Chapter 5

The Sensitivity of Commercial TLD to UV Radiation

5.1 Introduction

The possibility to use commercial TLDs in detection of UV radiation was investigated previously by a lot of scientist.

The earliest report about the effect of UV radiation on $CaSO_4$:Mn was studied by Wiederman (Vij, 1993). Bassi (1975) showed high intrinsic TL of CaF_2:Dy to UV light after it being treated at high temperature. Recently, Oster (1994) and Potiens (1996) suggested to use AL_2O_3 and $CaSO_4$:Dy in UV dosimetry.

Pradhan (1996) showed that AL_2O_3:C is the most sensitive TL material to UV and ionizing radiation and visible light does not cause intrinsic TL.

5.2 Sensitivity to UV lamp

The commercial TLDs were exposed to UV light (200-400 nm) at 8 cm without any filter.

Their sensitivity can be classified to three groups. The first group includes TLD-400 that is not sensitive to UV radiation. It was exposed to UV radiation for more than 60 minutes. No clear glow peak was found. In addition, the reading of TL intensity was near the background as shown in figure (5.1, C).

The second group includes TLD-200 and TLD-900. These materials are sensitive to UV radiation. They have a linear response to exposure time of UV radiation. The variation of TL intensity against exposure time was by the factor 0.33 for TLD-200 and 7 for TLD-900 as shown in figure (5.1, B and F).

The third group includes TLD-100H, TLD-500 and TLD-700H. These materials are very sensitive to UV radiation. TLD-100H and TLD-700H have a linear response until 5 minute of exposure time to UV radiation and the change in TL intensity was small after that time as shown in figure (5.1, A and E). TLD-500 is the most sensitive one to UV radiation. The high TL intensity was observed after 1 second of exposure time to UV light (Oster 1994), and it saturates at ~ 100 J/m^2 of UV dose (Al_2O_3:Si,Ti, Vij 1993) as shown in figure (4.11, D).

TLD-900 is the most sensitive one to UV radiation. It has a linear response to UV radiation similar to that measured by a UV meter. The range of linearity was found to be between (864 – 28,512 J/m^2), the phosphor behaves superlinearly up to 50,000 J/m^2 (Vij 1993).

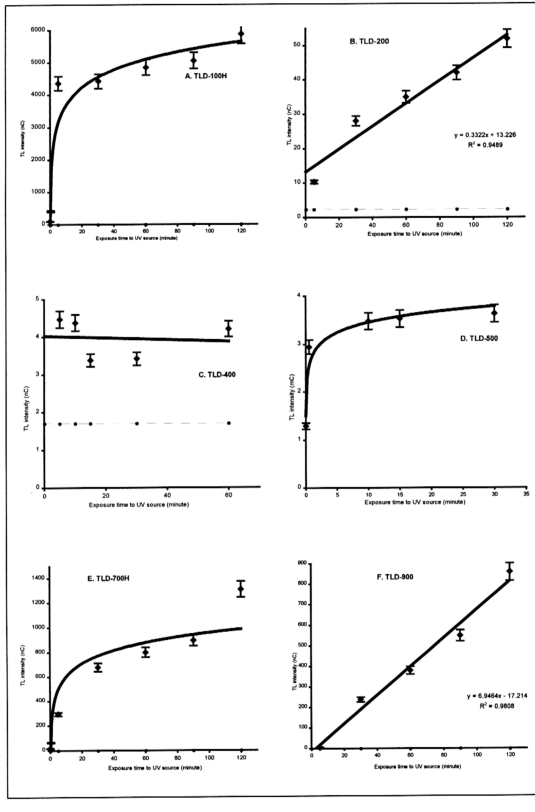

Figure (5.1): The Sensitivity of commercial TLD to UVR

5.3 Sensitivity to the sunlight

TLD-100H, TLD-700H and TLD-500 showed a very small response to the sunlight as shown in figure (5.2, A and C). It is possible that the TL intensity of these materials can be removed by the long time exposure to the visible light, which can release the trapped electrons caused by UV radiation. See section (5.5) for the effect of light on TL intensity.

TLD-200 showed a linear response and small change in the TL intensity with exposure time to sunlight, figure (5.2, B). Its response was different from that of the UV meter (UM-25), being less at long exposure times.

TLD-900 has a linear response with exposure time to the sunlight, but its sensitivity is less than TLD-500 and TLD-200. It has sensitivity to sunlight that is similar to the response of UV meter (UM-25) as shown in figure (5.2, D).

5.4 Glow curve

The glow curve for TLD-500 shows an identical dosimeteric glow peak when they were exposed to UV lamp and sunlight. The same result was found with TLD-900. On the other hand, TLD-200 shows different result as showing in the following sections.

5.4.1 UV lamp

TLD-100H, TLD-500 and TLD-700H show a dominant glow peak at 143, 287 (Oster 1994) and 140 ^{o}C respectively as shown in figure (5.3, A and C).

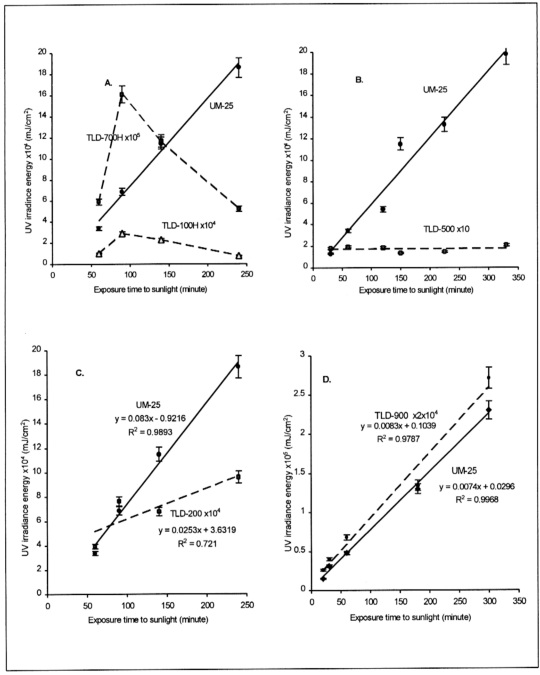

Figure (5.2): The sensitivity of commercial TLD to the sunlight

TLD-200 and TLD-900 show a shoulder and a peak, The peaks were at 220 and 305 °C for TLD-200 (Bassi 1975) and 195 and 290 °C for TLD-900 (Chandra 1976) as shown in figure (5.3, B and D). It was observed that the shoulder in the glow curve of TLD-900 could be removed by exposing it to visible light or after storage in the dark at room temperature for 24 hours. The shoulder of TLD-200 is stable at room temperature and does not affect by the visible light. This shoulder can be removed by annealing TLD-200 at 190 °C for 10 minutes.

The glow curve for TLD-200 and TLD-500 (Oster 1994) show a glow peak at low temperatures (~100 °C) after direct exposure to UV lamp. This glow peak is not stable at room temperature, and it fades very fast during first few minutes for TLD-500 and after 24 hours for TLD-200.

The glow peaks at high temperatures for TLD-200, TLD-500 and TLD-900 are stable at room temperature. The TL intensity of these glow peaks show an increase in the reading with exposure time to UV lamp.

5.4.2 Sunlight

No clear glow curve was found when TLD-100H and TLD-700H have been exposed to sunlight. The glow curve for TLD-500 and TLD-900 show one glow peak at high temperature. The location of the glow peaks is identical of that when they were exposed to UV lamp as shown in figure (5.3, C and D). TLD-200 show one glow peak at ~200 °C which is the location of the shoulder as shown in figure (5.3, B). It was observed that this glow peak is not sensitive to visible light, and it is similar to the glow curve when exposed to gamma rays (Bassi 1975).

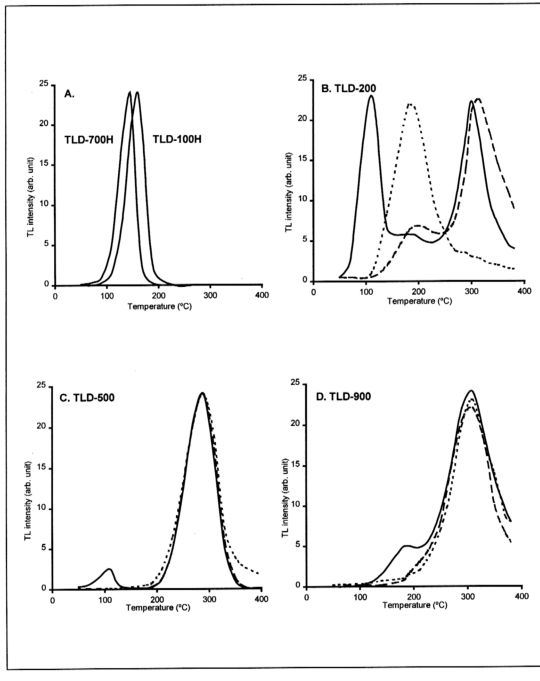

Figure (5.3): The glow curve for Commercial TLD, (———) Directly after exposure to UV lamp, (– – – –) After 24 h of exposure to UV lamp and (- - - - - -) After 24 h of exposure to sunlight.

It is possible that the glow peak at high temperature could be sensitive to wavelength < 290 nm which give us an explanation the absence of this peak in the glow curve when expose to the sunlight.

5.5 Effect of the light on TL intensity

The light can also cause severe fading in TL intensity for commercial TLDs as in $Ln_2O_3:RE^{3+}$ phosphors.

The dosimetry glow peak for TLD-100H, TLD-700H and TLD-500 (Pradhan 1996) can be affected severely by visible light. It can remove totally the TL intensity after exposure to sunlight or 100W bulb for 30 minute as shown in figure (5.4).

For TLD-200 and TLD-900 , ~20% of the TL intensity of the dosimetry glow peak can be removed after 30 minute of exposure to 100W bulb, and more than 60% after 30 minutes of exposure to sunlight. TL intensity becomes approximately stable after 30 minutes of exposure to UV light, where the visible light would no longer affect the TL intensity. The high light fading when exposed to sunlight could be due to the high intensity of visible light in sunlight compared with 100W bulb.

5.6 Stability of TL intensity at room temperature

Most of the glow peaks at high temperatures showed low fading. The high fading is mostly due to the non-stability of the glow peaks at low temperature.

Although TLD-100H and TLD-700H are highly sensitive to UV radiation, their glow peaks are not stable at room temperature.

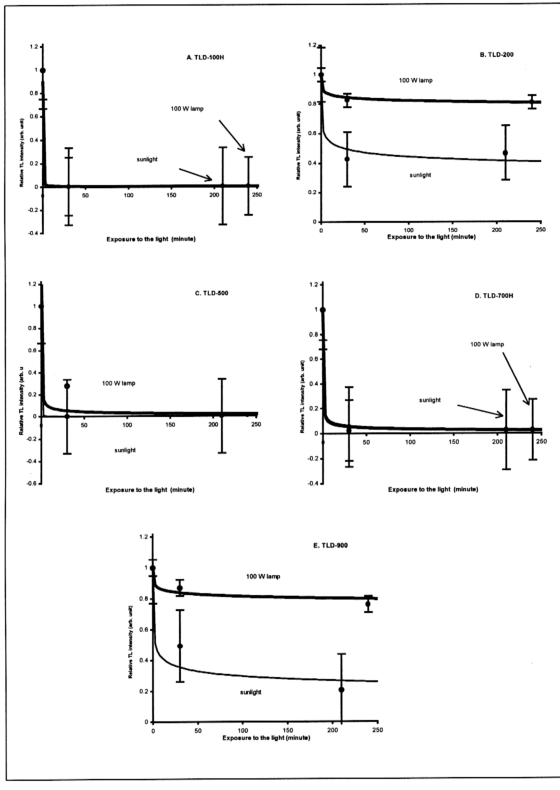

Figure (5.4): The light fading of commercial TLD

After 24 hours of storage time, most of the TL intensity was removed and it approximately reached the background reading as shown in figure (5.5), which means that the trapped electrons are not stable in the dark at room temperature.

For TLD-900, the first glow peak is slightly stable at room temperature during the first 24 hour after exposure to UV lamp. The second peak lost ~ 30% of its intensity after two days as shown in figure (5.5). The 40% thermal fading of TLD-900 in figure (5.5) include 10% of the total fading for the shoulder.

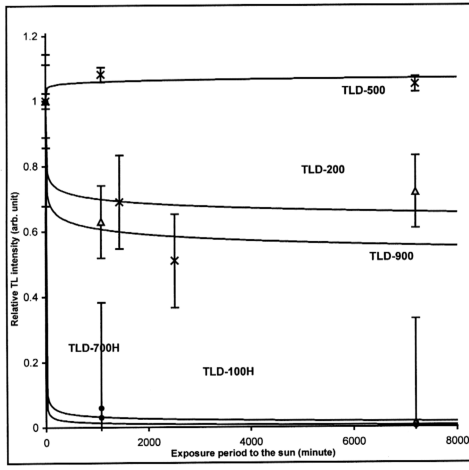

Figure (5.5): The thermal fading for commercial TLD

For TLD-200, the first peak is not stable at room temperature and disappears after 24 hour while the shoulder and the peak at high temperature are approximately stable at room temperature. Bassi (1976) found that the thermal fading for TLD-200 was ~50%.

No thermal fading has been observed for TLD-500. TL intensity is stable at room temperature. Among the TLD materials investigated, TLD-500 showed negligible thermal fading.

5.7 Reproducibility chart

The reproducibility chart in figure (5.6) shows the stability in the reading of the most sensitive TL materials to UV light and sunlight. The TL materials have been exposed to the UV light for the same exposure time for separate days and the deviation in the readings was < 10% of the average. The stability in the intrinsic response of this material to UV radiation can give us an indication about the possibility to use them many times in the detection of UV radiation.

5.8 Conclusion

The intrinsic sensitivity of these TLD materials to solar UV radiation is considerably weak due to the high light fading. TLD-500 is the most sensitive one to UV radiation, but the light can cause severe TL fading. TLD-200 and TLD-900 have a linear intrinsic response to solar UV radiation. Their glow peaks at high temperature are sensitive to UV radiation and stable in the dark at room temperature. These two TLD materials are the most suitable in solar UV dosimetry.

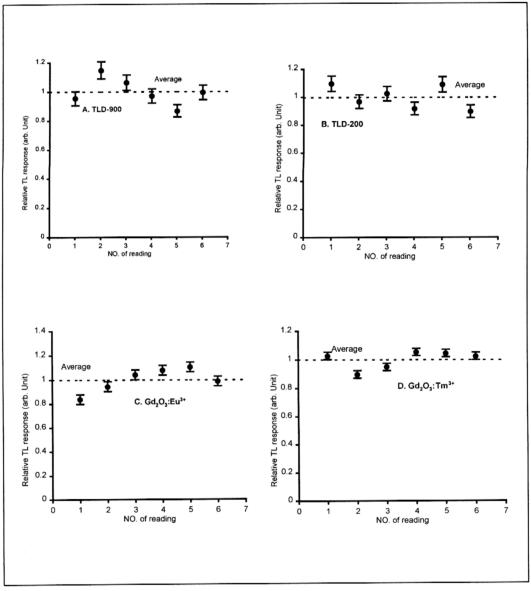

Figure (5.6): The reproducibility chart of TL materials