International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869 (O) 2454-4698 (P) Volume-8, Issue-5, May 2018

Characterization of TL-D200 and TL-D100 for Thermoluminescent Radiation Dosimetry

Riyadh Ch. Abul-Hail, Murad K . Abdallah

***Abstract*— The thermoluminescence (TL) properties of TLD-100 and TLD-200 have been studied and their reproducibility, Lower detection limits, Calibration curve and fading are discussed. It is found TLD-200 samples presented the highest TL sensitive from TLD100 and that all the batches have high uniformity which makes them capable for environmental use .it has been shown that two is good reproducibility in the measurement as the results have indicated it is found that the coefficient of variation for TLD-100 and TLD-200 are 3.15, 2.25 respectively. The rate of thermal fading of both Lithium fluoride and calcium fluoride dosimeters equals (11%,13%) respectively for three months.**

***Index Terms*—TL, TLD 100, TLD-200., Lithium fluoride, calcium fluoride**

I. INTRODUCTION

A thermoluminescent dosimeter, or TLD, is a type of radiation dosimeter. A TLD measures ionizing- radiation exposure by measuring the intensity of visible light emitted from a crystal in the detector when the crystal is heated. The intensity of light emitted is dependent upon the radiation exposure.Materials exhibiting thermoluminescence in resp-onse to ionizing radiation include but are not limited to calcium fluoride, lithium fluoride, calcium sulfate, lithiumborate, calciumbo rate , potassium bromide e and feldspar. It was invented in 1954 by Professor Farrington Daniels of the University of Wisconsin-Madison [1]. The two most common types of TLDs are calciumfluoride and lithium fluoride, with one or more impurities to produce trap states for energetic electrons. The former is used to record gamma exposure, the latter for gamma and neutron exposure (indirectly, using the Li-6 (n, alpha) nuclearreaction; for this reason, LiF dosimeters may be enriched in lithium-6 to enhance this effect or enriched in lithium-7 to reduce it). Other types include berylliumoxide [2] calciumsulfate doped with Tm [3.]As the radiation interacts with the crystal it causes electrons in the crystal's atoms to jump to higher energy states, where they stay trapped due to intentionally introduced impurities (usually manganese or magnesium) in the crystal,[4] until heated. Heating the crystal causes the electrons to drop back to their ground state, releasing a photon of energy equal to the energy difference between the trap state and the ground state. The use of thermoluminescence in dosimetry date from 1940,

when the number of people working on places with radiation sources such as hospitals, nuclear reactors etc. exposed to ionizing radiations (γ-rays, X rays, α and β-particles, UVA and UVB) increased and efforts to develop new types of dosimeters began [5].In this paper we present sensitivity, calibration curve and thermal fading for the dosimeters of TLD-100 and TLD-200.

Riyadh Ch. Abul-Hail, Physics Department, Basrah University, Education College for pure sciences/ Basrah, Iraq.

Murad K . Abdallah, Physics Department, Basrah University,Education College for pure sciences/ Basrah, Iraq.

II. MATERIAL AND METHODS

A series of experiments are conducted by using two groups of thermoluminscence dosimeters one of which include lithium fluoride dosimeters and the other calcium fluoride dosimeters and each group contain 20 dosimeters.

1-Pre-irradiation annealing

To drain the electrons traps that they contain because of their exposure to background radiations in the laboratory or to get rid of the remaining electrons trapped in the deep traps because of previous irradiation processes [6] which the measuring instruments fail to drain during thermolumine-scence, we use the method recommended by the researchers in this field and which includes putting the dosimeters in an Oven at 400 ^{o}C for one hour then moving them directly to another Oven at 100 ^{o}C for two hours, then leave it to cool down at the room temperature every time before the use of dosimeters for irradiation [7,8]. Also this treatment increases the sensitivity of a dosimeter [9].

2-Post-Irradiation Annealing.

This process is used so as to get rid of the glow peaks that fade at room temperature, i.e. the low temperature peaks [10]. The dosimeters are put in an oven at 100 ^{o}C for 20 minutes directly after irradiation, and they are left to cool at room temperature, then they are ready to be read in the thermoluminescence reader**.**

3-Condition of Measuring.

The dosimeter reading is registered by the thermolumines-cence reader at a heating rate of 5 ^{o}C/sec and to a temperature 300 ^{o}C for the dosimeters of lithium fluoride TL-D100 and to a temperature 320 ^{o}C for the dosimeters of Calcium fluoride TL-D200. Furthermore, the red light is used in the laboratory when the dosimeters are placed in the thermoluminescence reader in order to avoid the effect of ordinary light on them.

III. RESULTS AND CONCLUSION

1-Reproducibility.

The reproducibility of the TL response of the two materials was obtained by their TL evaluation for each dosimeter type after successive procedures of standard thermal treatments and irradiation with the Cs-137 source. The individual reproducibility (coefficient of variation) obtained for the TL detectors irradiated with 9.5 mrad Cs-137 are presented in Table 1. Also, it is found that the zero dose reading for lithium

fluoride and for calcium fluoride lie within the rang 7.75 mrad and 0.137 mrad respectively, see Figs. 1 and 2.

Table 1: Reproducibility of TL response.

TL Detector Coefficient of variation (%)	TL Detector Coefficient of variation (%)
TLD-200	2.25
TLD-100	3.15

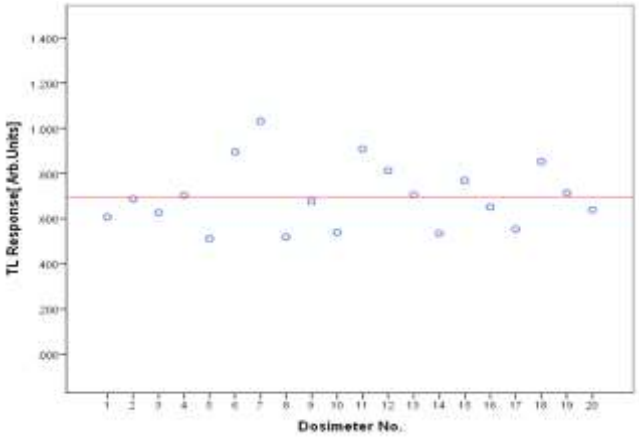

Fig.1. The zero dose reading of TLD-100 Dosimeters

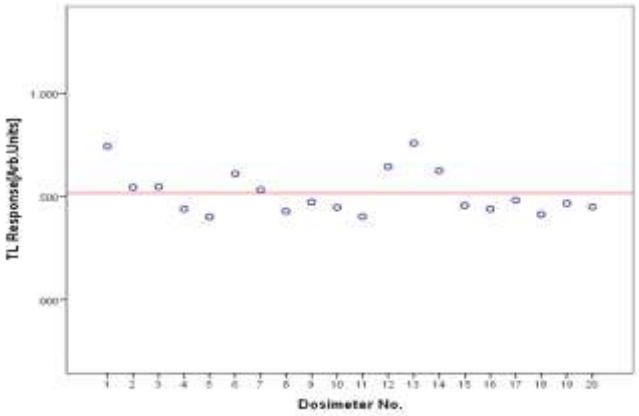

Fig.2. The zero dose reading of TLD-200 Dosimeters

2-Lower detection limits

Taking two times the standard deviation of 10 measurements of 6 not irradiated detectors of the two materials, TLD-200 and TLD-100 samples, expressed in terms of absorbed dose, it was possible to obtain the following results of 0.25 mrad, 4.5 mrad respectively.

3. Calibration curve

Dosimeters of Lithium fluoride TL-D100 of the same batch and which have close sensitivities are exposed to different doses of Gamma rays from the source C_S-137 gamma source-lie within (4.755-190.22)m rad after both processes of cleaning and annealing required are done together with the electronic equilibrium . After finishing the irradiation of these dosimeters, they go through post-irradiation annealing, then they are measured in the thermoluminescence apparatus in a temperature range between the room temperature and 320 ^{o}C and at heating rate 5 ^{o}C/sec. In the same manner, Calcium fluoride dosimeters TL-D200 of different doses are exposed to the same radiation source which ranges between 2.377-190.22 mrad.

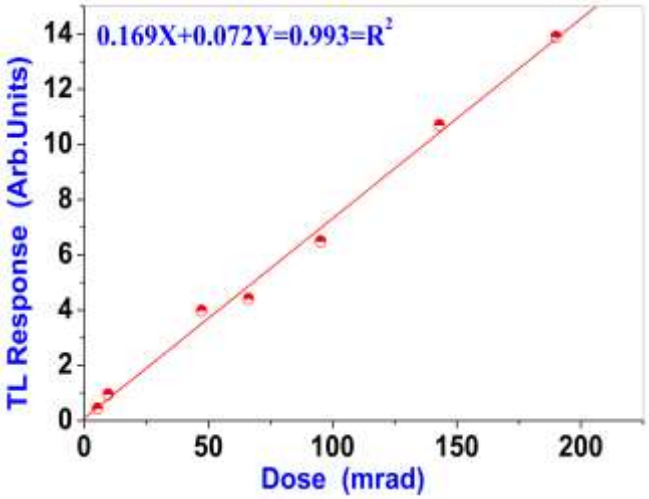

Fig .3. Calibration curve of TLD-100 dosimeters

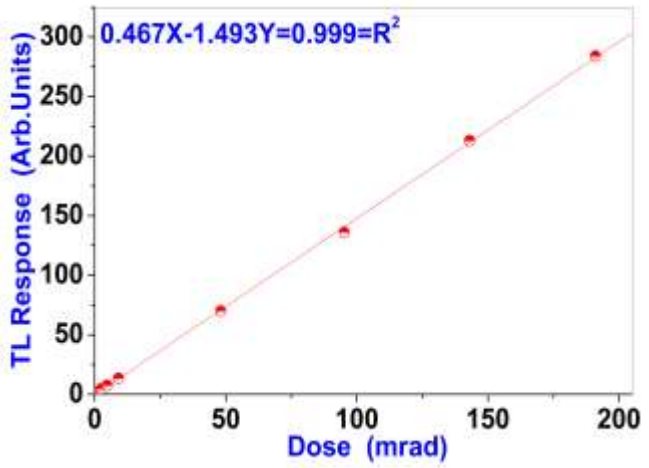

Fig .4. Calibration curve of TLD-200 dosimeters

After irradiation is done, post irradiation annealing is conducted. Then, the TL of these dosimeters are measured in the thermoluminescence TLD reader apparatus. The results of this experiment are shown in Fig.3 and4 where it is observed that the relation between the dose and the response of these two materials is simple and linear, a matter that proves their easy use to measure radiation doses in the range mentioned above. Also, it is found TLD-200 samples presented the highest TL sensitive of TLD100 .See Figs. 5 and 6

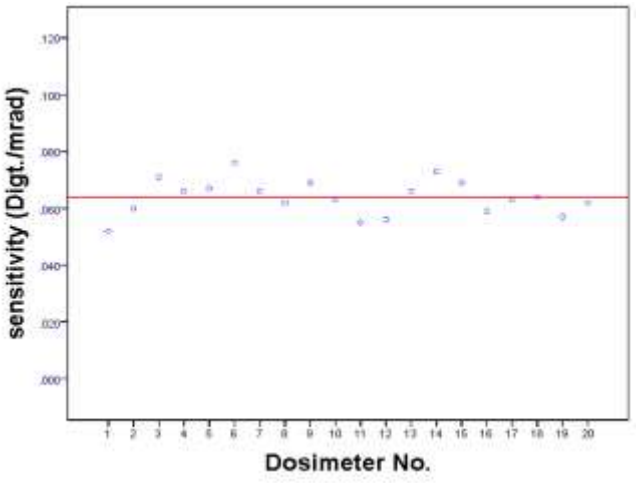

Fig.5. TL-Sensitivity of TLD-100 Dosimeters

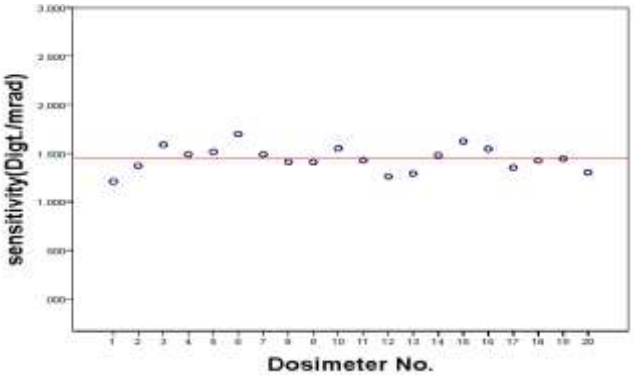

Fig.6. TL-Sensitivity of TLD-200 Dosimeters

IV. THERMAL FADING

When the dosimeters are placed in the positions needed to measure the irradiation doses of salt samples studied. The temperature of these dosimeters inside plastic containers corresponds with that of the surrounding, i.e. the temperature of the room where the sample are kept. This condition leads to a loss (fading) of the thermoluminescence signal that is why, the researcher measures the thermal fading of thermoluminescence dosimeters by taking a batch of Lithium fluoride and another of Calcium fluoride. After pre-irradiation annealing is performed to them, these dosimeters are given a fixed dose of 480 mrad. Post-irradiation annealing is done directly after. Then the thermoluminescence of two samples of each of Lithium fluoride batch and Calcium fluoride batch is read. The remaining samples are stored in the room where salt samples under study are kept in order to read their thermoluminescence at different consecutive times. The rate of thermal fading of both Lithium fluoride and calcium fluoride dosimeters equals (11% , 13%) respectively for three months, and this agrees experimentally with the results obtained by the researchers [11-13]. See Figs. 7 and 8

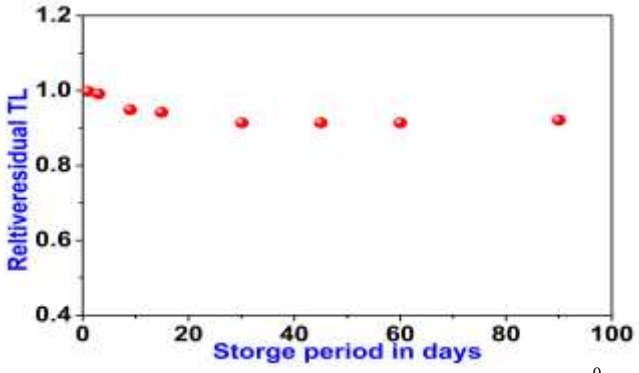

Fig.7. Thermal fading of TLD-100 at Temperature 25 ^{0}C

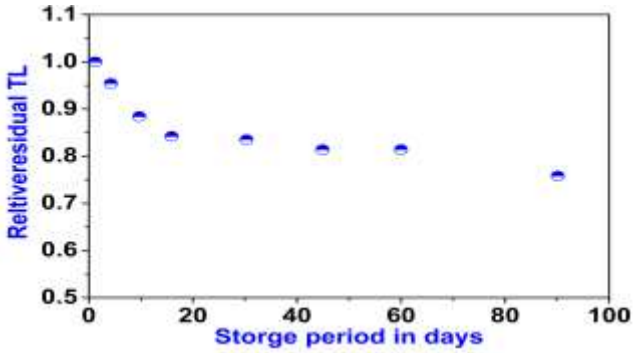

Fig.8. Thermal fading of TLD-200 at Temperature 25 ^{0}C

IV. CONCLUSION

All two TL materials presented usefulness for low-dose dosimetry. The lower detection limits were 2 mrad, 6 mrad respectively for TLD-200, TLD-100 respectively. Experimental observation have indicated that there is a linear relation between response and dose for both materials .It is also found that most dosimeter of the same materials have nearly equal sensitivities and that all the batches have high uniformity which makes them capable for environmental use. It has been shown that there is good reproducibility in the measurements as the results have indicated it is found that the coefficient of variation for TLD-100 and TLD-200 are 3.15% and 2,25% respectively. The rate of thermal fading of both Lithium fluoride and calcium fluoride dosimeters equals (11% ,12%) respectively for two weeks. measurements as the results have indicated it is found that the coefficient of variation for TLD-100 and TLD-200 are 3.15% and 2,25% respectively. The rate of thermal fading of both Lithium fluoride and calcium fluoride dosimeters equals (11% ,12%) respectively for two weeks.

REFERENCES

[1] Radiation Dosimetry John Cameron. Environmental Health Perspectives Vol.91, 1991 pp.45-48,
[2] Tochilin, E., N. Goldstein, and W. G. Miller. "Beryllium oxide as a thermoluminescent dosimeter." Health physics 16(1) (1969) 1-7.
[3] Yamashita, T., et al. "Calcium sulfate activated by thulium or dysprosium for thermoluminescence dosimetry." Health physics 21(2) (1971), 295-300.
[4] Faiz M. Khan (2003). "The Physics of Radiation Therapy". Lippincott Williams & Wilkins.
[5] McKeever SWS (1985) Thermoluminescence of Solids. Cambridge University Press. 8 p
[6] Burke. K and Sutton.D "Optimization and deconvolution of lithium fluoride TLD-100 in diagnostic radiology " the British Journal of Radiology 70(1997), 261-271
[7] Henri W.Julis and Cees W.Verhoef "Effects of storage intervals on the sensitivity and fading of LiF TLDS" Nuclear Inst and methods 175(1980),177-179
[8] Mallah.A.S, *eta1* "Environmental Radiation Measurements using TLD in and around Aere,Dhaka" Radiation protection dosimetry14(3) (986),261-263
[9]Prokic,M. " Dosimetric characteristics of Li2B4O7: Cu, Ag, P Solid TL Detectors "Radiation protection dosimetry, 100(1-4) (2002) ,265-268
[10] E.Piesh and B.Burgkardt(1984) "Enviromental monitoring "Radiological protection-No.29.
[11] Meckeever S.W.S"Thermoluminescence of solids" Cambridge University press p 2. (1985)
[12] Gopal B.Saha(nd)"Fundamenals of Nuclear pharmacy Fifth Edition,2000.
[13] Th. M. Salman, A. Y. AL-Ahmad, H. A. Badran and C. A. Emshary, Physica Scripta 90 ,(2015) 085302 (8pp)