Transactions of the Korean Nuclear Society Virtual spring Meeting
May 13-14, 2021

Study on the relationship between thermoluminescent(TL) sensitivity and thermoluminescent material LiF:Mg,Cu,Si powder particle size

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1. Introduction

The technology for using radioisotopes and radiation generating devices is spread across educational institutions, research institutions, medical institutions, and the general industry, and the number of exposure cases of radiation-related workers and radiation workers by radiation is continuously increasing. For this reason, personal dosimeters using thermo-luminescent(TL) materials have been mainly used among various methods for measuring the exposure radiation dose for the purpose of radiation protection. Dosimeters made of TL materials are mostly molded in chip shape and used, and in some cases, dosimeters in powder form (powder TL) are used. The powder-type dosimeter is used to calibrate the radiation generating device 1) in the field of therapeutic radiation, analyze the patient's epidermal dose, and measure the dose gradient at the end of the radiation beam axis. There is also a case study used 2-3). The main powder TL used at this time is a LiF:Mg,Ti material, and if LiF:Mg,Cu,Si is used, a chip-type dosimeter is pulverized to produce a powder TL. In this study, a powder TL was prepared directly from LiF:Mg,Cu,Si, and the TL sensitivity according to the powder size was measured to produce an optimal powder TL dosimeter.

2. Methods and Results

A new TL material LiF:Mg,Cu,Si in the form of a chip using LiF as a raw material was prepared. The thermal luminescent material processed in the form of a chip can be used as a personal dosimeter by making a card in which Teflon is fused,

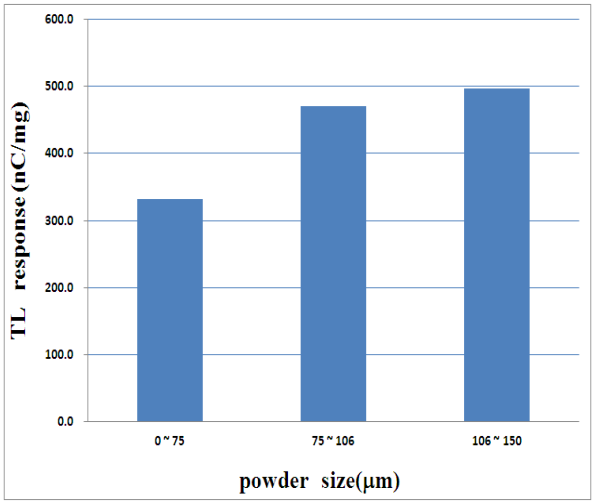

Fig 1. TL response(nC/mg) vs. powder size

and it can be used as a dosimeter directly in the form of powder by pulverizing the material in the form of a chip.
In this study, a TL material was prepared by directly sintering the powdered raw material. During the process of manufacturing the chip-type TL material, the sintered powder is directly sintered in a powder state without compression molding in the sintering step, and then the sintered powder is heat treated in two stages (300℃/10 minutes, 260℃/10 minutes). After classifying the powdered TL material into three standard meshes of 100, 140 and 200 mesh with a particle size of 150 to 106 μm, 106 to 75 μm, and 75 μm or less, the standard gamma radiation field (Cs-

Table 1. The TL response per mass(nC/mg) of new LiF:Mg,Cu,Si vs powder size(μm)

Diameter	~ 75 μm			75~106 μm			106 ~150 μm		
	Response (nC)	Mass (mg)	rate (nC/mg)	Response (nC)	Mass (mg)	rate (nC/mg)	Response (nC)	Mass (mg)	rate (nC/mg)
1	4377.0	12.7	344.6	5141.0	10.8	476.0	6401.0	12.4	516.2
2	4371.0	12.9	338.8	5346.0	10.8	495.0	5461.0	11.2	487.6
3	4169.0	12.7	328.3	4788.0	10.6	451.7	5921.0	12.0	493.4
4	4235.0	12.6	336.1	5034.0	11.0	457.6	5922.0	11.9	497.6
5	4226.0	13.6	310.7	6359.0	13.5	471.0	6130.0	12.5	490.4
Mean	4275.6	12.9	331.7	5333.6	11.3	470.3	5967.0	12.0	497.1
S.D	93.3	0.4	13.1	607.5	1.2	17.0	344.6	0.5	11.3

137) was irradiated with a radiation dose of 10 mGy.
The powdered TL material irradiated with radiation was read for 23 seconds under the reading conditions of preheat 50°C, heating rate 15°C/s, and reading temperature 300°C using a reader Harshaw 4500 at the Korea Atomic Energy Research Institute. Each powder size was measured 5 times, and for comparison, a chip-type TL device having a diameter of 3.6 mm, a thickness of 0.45 mm, and a mass of 10.9 mg was prepared, and the same amount of radiation dose of 10 mGy was irradiated in the same reference gamma field (Cs-137).

3. Results and Discussion

First, prepare 15 chip-type TL elements with a diameter of 3.6mm, thickness of 0.45 mm and an average mass of 10.9 mg, and irradiation with a radiation dose of 10 mGy at the standard gamma radiation field (Cs-137), and then Harshaw 4500, a reading device at the Korea Atomic Energy Research Institute. As a result of measurement, the TL sensitivity per unit mass was 241.6 ± 16.6 nC/mg.
After classifying the powdered TL material into a standard mesh of 100, 140 and 200 mesh by particle size of 150 to 106 μm, 106 to 75 μm and 75 μm or less, The radiation dose of 10 mGy in the same standard gamma ray field (Cs-137) was irradiated and measured five times for each particle size with a reader Harshaw 4500. The average sensitivities (nC/mg) were (331.7 ± 13.1), (470.3 ± 17.0) and (497.1 ± 11.3) nC/mg, respectively, for each particle size distribution. As for the sensitivity per unit mass, as shown in Figure 1, the larger particle size was, the higher sensitivity was.

4. Conclusions

After preparing a powder-type high-sensitivity TL material LiF:Mg,Cu,Si using LiF as a raw material, the thermoluminescence response sensitivity by powder size distribution was measured and compared with a chip-shaped TL element.
The results showed up to 2 times more response sensitivity depending on the powder size.
As a result, the thermal phosphors LiF:Mg,Cu,Si in powder form are analyzed for environmental dose according to the powder size through further studies such as linearity and reusability for radiation, LLD and fading, etc. It will be able to be applied in various fields in various fields

5. References

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