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COMPARATIVE STUDIES ON THE THERMAL FADING OF CALCIUM FLUORIDE DYSPROSIUM CAF_2:DY (TL-D200) CRYSTAL AND POWDER

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Abstract
In the present study, thermal fading of calcium fluoride dysprosium CaF_2:Dy (TL-D200) crystal and powder have been investigated in detail, for storage time in different temperatures .The rate of thermal fading of both measurements of calcium fluoride dysprosium crystal ,and powder, found to be equal (0.11%, 0.14%, 0.16%,0.25% -0.12%, 0.15%.0.18% 0.30%) respectively at storage time for six weeks indicate that there is a slight difference in the thermal fading for them. This enhances their use in dosimeters to measurement of radon emanation rate resulting from background radiation for difference sources.

Keywords: Thermoluminescence, Thermal fading, CaF_2:Dy (TL-D200) crystal, CaF_2:Dy powder.

INTRODUCTION

Thermoluminescence is the emission of light from an insulator or semiconductor when it is heated. This is not to be confused with the light spontaneously emitted from a substance when it is heated to candescence. Thermoluminescence is the thermally stimulated emission of light following the previous absorption of energy from radiation. In this statement can be found the three essential ingredients necessary for the production of thermoluminescence. Firstly, the material must be an insulator or a semiconductor –metals do not exhibit luminescent properties .Secondly, the material must have at some time absorbed energy during exposure to radiation .Thirdly , the luminescence emission is triggered by heating the material [1].Several thermoluminescence phosphors are now used routinely in machdosimeteric application. Many thermoluminescence phosphors, like LiF, $CaSo_4$, CaF_2 and $CaSo_4$: Dy have been examined for their use in dose estimation [2-4]. A thermoluminescence dosimeter should possess many features such as :(a)-it should have small size and should tissue equivalent ,which is useful for a variety of application in medicine[5], (b)-it should be sensitive to large rang of exposure such as from low of about 0.2µGy to 10^3Gy with good linearity[6],(c)-it should be usable many time by annealing with a minimum change of

efficiency ,and it should be a little loss from exposure period 3- 12 month [7]. In this study, the aim of this work is to investigate thermal fading of CaF_2: Dy crystal and powder for different temperatures in the same storage time.

Materials and methods

In the present study, two types of materials have been used .First one is calcium fluoride dysprosium CaF:Dy (TL-D200) crystal ,and the second is CaF:Dy powder. Each of them irradiated by using a Cesium-137 gamma source made by J.L. shepherd and associates company ,California was placed in the irradiation room of the thermoluminescence Laboratory at the Department of Physics ,college of Education for Pure Science, University of Basrah [8],in this work, the source gives a dose rate 48 rad/min. The annealing of the TLDs were carried out by Program-1 of the TLD annealing oven, which heats the TLDs at 400^0C for two hours and then at 100^0C for one hours. The TLDs were then stored at the room temperature. The thermal treatments of the TLDs were done for the complete bleaching of the previous dose information and re-generation of the specific defect in the crystal. The post irradiation annealing of TLDs has been done in order to free the lower trap electrons before readout. Annealing of TLDs was performed at 100^0C for 10 minutes using program-2 of the TLD annealing oven. This is, therefore, utilized to minimize the variation of changes in the glow curve due to fading. The TL-response has then been measured with a Harshaw model 2000B/C) with a flow of nitrogen at a constant rate, manufactured by Harshaw, Cleveland USA, was utilized, Harshaw 2000B/C Reader using the planchete heating method. The sample is heated in contact with a stainless steel crucible; the temperature is controlled by thermocouple placed in close contact with the sample holder. After irradiation the sample is heated with a linear pump of about 5 ^{0}C/s from 30-300 ^{0}C.

Result and discussion

The fading of the thermoluminecencent (TL) output signal is a bother some property of thermoluminescent dosimeters (TLD_S) that is important to characterize in order to accurately relate TL-output with amount of radiation exposure. Researchers often attach importance to this topic, which is characteristic of thermoluminescent dosimeters as a measure of radiation doses. High pre-and post-irradiation fading prevents the attainment of high accuracy in dosimetry measurements, especially in routine dosimetry when the exact duration and time of exposure are not known. An attempt was made at the In the TL-laboratory of the Department of Physics, Basra University to reduce the fading following or preceding gamma radiation, by employing a high post-irradiation preheat temperature of 0.0 ^{0}C 30.0 ^{0}C ,60.0 ^{0}C.and 90.0 ^{0}C. Measurements of calcium fluoride dysprosium CaF:Dy (TL-D200) crystal ,and the second is CaF:Dy powder, for fading period's time that varied from 1 to 6 weeks. Findings showed relatively little fading for both dosimeters see figs. 1 and 2.This enhances their use in dosimeters to measurement of radon emanation rate [9] .The rate of thermal fading of both measurements of calcium fluoride dysprosium crystal ,and powder, equals (0.11%, 0.14%, 0.16%,0.25% -0.12%, 0.15%.0.18% 0.30%) respectively at storage time for six weeks see table .1. This result agrees experimentally with the results obtained by other researchers [10-14].

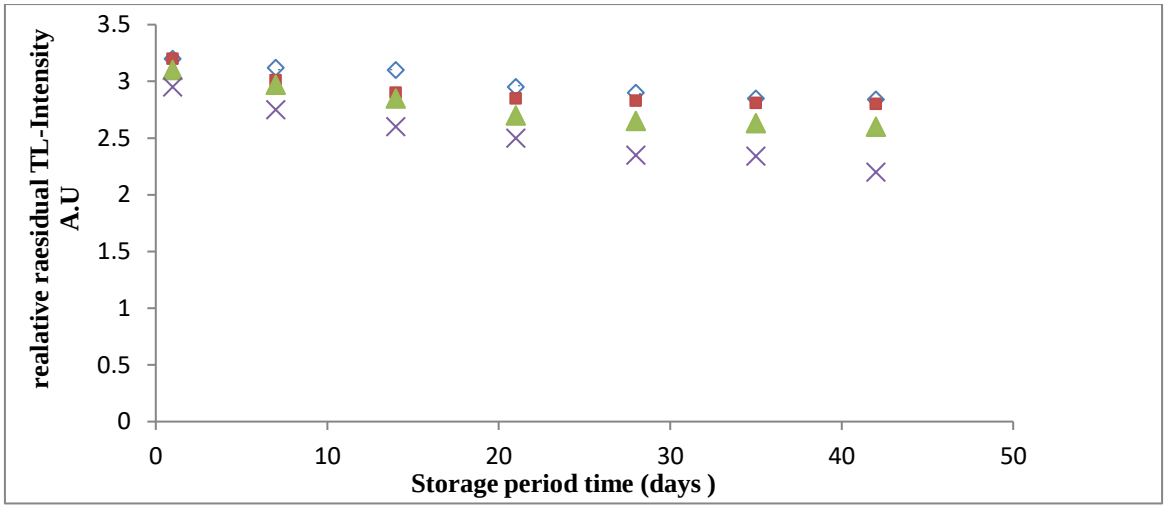

Fig. 1. Thermal fading of calcium fluoride dysprosium crystal at different temperatures.

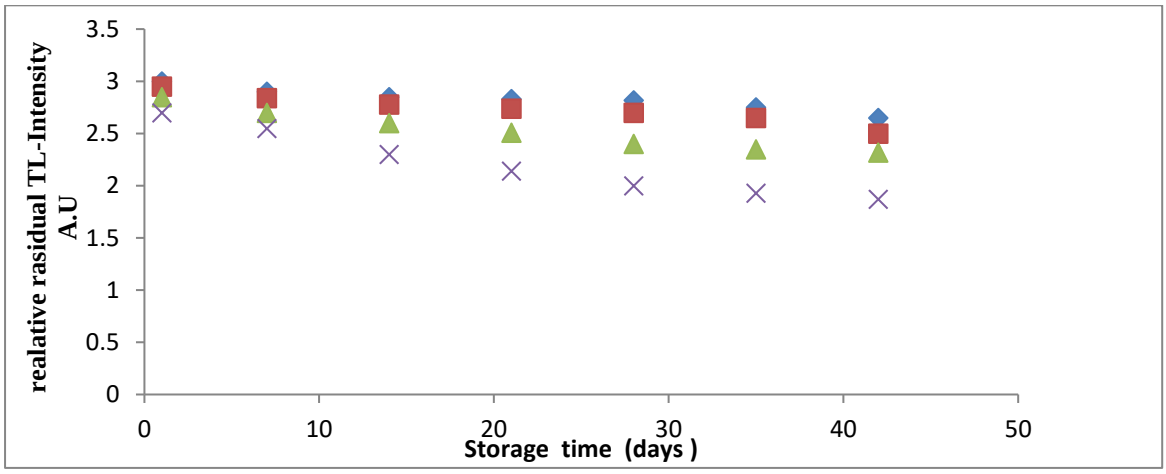

Fig. 2.Thermal fading of calcium fluoride dysprosium powder at different temperatures.

Table 1: Percentage the thermal fading for calcium fluoride dysprosium CaF:Dy crystal and powder for a time period 6 weeks.

percentage the thermal fadingCaF:Dy crystal --- CaF:Dy powder		Storage Temperature ^{0}C
0.11%	0.12%	0
0.14%	0.15%	30
0.16%	0.18%	60
0.25%	0.30%	90

Conclusion

The results of this study, indicate that there is a slight difference in the thermal fading for CaF_2: Dy crystal and powder. This enhances their use in dosimeters to estimate the average dose rate of gamma-rays resulting from background radiation for difference sources.

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