

EPR Dosimetry for ageing effect in NPP

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1. Introduction

As one of the retrospective dosimetry method, EPR spectroscopy has been studied by many researchs up to these days. As a dosimeter for EPR spectroscopy, Alanine is already a well known dosimeter in the field of radiation therapy and dose assessment in radiological accident by its characteristics as good linearity in a wide range of energy level and extremely low signal fading on time. Through technical document of IAEA, the EPR dosimetry method using alanine sample was published in 2000 after research by coordinated project on management of ageing of in-containment I&C cables[1]. Although alanine sample is regarded as a good EPR dosimeter like above ageing assessment field[2], actually the assessment of radiation should be done at least for two fuel cycles, because of its relatively low irradiation environment in almost all spots in power plant. So, for getting more accurate detection value of radiation, another material is tested for being put in simultaneously inside the power plant with alanine[3]. The test result for lithium formate monohydrate ($\text{HCO}_2\text{LiH}_2\text{O}$) was presented below for checking its possibility for being applied as EPR dosimeter for this project[4][5].

2. Methods and Results

In this section, basic EPR spectroscopic signal, scanned by non-quantitative point of view, was presented for possibility of applying lithium formate material as dosimeter for EPR spectroscopy

2.1 preparation of material

Lithium formate monohydrate(powder, 98%) was purchased in local market for experiment. Sample material is weighted about 200mg for being put into quartz tube(OD 5mm) and scanned by EPR system.

The measurement was done at room temperature($\approx 295^\circ\text{C}$) using an X-band spectrometer(Bruker). The applied parameters were as follows, modulation frequency:100 kHz, modulation amplitude:1.25 mT, time constant:5.12s, conversion time:40.96s and microwave power:2.52 mW, scanning:10 times for each sample. The treated sample was irradiated by Gamma ray(Cs-137) blood irradiator ranged from 25 cGy to 200 cGy for additive method by 25cGy.

The signal intensity of Fig 1. was managed to get proper value by subtract original non-irradiated spectroscopy signal.

2.2 Properties of material

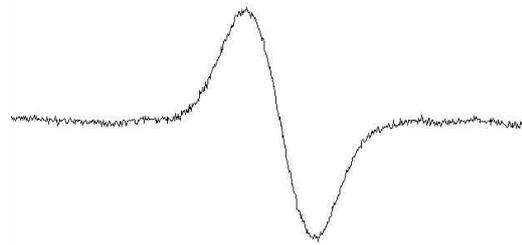


Figure 1. first derivative EPR spectra of lithium formate powder (200 mg) irradiated to 1 Gy with Sc-137 gamma rays

Although properties of Lithium formate powder is almost same as those of alanine. Some different point to be noticed is that the spectra of material has no dose signal in case of non-irradiation to radiation. But important characteristics like no dependence on dose & dose rate is very similar with that of alanine. No zero dose signal also could be a good characteristics to detect low dose under 1 Gy dose range.

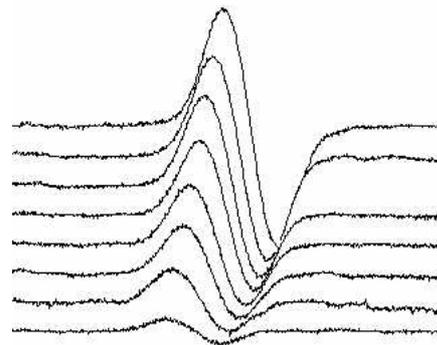


Figure 2. first derivative EPR spectra of lithium formate powder (200 mg) irradiated from 0.25 Gy to 2 Gy by the 25cGy with Sc-137 gamma rays in additive method (from front spectra)

Lithium formate powder shows relatively good sensitivity to the radiation even at small quantity of sample. And also the dose-response linearity is

excellent to be used as EPR sample. Figure 2. shows response characteristic of lithium formate sample. But like alanine dosimeter, under the 1 Gy dose level, the S/N ratio become increased and accuracy is not so good. Below Figure 3. is made on the data of figure 2 experiment and it shows dose-signal linearity. The experiment was done for accuracy three times. It also shows at low dose range(0.25-1Gy) that relatively unstable signal deviation can be found in the figure 3.

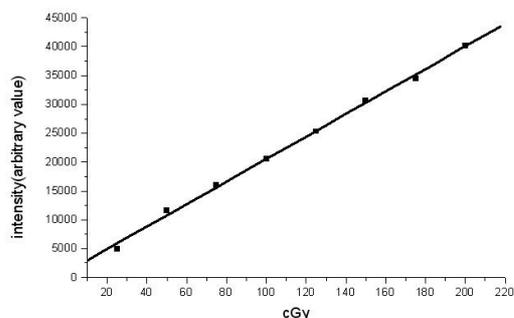


Figure 3. Dose-signal plot of lithium formate powder (200 mg) irradiated from 0.25 Gy to 2 Gy by the 25cGy with Sc-137 gamma rays in additive method

This experiment output only present the possibility of application of lithium formate powder as EPR dosimeter with alanine. Current some study also show that the accuracy of alanine dosimeter at 0.5Gy is about 6.7% standard deviation while 4.3% in lithium formate dosimeter[6]

3. Conclusion

To use some material as dosimeter for long period, at least one year, needs more stable characteristics in many fields. For example, the sensitivity at low dose radiation, time & energy independence, dose & dose rate independence, stability of signal at the various situation including moisture and temperature variation should be tested before being used as dosimeter. Alanine has already been applied in last some years and the result was accepted as proper one. For getting more accurate radiation dose, trial of many various samples should be done simultaneously. Some problem related to, for example, the effect of complex field by gamma and neutron rays and time dependence of signal should be studied before radiation assessment application in NPP[7].

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