CV(Containment Vessel) building, for estimating accumulated dose level. Normally, all three peaks' of signal intensity area was used for dosimetry, but actually this area is related with peak to peak amplitude, and this peak amplitude is generally used as signal intensity. Also, under the relatively strong microwave intensity, the weak "satellite line" beside main central peak could be found which interpreted as the combination effects of "spin flip" of neighboring hydrogen protons of methyl group of paramagnetic center and R_2 radicals. Ratio of the "satellite and main central peak" is frequently expressed as "x/y ratio". Decrease of the peak ratio has been explained by less saturation resistance of main peak amplitude. And it is interpreted also as decrease of spin-lattice relaxation time $T_{1,}$ by thermal effect of high LET radiation, which caused crystallographic defect and plastic deformation in alanine lattice. From experiment in this paper, the intermediate value of x/y ratio when irradiated simultaneously with tow types of radiation(gamma and neturon ray for example, high and low LET radiation) was shown and it could be explained that each population of radicals influenced to the saturation characteristics of the main peak. Experiment also showed that "x/y ratio" of alanine dosimeter which was returned from nuclear pwoer plant constantly decreased with mixed radiation dose and increased with additive only gamma irradiation. This result indicated good agreement with the already reported papers about "x/y ratio" change in different LET radiation. In this study, the influence of radical population to "x/y ratio" was observed by irradiation of mixed field and additive gamma irradiation. And this result could be applied to estimated gamma dose quantity which exposed mixed radiation field in nuclear power plant.

Materials and Methods

In this experiment, bioMax commercial alanine dosimeter was used which contained alpha amino acid alanine and Teflon as binding material. Standard alanine dosimeters for e-scan were irradiated in NPL(National Physical Laboratory, United Kingdom) by coblat-60 gamma-ray, which dosimeters were irradiated at dose rate of 40 Gy/h(absorbed dose to water, standard graphite calorimeter). Installation period of pallet in nuclear power plant was two fuel cycles. Acetal polymer capsules were carefully fastened on the cable not to be shocked by external force.

Results and Discussion

The spectrum of alanine samples irradiated with only gamma ray and both gamma and neutron rays showed shape difference as belows.

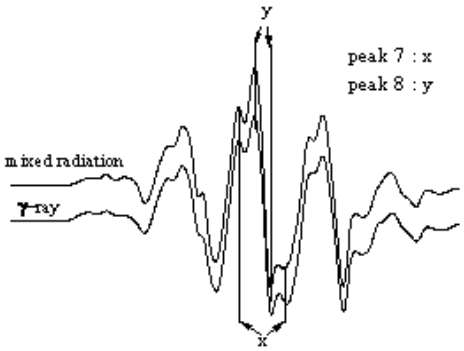

Fig. 1. Signal of alanine pallet irradiated with gamma-ray(1,500Gy) and mixed radiation measured with reference of Co-60(1,800Gy), showed ratio difference.

The difference of spectrum shape, "x/y ratio", is known as occurring from difference of LET value(linear energy transfer) in radiation quality. In general, the ratio becomes apparently lower than that of photons when exposed to high LET radiation. And it shows the intermediate value in mixed field radiation that composed of high and low LET radiations(gamma and neutron, for example).

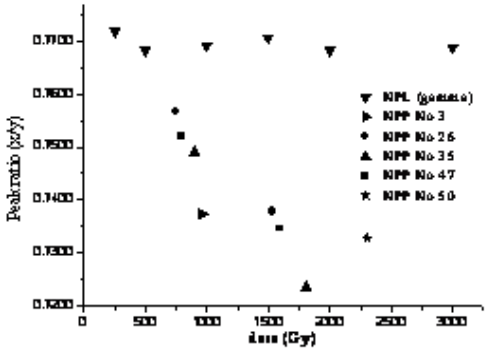

Fig. 2. Peak ratio of alanine pallet, "x/y ratio", which is gamma ray irradiated from NPL and returned from NPP after 1 and 2 fuel cycle.

Conclusion

The "x/y ratio" were know as being decided as population of free radicals which influenced by LET difference of each radiation in mixed radiation field. As we can see figure 2, spectrum shape of alanine from nuclear power plant was identified from that of only gamma exposed alanine pallet spectrum. This decrease of ratio is known as being determined by relative ratio of radicals by each radiation, gamma and neutrons, and factors for each populations.

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