Property of the lithium formate powder for EPR dosimetry.

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1. Introduction

The use of nuclear energy for electricity generation can be considered extreme safety because some components simply wear out, corrode or degrade to a low level of efficiency. To achieve optimum safety, we installed strictly selected dosimeters in the nuclear power plant.

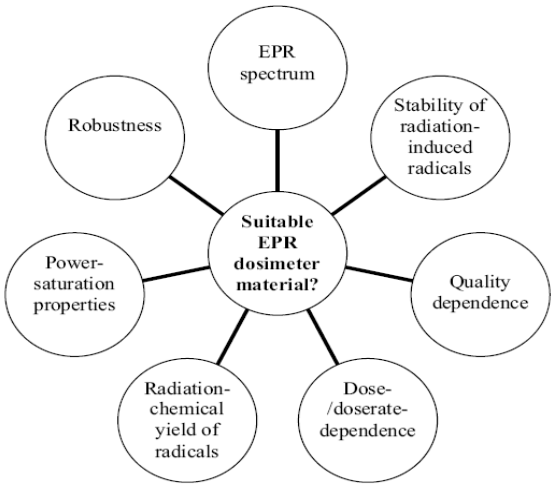

Fig. 1. Important considerations for the evaluation of an EPR dosimeter material.[1]

The alanine dosimeters and lithium formate powders were fixed on the targeted cable or nearest position to measure dose quantity to get accurate value. Alanine dosimeters and lithium formate powders, which installed period of one or two fuel cycle, were scanned by commercially used two different ESR systems, E-SCAN for alanine dosimeter and x-band EMX EPR (Electron Paramagnetic Resonance) spectrometer of Bruker [2,3].

In our last investigations, we confirmed that under the environment of mixed radiation field, slightly different LET value of each radiation causes the change of some ratios in spectrum like pitch to pitch value of central peaks.

For the purpose of a preliminary investigation of an accurate dosimetry, first of all, lithium formate powder which was irradiated gamma rays measured.

2. Methods and Results

2.1 Dosimeters

The Polycrystalline lithium formate monohydrate powder ($HCO_2Li \cdot H_2O$, 98%) was purchased from Sigma-Aldrich Co. and stored at strictly sealed condition for blocking loss of moisture. For lithium formate powder was easily lost moisture, sealing is very important at laboratory.

To hold lithium formate powder (80mg±1mg) inside the quartz tube, it configured that lithium formate powder and teflon in the quartz tube like fig. 2 and used that manganese standard sample in the teflon plug for normalization about change of measurement conditions.

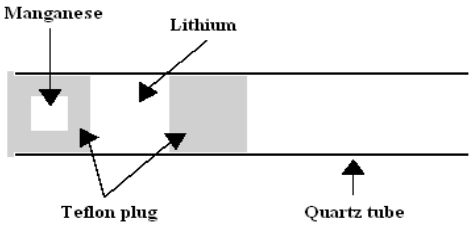

Fig. 2 Lithium formate powder, Manganese and Teflon plug in quartz tube.

2.2 Equipments

The spectrometer used for all EPR measurements was a Bruker EMX X-band instrument. A double rectangular cavity operating in the TE104 mode with a nominal center frequency of 9.7 GHz was used.

EMX spectrometer was recorded with a microwave power of 20.02mW, a modulation frequency and amplitude of 100kHz and 0.1mT, a time constant of 5.12ms. The magnetic field sweep width was 18.0mT, while the number of sampling points was 1024, the microwave frequency was about 9.77GHz.

The e-scan is ESR spectrometer dedicated to the evaluation of absorbed dose in alanine dosimeters (either film or pellet). With the appropriate accessories, the e-scan measures absorbed dose from a few Gray to about 200 kGy.

Equilibrium time at cavity before each measurement was 10min and maintained for entire experiment process.

Dosimeters used in this experiment was irradiated by cesium-137 at rate of 6 Gy/min±4% in blood irradiator (IBL 437C).

Annealing was performed in a muffle furnace (yamato-fo100) in air at 343K for stated interval of 30min. The annealing temperature was controlled by a thermocouple that provided the temperature measure-ment accuracy within ±1℃.

2.3 Results

As below in Fig. 3, lithium formate powder which already exposed gamma ray for 2200 Gy was heated for

150 min with non-sealing. It shows the fading characteristics at annealing temperature of 343K.

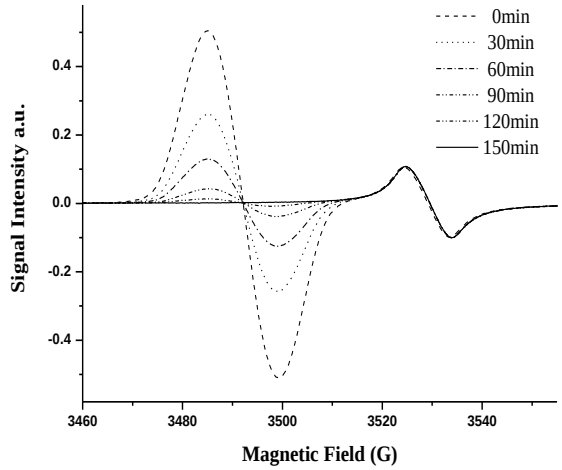

Fig. 3. Spectrum change of lithium formate powder which was annealed at temperature of 343K for 150min, signal of the right side is manganese standard sample spectrum for comparison. Lithium formate powder was exposed gamma radiation of 2200Gy.

Lithium powder was measured by the every half hour for signal observation. The results of the thermal annealing studies are basically as expected from previous studies [4,5].

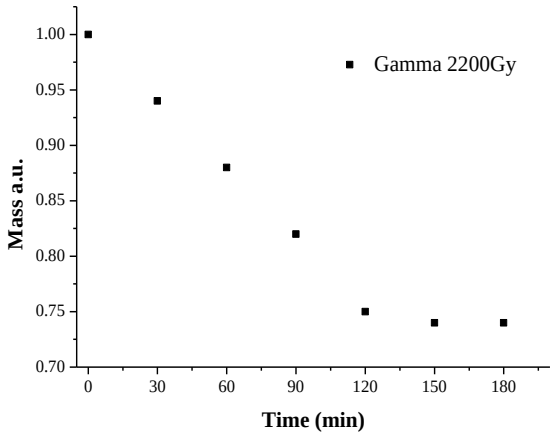

Fig. 4. Decreased mass of lithium formate powder which was annealed at temperature of 343K for 180min. Lithium formate powder was exposed gamma radiation of 2200Gy.

But this case which is annealed temperature at 343K more effect of decreased mass for dehumidification than temperature. At the fig 3, 4, it can confirm that similar tendency. Samples of same condition compared case of completely sealed lithium formate powder that annealed at temperature of 343K for 150min with non-sealed lithium formate powder that annealed at temperature of 343K for about 180min.

In case that non-sealing, intensity disappeared like fig. 3 but intensity of complete sealing appeared like non-annealing nearly.

3. Conclusions

Signal changes of lithium formate powder which was influenced by heating were showed that all the estimated radical quantity in lithium formatted powder could be underestimated by effect of sample conditions.

In this case, decreased mass for dehumidification give to effect more than annealing temperature.

This experiment can also help us to check the radiation quality in real situation.

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