Radiation Effects, 1982, Vol 00, pp 111-111
0033-7579/82/3333-4444$06.50/0

BETA RADIATION DOSIMETRY USING NaCl:Tl(T) THERMOLUMINESCENT PHOSPHOR

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(*Received October 20, 1981; in final form January 28, 1982*)

The present paper discusses the development of the NaCl:Tl(T), (10^{-3} m f. of thallium concentration) phosphor as dosimeter material for beta-radiation thermoluminescent dosimetry (TLD). The TLD grade NaCl:Tl(T) powder was prepared by annealing the NaCl:Tl powder obtained from aqueous solution by method of crystallization at 750°C for two hours in open air. The thermoluminescence (TL) behaviours of NaCl:Tl(T) phosphor were examined in different physical situations It is inferred from the present experimental work that, due to their high TL-efficiency, capability of registering beta-dose in the range 10-10^4 R, resistance to radiation damage and negligible fading, the NaCl:Tl(T) phosphors are found suitable for beta-dosimetry.

INTRODUCTION

In view of the rapid growth in the beneficial uses of ionizing radiation in various fields like medicine, industry, agriculture, etc., on one side, and its adverse effects on human body of professional worker on other side, it is found highly essential to estimate the energy (dose) of ionizing radiation in radiation applications. Many methods have been developed for the exact determination of energy of ionizing radiation.[1] Recently, thermoluminescent dosimeters (TLDs) have been established to be the most suitable devices for such measurements.[1-4] A large number of thermoluminescence dosimeter systems, namely; LiF, $CaSO_4$:Tm, CaF_2, CaF_2:Dy, Al_2O_3 etc., have been developed for the radiation dosimeters by many health physicists.[1,2,5,6] The performance of these phosphors appeared to be quite satisfactory for the dosimetry of X-ray, γ-ray and thermal neutrons. However the same was not fully satisfactory for beta dosimetry. Therefore, as an experiment, the attempt has been made to develop NaCl:Tl phosphor as a solid state dosimeter material for beta-radiation thermoluminescent dosimetry.

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EXPERIMENTAL

The TLD grade specimens of NaCl:Tl, thallium concentration 10^{-3} m.f., were obtained by the method of recrystalization from aqueous solution. These as-obtained NaCl:Tl specimens of mesh size ⟨80⟩120 were subjected to standard heat treatment, namely, annealing at 750°C for two hours and subsequently quenching to room temperature in open air. Such heat treated specimens were designated as NaCl:Tl(T) phosphors. 20 mg of NaCl:Tl(T) sample was used for all beta-dosimetric work. The excitation source used in present work was Sr^{90}–20 m/ci with a dose rate of 700 R min^{-1}. After exposure, the powder was uniformly spread on the Kanthal plate. The powder was subsequently heated to around 350°C with heating rate 200°C min^{-1} by passing fixed a.c. current through the Kanthal plate. The TL-glow curves were recorded with the experimental arrangement described previously.[7]

RESULTS

Figure 1A presents typical TL-glow curves of untreated and 750°C quenched pre-heat-treated NaCl:Tl specimens (10^{-3} m.f. of Tl) for a beta-dose of 700 R. It is seen from the Figure 1A that the untreated specimen exhibits dominant glow

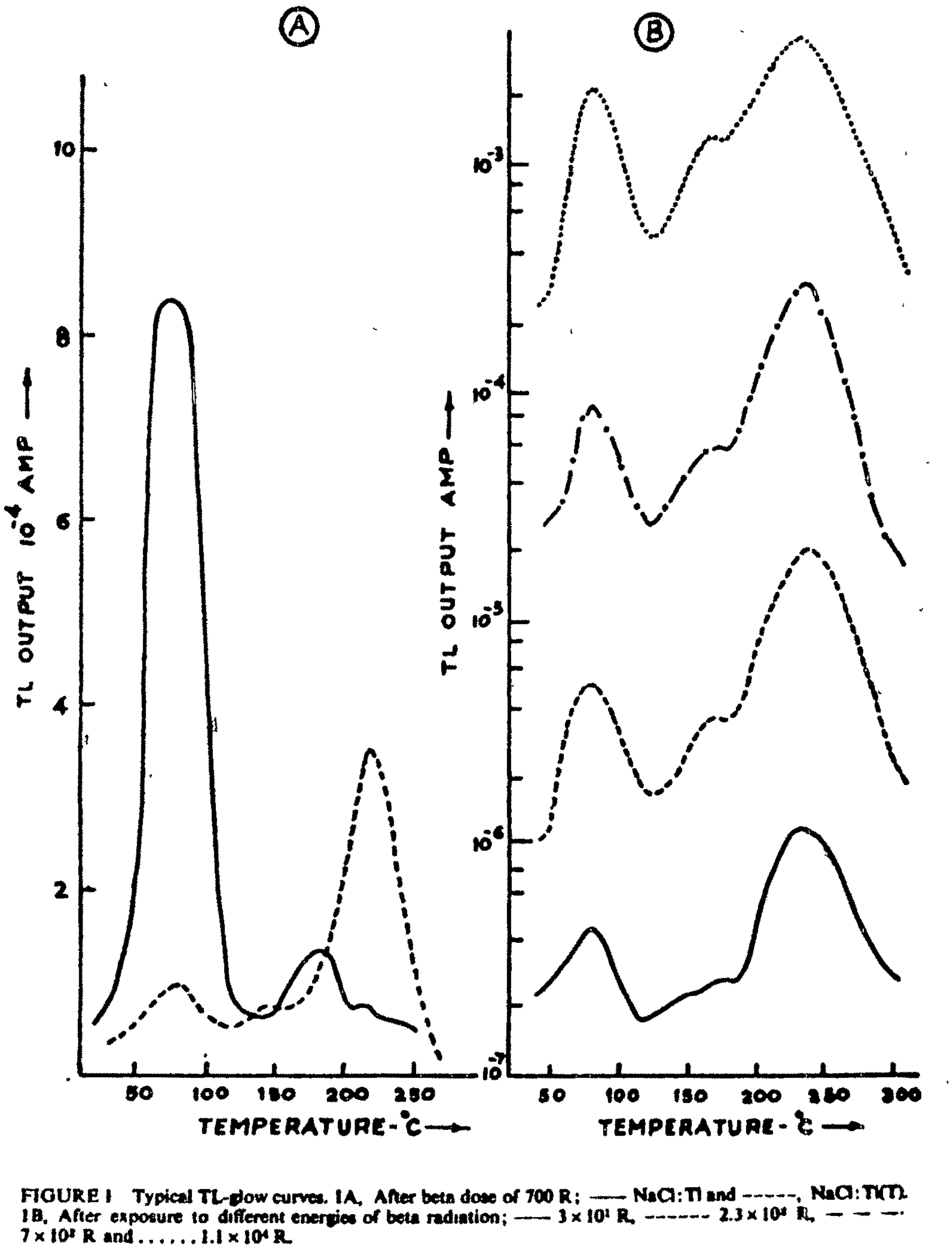

FIGURE 1 Typical TL-glow curves. 1A, After beta dose of 700 R; —— NaCl:Tl and ------, NaCl:Tl(T). 1B, After exposure to different energies of beta radiation; —— 3×10^1 R, ------- 2.3×10^2 R, — — — 7×10^2 R and ...... 1.1×10^4 R.

peak at low temperature while that appear at higher temperature, around 230°C (Peak III) in the case of thermally treated specimen namely NaCl Tl(T). The TL-glow curves displayed by NaCl:Tl(T) specimens after exciting them to four different energies of incident beta radiation are exhibited in Figure 1B. The figure indicates that the growth of 230°C glow peak is more striking with increase in beta energy. Since 230°C glow peak in NaCl.Tl(T) phosphor appears at high temperature and grows systematically with increase in incident energy of beta-radiation, it is considered for beta dosimetry work.

Figure 2A shows the response of intensity of 230°C glow peak with different known incident doses of beta-radiation to NaCl:Tl(T) phosphor. It gives straight line supralinear relation between the incident beta energy and TL-output to peak III. The variation in TL-output at the peak III of the NaCl:Tl(T) phosphor has also been examined with different post-irradiation intervals starting from an hour to 10 days. The plot of TL-intensity of peak III versus post-irradiation interval is presented in Figure 2B. It shows minor variation of TL-output of 230°C peak with the increase in the room temperature post-irradiation decay time. This means the fading is negligible. This also promises substantial storage stability of the present NaCl Tl(T) phosphor.

DISCUSSION

Many organic and inorganic chemicals exhibit thermoluminescence. The extensive work on TL-dosimetry[1-3] brings out the fact that those TL-materials which satisfy the following general properties are useful for the fabrication of TL-dosimeters. The general properties are:

i) Simple trap distribution,
ii) high TL-efficiency,
iii) long storage stability of trapped charge carriers at normal working temperature,
iv) resistance against disturbing environmental factors such as light, humidity, radiation, etc.,
v) TL-spectrum of wavelengths in the wavelength region 300–500 nm in which the photodetector responds well and
vi) low-fading, reproducibility, low cost, easy availability.

Extensive experimental work has been done on the behaviour of TL-glow curve of NaCl Tl(T) phosphor after UV- and X-ray irradiation.[8,9] It is well established that a complex formed by a Tl^+ ion nearby a cation–anion vacancy pair (Tl^+—|+|−|) located in dislocation region of the host lattice is responsible for thermally induced TL. It is suggested that similar type of TL-centres are associated with 230°C glow peak exhibited by beta irradiated NaCl Tl(T) phosphor in the present work. The proposed mechanism for the TL around 230°C is as follows. The irradiation of the NaCl:Tl(T) phosphor at room temperature with beta-irradiation transfers the electron from a neighbouring Cl^- ion to the negative ion of the vacancy pair, one of the constituents of TL-centre. Thus, a hole situated on the Cl° atom gets trapped at the adjacent cation vacancy and the electron is captured at the anion vacancy of the pair. Warming the phosphor to 230°C, emission of low energy photons takes place through electron–hole recombination at the hole site. The excess energy, thus released excites the Tl^+ ion forming TL-centre for 230°C peak (peak III). The return of the excited Tl^+ ion to its ground state emits the characteristic emission of impurity ion (Tl^+). The Figure 3 shows the steps involved in TL of NaCl:Tl(T) phosphor around 230°C. It is very clear from the above discussion that present phosphor provides simple trap distribution with high concentration of trapping sites, which is the first property to be satisfied by an efficient dosimeter material.

The radiation damage produced due to beta irradiation will mainly involve production of ion vacancies either single or in aggregates. Because of volume considerations (ionic radii Na^+ 0.98 Å, Tl^+ 1.49 Å) the Tl^+ ions in solid solution in the interior of the lattice will prefer migration towards dislocation. The production of ion vacancies due to irradiation will thus be conducive to the formation of peak III centres. Such a process is supposed to continue till the beta radiation energy is raised to 10^4 R. Further increase in beta radiation is presumed to lead to the precipitation of the Tl as a separate phase at the dislocation sites which consequently will destroy the peak III centres. Thus the damage caused by the increase in the energy of the beta radiation places a limit on the performance of the phosphor as a dosimeter material.

Figure 1A indicates that NaCl:Tl(T) phosphor has substantial TL-output at peak III. On the other hand glow curves for different doses up to

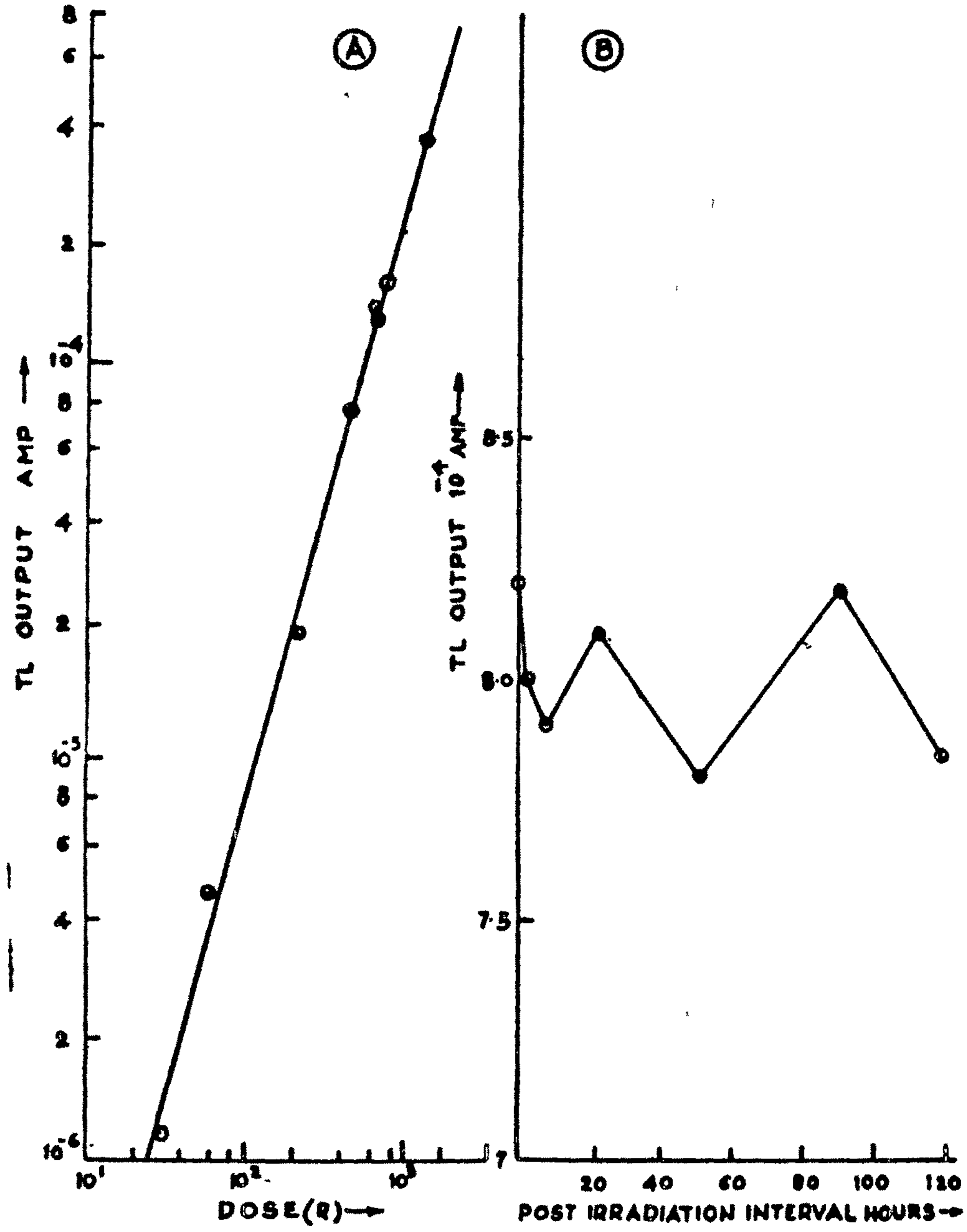

FIGURE 2 2A, TL output at 230°C of NaCl:Tl(T) (10^{-8} m.f.) as a function of incident beta dose (R). 2B, The TL decay of beta irradiated NaCl:Tl(T) (10^{-8} m.f.) phosphor stored at room temperature. Beta dose 700 R.

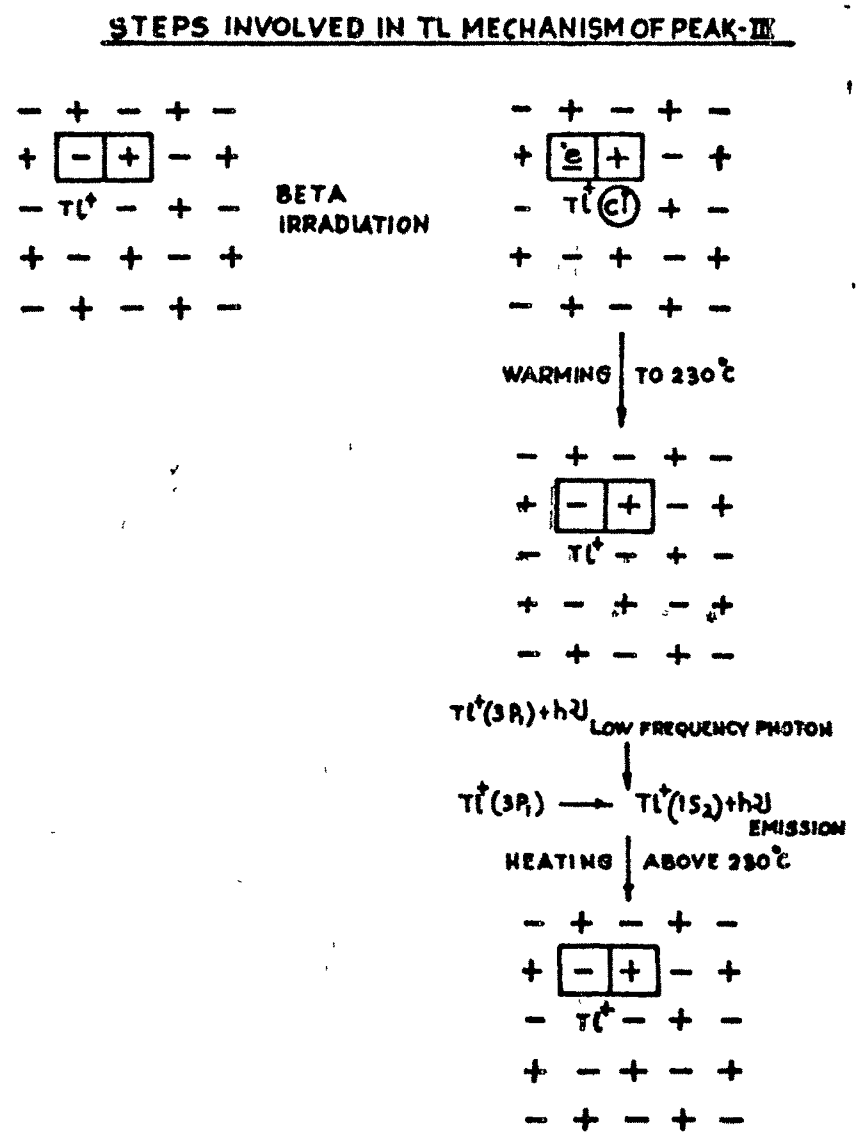

FIGURE 3 Steps involved in TL mechanism of peak III in the case of beta-irradiated NaCl:Tl(T) phosphor

10^4 R of beta-radiation have more or less identical stable characteristics (Figure 1B). Thus it is found that higher doses do not alter the glow peak position and shape. The temperature of glow peak III is also high. Therefore, it can be said that the requirement Nos. (ii), (iii) and (iv) listed above to be fulfilled by an efficient dosimeter material are fairly well satisfied by the NaCl:Tl(T) phosphor. As shown in the mechanism of TL for peak III (Figure 3), the TL-Emission around peak III results from the transition $Tl^+\ {}^3P_1 \rightarrow Tl^+\ {}^1S_0$. It has been reported earlier[9] that this emission lies in the wavelength region 300–500 nm. This is the region where the photodetector used in present work responds well, which fulfills the property No. (v).

The response of TL-output of peak III with different known incident energies of beta-radiation in the energy range 10–10^4 R is presented in Figure 2A. It shows straight line supralinear relation between the incident beta energy and TL intensity of peak III. The intensity of peak III as a function of storage time (in hours), Figure 2B, does not indicate significant change in the intensity of the glow peak III of NaCl:Tl(T) material. This indicates negligible fading. This also reduces the error in measurements of unknown doses, at the same time promises the large storage stability at normal working temperature (property No. (ii)). Thus supralinear TL-response, negligible fading along with additional properties like, reproducibility of glow curves; desirable shape and size of the phosphors, and very low cost of the material encourage the author to propose that NaCl:Tl(T) material can be used to fabricate the solid state dosimeters for beta-dose measurements in the range 10–10^4 R. Of course, in its use there are certain disadvantages mainly, atmospheric contamination which is quite serious. This can, however, be eliminated by shielding the phosphor from direct exposure to contaminating agents.

ACKNOWLEDGMENT

We are grateful to Dr. S. D Soman and Dr. C. M Sunta, Health Physics Division, Bhabha Atomic Research Centre, Bombay, India, for the encouragement and the experimental facilities provided for the present work One of us (TRJ) is indebted to the UGC, New Delhi, for the award of National Associateship.

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Journal of Luminescence 31 & 32 (1984) 142-144
North-Holland, Amsterdam

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EFFECT OF Ba^{2+} AND Ca^{2+} IMPURITIES ON THE THERMALLY STIMULATED LUMINESCENCE OF SODIUM CHLORIDE.

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Sodium Chloride specimens doped with Ba^{2+} and Ca^{2+} impurities were examined for their thermoluminescent behaviour after exposure to gamma radiation. Effect of variation in Ba concentration on NaCl:Ba for fixed irradiation dose (800R) and of change in the radiation dose on NaCl:Ca for fixed Ca concentration have been investigated.

1. INTRODUCTION

Recent experiments on thermally stimulated luminescence (TSL) of doped and undoped sodium chloride have revealed the wide application potential of these materials in detecting and estimating the dose of ionizing radiations [1,3]. The specimens used in the experiment were obtained by crystallization from aqueous solutions. They were subsequently annealed at 750°C for two hours and then rapidly air-quenched to room temperature. Such samples, designated as NaCl:Ba(T) and NaCl:Ca(T), have been reported to be suitable dosimeter materials[1,4].

2. EXPERIMENTAL

The experimental set-up and the procedure for recording the thermal glow curves have been described elsewhere[1]. The rate of heating used was 200°C/min. The sources of gamma radiation were ^{60}Co (10 mCi) and ^{226}Ra (9 mCi).

3. RESULTS

It is seen from Fig. 1 that change in Ba concentration gives rise to four peaks positioned at 90, 140, 180 and 220°C. Out of these peaks, the one at 220°C appears with highest intensity for optimum Ba concentration (10^{-2} m.f.). Fig. 2A presents the typical glow curves displayed by NaCl:Ca(T), with different doses.

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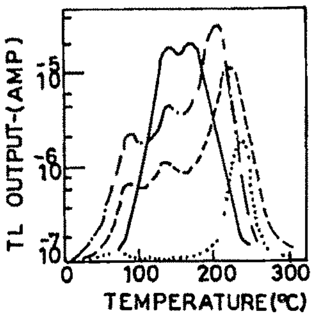

FIGURE 1

TL glow curves of NaCl: ....., NaCl:Ba(10^{-5}m.f.) _ _ _ _ _ _ , NaCl:Ba(10^{-2}m.f.) _ . _ . _ . and NaCl:Ba(10^{-1}m.f.) ______, gamma dose 800 R.

TSL response at 147°C as a function of ^{226}Ra - gamma exposure dose is shown in Figure 2B. It is clearly observed that the dominant peak at 147°C increases in intensity with the increase in gamma dose, other features of the curve remaining unaltered. The response of intensity varsus dose is observed to be linear.

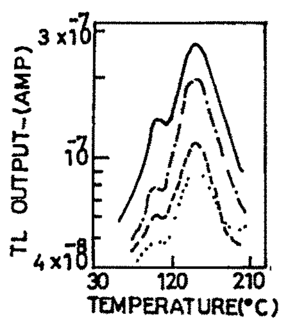

FIGURE 2A

Glow curves for NaCl:Ca(T) ^{226}Ra - gamma doses .... 500 mR, ------- 1 R, _ . _ . _ . _ . 2 R and ____________ 3 R.

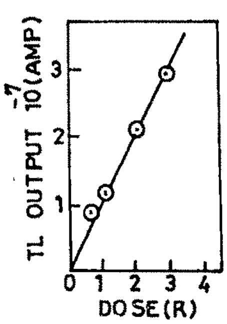

FIGURE 2B

TL - Dose response for 147°C peak.

4. DISCUSSION

The 220°C peak in Nacl:Ba(T) has been found to satisfy the basic dosimetric requirements. The centre associated with the peak is presumed to be impurity - vacancy dipole and its companion negative ion vacancy, the complex being situated in the dislocation region. This premise is based on the concept of charged dislocation in which the charge is presumed to be induced due to cloud of negative ion vacancies surrounding the dislocation. The shift in the peak position with variation in Ba concentration is attributed to the location of the dipoles at different lattice distances from dislocation.

As in NaCl:Ba, it is suggested that the Ca-dipole and its companion negative ion vacancy situated in the dislocation region is responsible for the origin of 147°C peak. The increase in dose is presumed to increase the number of radiation induced excited centres inherently present which in turn gives rise to enhancement in the intensity of the glow peak with the dose. The indentical nature of the glow curves for different low radiation doses confirms the resistance of the material to radiation damage. Considering linear response, high TSL - sensitivity, resistance to radiation damage, desirable shape and size of the phosphor, very low cost and excellent reproductability, the present material is obviously suitable in TSL - radiation dosimetry for the low energy dose range of 500 mR to 3 R.

5. CONCLUSIONS

It is concluded that the study of the thermoluminescent behaviour of divalent impurity doped NaCl as a function of impurity concentration and radiation dose reveal characteristics which are important from dosimetry aspect.

ACKNOWLEDGEMENT

The authors are thankful to the Health Physics Division. BARC, Bombay, India for the experimental facilities provided in the course of the present work. One of us (OHM) is thankful to the M.S. University of Baroda for the grant of research fellowship.

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Health Physics Vol 00 No 00000, pp 000–000 1986
Printed in the U S A

0017-9078/86 $3 00 + 00

Pergamon Press Ltd

1986

EFFECT OF VARIABLE DOSES OF ULTRAVIOLET RADIATION (253.7 nm) ON THERMOLUMINESCENCE NaCl:Ca(T) MATERIAL

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(*Received* 14 *February* 1985; *accepted* 3 *August* 1985)

Abstract—This paper studies the thermoluminescence (TL) glow curves of NaCl:Ca(T) phosphors to various doses of 253 7-nm ultraviolet (UV) radiation at room temperature. TLD grade NaCl:Ca(T) material was obtained by crystallization from solution and was subsequently annealed at 750°C for 2 h, followed by sudden quenching We undertook measurement of the effect of variable UV radiation doses (10^2 to 10^6 J m^{-2}) on the TL behaviour of NaCl:Ca(T) phosphors. It was observed that the phosphor exhibits a dominant peak around 167°C along with a weak peak at lower temperature. The high-temperature peak (Peak II) is found to grow linearly with the increase in UV dose in the range of 10^2 to 10^6 J m^{-2}. Since the nature of the glow curves under the influence of different doses remains more or less identical, it is believed that the phosphor does not undergo radiation damage and displays high intrinsic TL around Peak II. Examination of the system for fundamental dosimetry requirements shows that it can be used in dosimetry work at 253.7 nm

INTRODUCTION

THE EXACT assessment of the radiant exposure of UV radiation has grown in importance due to increased use of UV radiations in medical and other fields. Detailed studies are also important in assessing effects of these radiations on the skin and eyes of professional workers. Therefore, researchers are actively engaged in exploring techniques and instruments for estimating UV radiation exposure. The current practice is to use the TL technique in UV radiation dosimetry. However TL phosphors usually used in estimating γ, β, neutron and x-ray doses were found unsuitable for UV dosimetry, because of their poor intrinsic TL sensitivity. However several TL phosphors, such as LiF:Mg:Ti, $CaSO_4$:Tm and natural CaF_2, have been made sensitive to UV radiation with pre-irradiation to high γ doses and/or partial annealing (Su76; Na71; Su70). The preparation of TLD material and the mechanism of TL emission are complex and time-consuming which limits the wide use of such phosphors in solid-state dosimetry. Recently a few TL phosphors with high intrinsic TL sensitivity and direct response to UV stimulation have been reported (Dh76; Ba76; Me78; La79) thereby making the TLD (UV) simple and practicable. The present paper deals with the study of (1) the UV-induced TL in NaCl. Ca material, (2) the effect of varying UV radiation doses on the TL of the phosphor, and (3) to assess its suitability as a possible UV dosimetry material at 253.7 nm

EXPERIMENTAL PROCEDURES

The powder specimens of Ca-doped NaCl (10^{-3} molar fraction) were obtained by recrystallization from aqueous solutions The specimens were annealed at different temperatures, 550 and 750°C, in air for 2 h each in a silica boat and subsequently quenched to room temperature The microcrystalline TLD-grade powder of mesh size ⟨80⟩ 120 was then collected. The TLD-

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grade material quenched from 750°C was designated as NaCl:Ca(T). A quantity of 20 mg was spread uniformly on a kanthal plate. The specimen was excited by using the standard UV wavelength (253.7 nm) from a Jerall-Ash-Mercury lamp† kept at a distance of 3.0 cm. The output of 253.7 nm at this distance was around 100 J m^{-2} s^{-1}. No external filter was used during irradiation. Ultraviolet doses in the range 10^2 to 10^6 J m^{-2} were used by varying the time of exposure from 2.5 s to 8 min The TL glow curves of UV-irradiated NaCl:Ca(T) phosphors were recorded by the TL reader (Jo78). The heating rate for the present work was 180°C min^{-1}.

RESULTS

Figure 1 shows the TL glow curves of untreated and thermally treated NaCl.Ca specimens after a test dose of 2.4 × 10^4 J m^{-2} at room temperature. It is observed in Fig. 1 that NaCl:Ca(T) phosphor displays a well-defined peak around 167°C (Peak II) along with a weaker peak at a lower temperature. This indicates the high sensitivity of the phosphor to UV radiation.

The TL curves exhibited by NaCl.Ca(T) for five different doses of UV irradiation in the range 10^2–10^4 J m^{-2} are shown in Fig 2(A). It can be observed that (1) Peak II grows with the increase in magnitude of the UV dose, and (2) its position as well as shape remain unaltered Figure 2(B) exhibits the intrinsic TL sensitivity of Peak II as a function of UV dose. The response is linear for the dose range of 10^2 to 10^4 J m^{-2} Figures 3(A) and 3(B) demonstrate the TL glow curves of five different UV doses in the range of 10^3 to 10^5 J m^{-2} and the TL response of Peak II to the UV dose, respectively. It is observed that the TL response is linear even in this high dose range. The overall TL response of Peak II in the dose range 10^2 to 10^6 can be seen in Fig. 4 The response is linear up to 4 × 10^3 J m^{-2} and is supralinear beyond.

The thermal glow curves of the specimen were also recorded under identical experimental conditions after exposing them to γ doses from a ^{226}Ra source. The TL glow curves after the 1-R γ dose and those after the UV dose of 6 × 10^3 J m^{-2} are identical in intensity and in shape but for the slight differences in peak temperatures (Fig. 5A). Figure 5(B) exhibits the TL decay for Peak II of the UV-irradiated NaCl:Ca(T) test dose of 2.4 × 10^3 J m^{-2} stored at room temperature. Obviously, no anomalous fading has been observed. The material was protected from light during the storage. The present study applies only to 253 7 nm and the relative sensitivity as a function of wavelength has not been investigated.

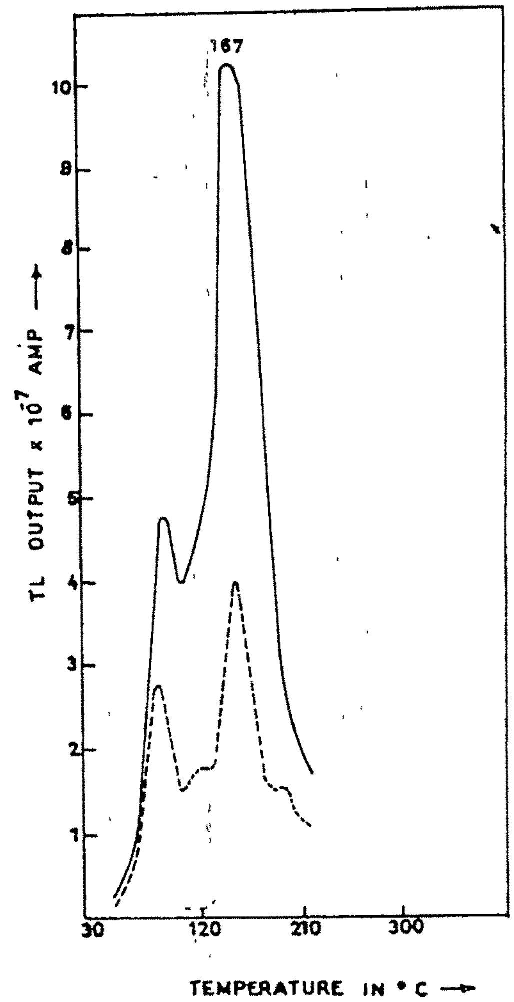

FIG 1. Typical TL glow curves of untreated NaCl·Ca (UV dose· 2 4 × 10^4 J m^{-2}) (· · · · ·): typical glow curve of 550°C-quenched NaCl:Ca (-----); and typical glow curve at 750°C-quenched NaCl.Ca(T) (——).

† Jerrall Ash Model 45-544, 10 W, 253 7 (85%). Jerrall Ash Co., 596 Lincoln St. Waltham, MA.

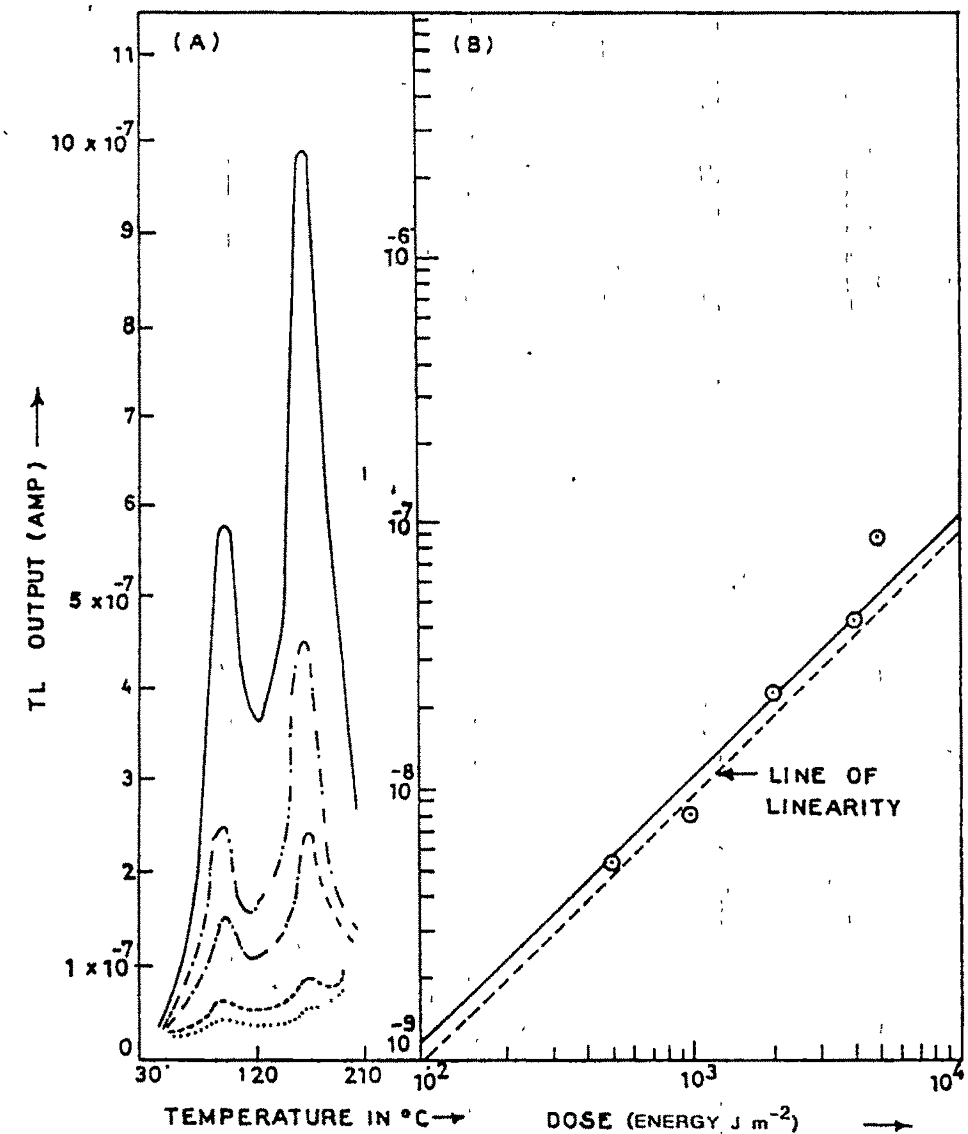

FIG. 2. (A) Typical TL glow curves for different low doses of UV for NaCl.Ca(T) (10^{-3} molar fraction): for 5×10^2 J m^{-2} (• • • • •); for 10×10^2 J m^{-2} (-----), for 20×10^2 J m^{-2} (–•–•–•–•), for 40×10^2 J m^{-2} (–• •–• •–• •–); and for 50×10^2 J m^{-2} (——). (B) TL output at Peak II of NaCl:Ca(T) as a function of incident UV dose (J m^{-2}).

DISCUSSION

The use of intrinsic TL in the field of UV dosimetry is a recent development. The basic considerations of an efficient TLD material in UV dosimetry, like those in γ, β and other ionizing radiation dosimetries, have been suggested by earlier investigators (La79; Vo79; Jo83). The direct response to UV radiations and high intrinsic TL efficiency are essentially the fundamental requirements to be satisfied. The glow curves observed for untreated, 550°C-quenched and NaCl: Ca(T) (Fig. 1) illustrate the fact that the TL glow

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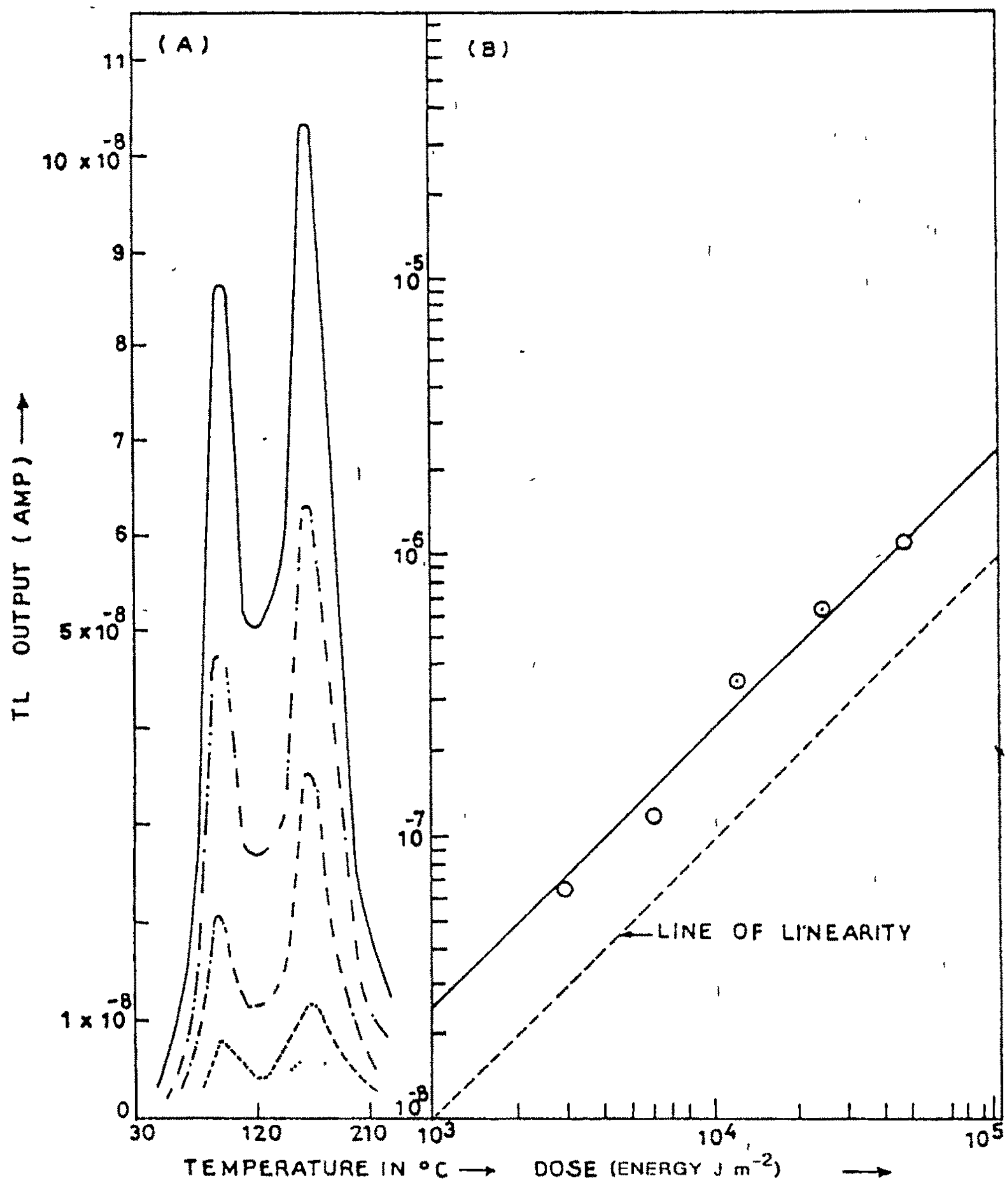

FIG. 3. (A) Typical TL glow curves for different high doses of UV for NaCl.Ca(T) (10^{-3} molar fraction) for 3×10^3 J m^{-2} (· · · · ·) for 6×10^3 J m^{-2} (-----); for 12×10^4 J m^{-2} (–·–·–·–) for 24×10^4 J m^{-2} (–··–··–··–); for 48×10^4 J m^{-2} (——). (B) TL output at Peak II of NaCl Ca(T) as a function of incident UV dose (J m^{-2})

curves result from direct interaction of UV radiation with the phosphor. Furthermore, NaCl Ca(T) material shows a prominent glow peak at 167°C (Peak II) These features show that the above-mentioned basic conditions are fulfilled by the present phosphor Peak I is not considered for dosimetry purposes due to its occurrence at lower temperature, and variation in its position

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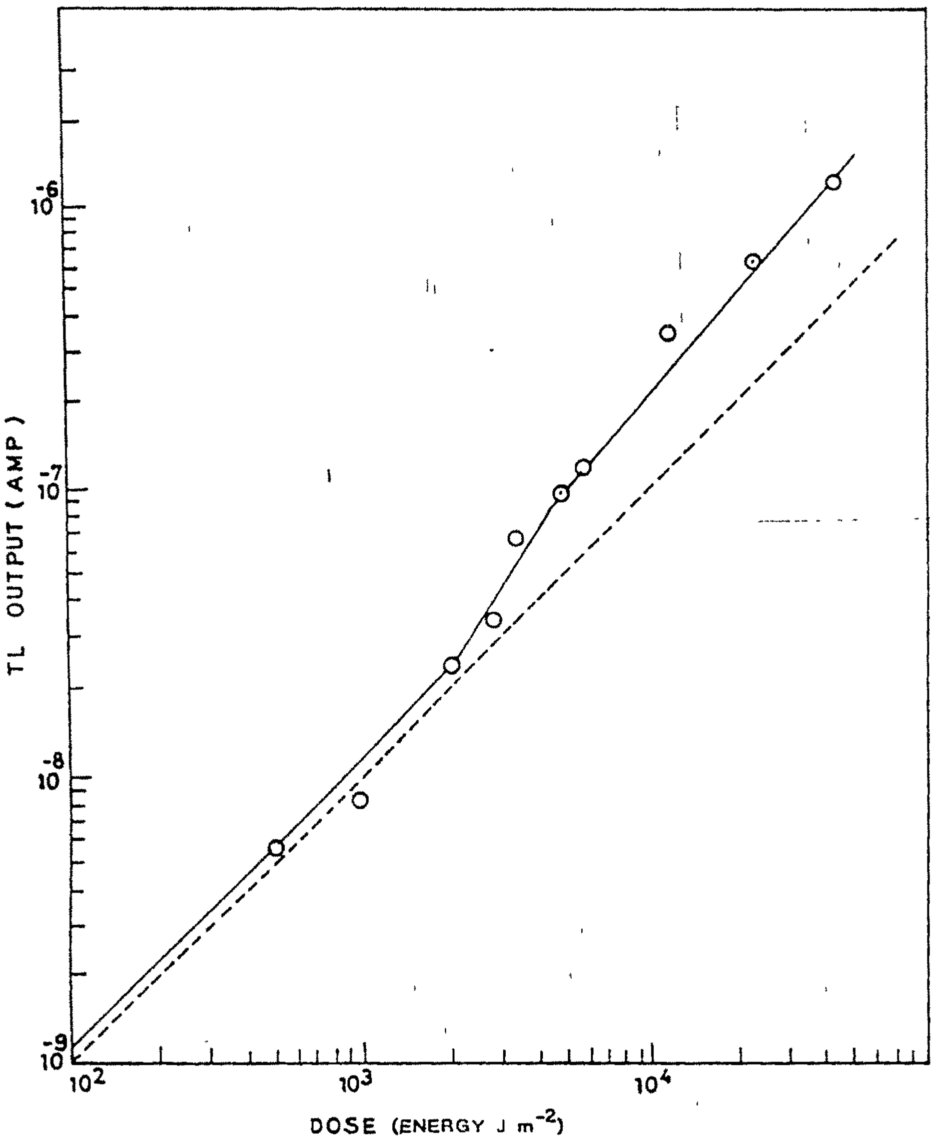

FIG. 4 TL yield of NaCl;Ca(T) as a function of UV dose (J m^{-2})

and intensity under normal changes in climate and/or room temperature.

From the consideration of charge compensation, it is generally accepted that in divalent impurity-doped alkali halides a large fraction of the impurity ions in solid solution is used up in the formation of impurity-vacancy dipoles. Such dipoles are presumed to exist in the crystal along with other crystalline defects such as positive and negative ion vacancies, dislocation, etc. It is proposed that in NaCl:Ca(T) the centre responsible for Peak II is a complex formed by the association of a dipole with a negative ion vacancy in the dislocation region. Because of thermal quenching, these centres in NaCl·Ca(T) are expected to be more numerous High concentration of these

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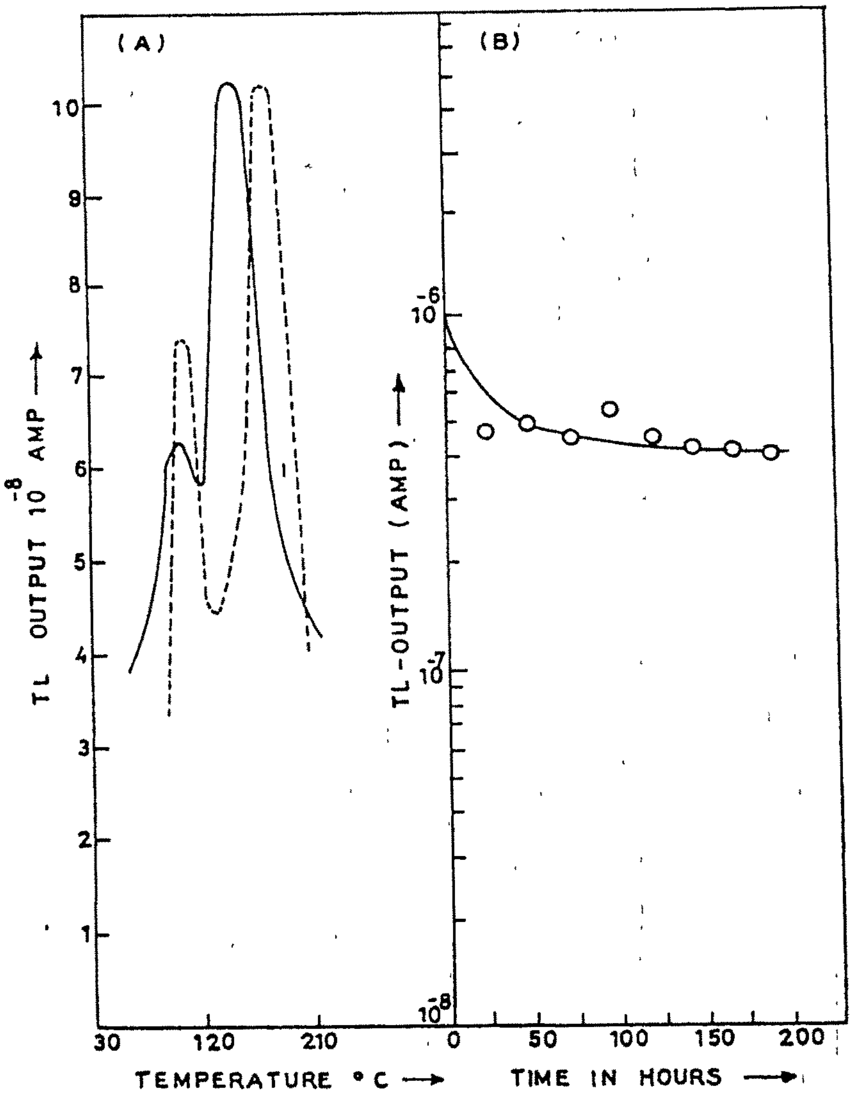

FIG 5. (A) Typical glow curves of NaCl:Ca(T): 1-R γ dose (——) and UV dose (-----) (6×10^3 J m^{-2}). (B) TL decay of UV-irradiated NaCl:Ca(T) phosphor stored at room temperature in darkness (test dose: 2.4×10^4 J m^{-2}).

centres, leading to enhanced TL output, satisfies one of the most important requirements of an efficient TLD material.

It is proposed that the TL mechanism in UV-irradiated NaCl:Ca(T) is different from that obtained after γ irradiation of the phosphors (Jo83). Ultraviolet radiation is incapable of producing electron-hole pairs directly since the energy required (~12 eV) is much higher than the energy of the incident UV radiation (5–6 eV). The TL exhibited by NaCl:Ca(T) (Fig. 1) possibly results from the removal of the bound electron from its parent activator ion due to multiple excitation by UV radiation. The liberated electron can get trapped at the nearby negative ion vacancy in the proposed complex centre. Warming the specimen to the temperature of Peak II releases the electron from its trap. The released electron returns to its parent activator ion in which process it first drops to the emission level of the activator and finally returns to the ground state with TL emission. The TL emission spectra of γ-irradiated NaCl: Ca(T) (Jo83) have revealed the fact that the TL emission in the temperature region 130–170°C is 375 nm, the characteristic emission of Ca^{++}. It can therefore be presumed that in the present case, the TL emission at Peak II (167°C) is around 375 nm which falls in the sensitive region of the photomultiplier (300–500 nm) used in the above measurements.

The occurrence of Peak II at higher temperature above 150°C with substantial TL output under UV irradiation (Fig. 1) suggests that the traps involved in the generation of Peak II are single valued, large in number and deep. Under such conditions, the UV radiation exposure once registered will not be lost under normal working temperature, i.e. the storage stability is high. The high intensity of Peak II also promises significant intrinsic TL efficiency.

Figures 2(A) and 3(A) show the systematic growth of TL intensity of NaCl.Ca(T) for UV doses in the ranges 10^2 to 10^4 and 10^3 to 10^5 J m^{-2}, respectively. The TL sensitivity of Peak II versus the UV dose (J m^{-2}) is linear in both high- and low-dose ranges (Figs. 2B and 3B). The overall TL response is linear up to 3×10^5 J m^{-2} (Fig. 4). Since the nature of the glow curves under the influence of different UV radiant exposure remains identical, it is suggested that the material does not undergo radiation damage and also exhibits the high intrinsic TL around Peak II.

The room-temperature fading of TL output at Peak II is negligible even after the post-irradiation period of 1 wk (Fig. 5B). The typical TL glow curves of NaCl.Ca(T) after irradiation with UV (6×10^3 J m^{-2}) and 1-R γ radiation recorded under the same EHT setting of the reader (Fig 5A) clearly shows that the TL sensitivities for γ and UV radiation are more or less identical This indicates that proper calibration will definitely help to express the UV sensitivity of NaCl:Ca(T) in an equivalent gamma dose (R)

Examination of the different phosphor characteristics suggests that it fulfills the requirements of a good TLD material, such as simple trap distribution, deep traps, high intrinsic TL efficiency, matching of TL emission wavelength from the phosphor with sensitive region of the detector, large measurable dose range and low fading. Additionally, reproducibility, easy availability at low cost, desired size and shape, ease of handling and reusability of the specimen leads one to believe that the NaCl:Ca(T) promises to be a well-suited system for use in UV dosimetry at 253.7 nm. Furthermore, the main drawback of the system, namely its high hygroscopy, can easily be eliminated by preventing atmospheric contact by using transparent PVC bags for sealing.

Acknowledgment—We are thankful to Shri S. D. Soman, Dr. C M Sunta and Dr K. S. V. Nambi of the Health Physics Division, Bhabha Atomic Research Centre, Bombay, India, for encouragement and for providing the experimental facilities Financial assistance from the Council of Scientific and Industrial Research, New Delhi is also gratefully acknowledged

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Changchun,April 18, 1987

Dear Colleague,

On behalf of the ICL-87 Programme Committee, it is a great pleasure to inform you that your paper titled:

Tribothermoluminescence of NaCl:Ca (T)

has been accepted. All accepted papers will be asked to present as posters. You or one of the co-authors of this paper are invited to present it during the poster session. In case none of the authors will be able to participate we regret that we are probably unable to publish your contribution in the proceedings.

You will find the detailed information for your presentation and an instruction how to prepare slides(for oral) and posters in the coming advanced programme very soon.

Looking forward to seeing you in Beijing.

Sincerely yours

Xu Xurong

Professor XU Xurong
Chairman of ICL-87

TOPICS-3,11,12

TRIBOTHERMOLUMINESCENCE OF NaCl:Ca (T)

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A B S T R A C T

Previously reported NaCl:Ca dosimetry material [Joshi etal, Health Physics, 1983] is discussed for its spurious thermoluminescence (TL). The spurious TL is shown to have no influence on UV dosimetry measurements.

TRIBOTHERMOLUMINESCENCE IN NaCl:Ca(T)

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The NaCl:Ca(10^{-3} mf) annealed and air-quenched from 750°C [NaCl:Ca(T)] has been reported to be suitable powdered dosimetric material for ionizing radiations[1]. The present work concerns with the understanding of the spurious TL (Tribothermoluminescence) exhibited by this material. The spurious TL can cause a serious error in the evaluation of low doses.

It is observed that NaCl(T) and NaCl:Ca(T) display a glow peak around 340°C without irradiation. UV irradiated NaCl:Ca(T) shows peak at 167°C alongwith peaks at 90 and 340°C. The peak at 340°C in both the phosphors disappears after the completion of the first thermal cycle. This peak is not observable in γ-irradiated specimens.

Compression, grinding, rapid crystallization and mechanical disturbances caused during stirring and spreading of the phosphor have been reported to excite the TL centres[2]. It is proposed that during heating of the specimen for the record of TL, around 300°C the atmospheric oxygen begins, interacting with the surface ions, thereby forming new recombination sites for the released electrons and holes. This results in spurious TL glow peak at 340°C. Due to the thermal release of trapped charges and recombination during first thermal cycle, no spurious TL is observed in the subsequent heating runs. The higher intensity of spurious glow peak in NaCl:Ca(T) than in NaCl(T) may be related to the distortion produced in the lattice by the incorporation of the impurity.

The non-occurrence of this peak in gamma irradiated specimens is obviously due to overshadowing of 340°C peak by dominant peak at 147°C. Previous experiments suggest that there is no marked change in the behaviour of 340°C peak on subjecting the specimen to the radiation doses differing in magnitude.

Since the UV-dosimetry peak temperature (167°C) is away on the temperature scale from the spurious TL glow peak temperature (340°C), spurious TL does not limit the use of NaCl:Ca(T) for UV and other low level radiation dosimetry.

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