(19) POSSIBILITY OF OBSERVATION OF ULTRAVIOLET RAYS VOLUME BY TLD - IN CONNECTION WITH FORMATION OF OZONE HOLE

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ABSTRACT; In order to observe and evaluate easily the ultraviolet rays volume brought about by the formation of ozone holes, this paper aims at examining a possibility of observation of the ultraviolet rays volume included in the sunlight, using TLD and centering on the relationship between the exposure time and TL glow peak intensity. The contents are as follows: (1) Both principle of measurement and dosimeter with respect to ultraviolet rays volume are outlined, and the TLD used in the present experiment is mentioned. (2) With respect to measurement of the ultraviolet rays volume, TL glow curves after irradiating ultraviolet rays are considered. (3) Experimental procedure, result and examination are mentioned, and possibility of observation of the ultraviolet rays volume is confirmed.

KEY WORDS; ultraviolet rays, TLD(Thermoluminescence dosimeter), ozonosphere(ozone hole), life style

1. Introduction

As one of the global environmental problems, destruction of the ozonosphere (formation of ozone holes) has recently been noticed internationally. The increase of the ozone holes brings about the increase of the volume of the ultraviolet rays(UV-rays) pouring on the surface of the earth. It is said that the increase of the volume has a bad influence on cells and genes of life, and also becomes a factor which brings about the increase of cutaneous cancer. Therefore, at present a counterplan must be taken in a great hurry.

In Japan, from April, 1993, the Meteorological Agency is going to observe seriously the ultraviolet rays volume included in sunlight, using improved observation apparatus.

If it is possible to observe and evaluate the volume brought about by the formation of the ozone holes by a simple method, this will become a familiar problem. Therefore, if citizens can easily use a TLD(Thermoluminescence Dosimeter) as a means of environmental recognition, this will become one of the big incentives for people to change their life style.

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In the present paper, in order to observe and evaluate easily the UV-rays volume brought about by the formation of the ozone holes, we made TLD in pellet by doping CaF_2 with the impurities[1)2)]. And then after exposing the TLD directly to the sunlight without any filter etc., we tried to measure the TL(Thermoluminescence). Indeed, we can measure the TL. We report here the possibility of observation of the UV-rays volume included in the sunlight, using TLD and centering on the relationship between the exposure time and TL glow peak intensity.

2. Principle of measurement and dosimeter with respect to ultraviolet rays volume

In general, radiation is divided into two kinds of rays, that is, a charged particle rays (α, β rays etc.) and electromagnetic waves (X, γ rays). Its fundamental characteristics is to ionize materials(ioning radiation). In this paper, in order to examine the relationship between the UV-rays volume and the ozone holes, we pay attention to X rays(γ rays) in the radiation mentioned above, and then take up UV-rays which is longer than X rays in wavelength. At present, facilities where radiation is used, for example, nuclear power plants, the film dosimeter is used for measuring a volume for personal dosimetry. One of the dosimeters for that purpose is the TLD. This time we tried the measurement of ultraviolet rays using the TLD.

Fig. 1 shows the principle of TL phenomenon[1)2)]. First, by irradiating radiation (X, or UV-rays), impurity ions trap electron or hole, and by the trap irradiation volume is memorized. And, by recombination of electron(or hole) trapped by impurities and hole(or electron), emission peculiar to impurity ion appears.

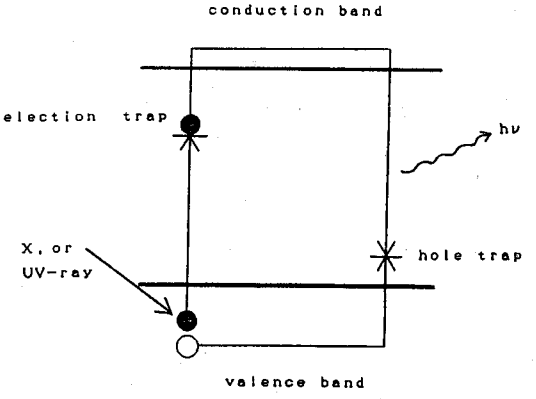

Fig 1. Principle of TL phenomenon.

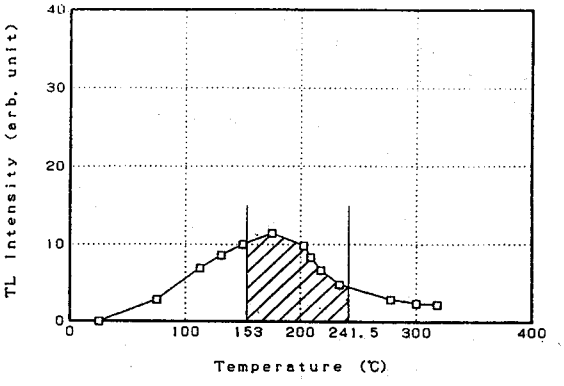

Fig 2. Dose measurement of the sunlight.

3. Measurement of ultraviolet rays volume

This time we made the sintered CaF_2 with Tb ion as impurities, and used it as a TLD device. Fig. 2 shows an example of glow curve. The area written with a slant line is in proportion to doses of Tb. The number of the reaction shown by the equation (1) below where Tb^{3} ion, the luminous center, turns into Tb^{4} ion by the simulation of UV-rays.

$$Tb^{3} \xrightarrow[\text{irradiated}]{\quad\quad} Tb^{4} \qquad (1)$$

The following equation (2) is got by heating Tb^{4} .

$$Tb^{4} + \text{electron} \xrightarrow[\text{heated}]{\quad} Tb^{3}{}^{*} \longrightarrow Tb^{3} + h\nu\ (545nm) \qquad (2)$$

As is seen in Fig. 3 (the relationship between the temperature and TL intensity), after irradiating the UV-rays (low pressure Hg-lamp) to the sintered CaF_2: Tb, the observed TL glow curve has a peak which is observed in the vicinity of 100 ℃ and 175 ℃. However, the TL peak in the low temperature side(100 ℃) may fade by such kinds of heat as room temperature and sunlight. Therefore, we have to be careful about the treatment of data. Consequently, we need to consider the other TL peak in the vicinity of 175 ℃, which is not influenced by those kinds of heat. If we take the TL in the vicinity of 175 ℃ the value is propotional to the UV-rays volume. The proper area of TL glow curve having the peak in the vicinity of 175 ℃ is taken to range from 153 ℃ ~ 242 ℃ for the present. And then by the radiation of Hg-lamp(13.5 W of low pressure Hg-lamp), we examined the relationship between the area and UV-rays volume. As a result, it is confirmed that this range is appropriate.

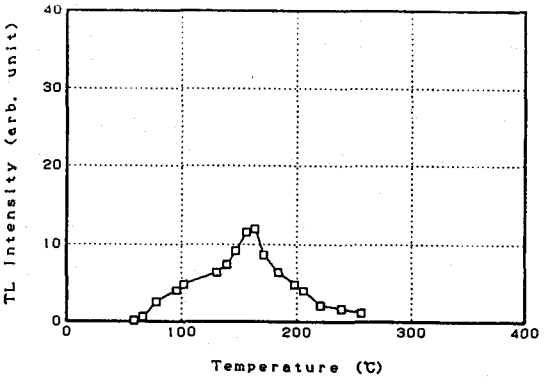

Fig 3. TL glow curve.
(after irradiating Hg-lamp)

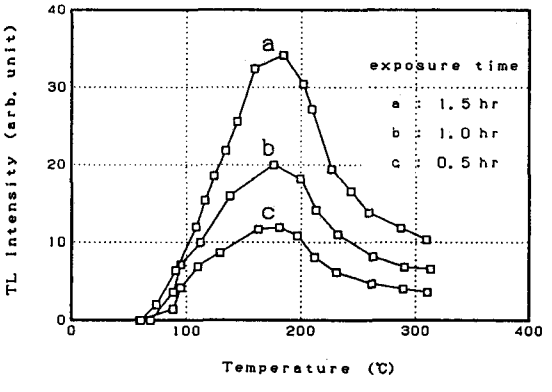

Fig 4. TL glow curve.
(direct exposure to the sunlight)

4. Experimental

4.1 Experimental method

we tried to expose TLD to the sunlight directly/indirectly to examine the influence of UV-rays included in sunlight. Therefore, we set up the two

one, and then tried to measure the UV-rays volume. Other experimental conditions are: use of no filter, and three exposure times (0.5, 1.0 & 1.5 hrs).

4.2 Experimental result and examination

In this experiment, we examined a possibility of observation of UV-rays volume included in sunlight, using TLD and centering on the relationship between exposure time and TL glow peak intensity.

Fig. 4 shows the TL curve under the condition of direct exposure to the sunlight, and Fig. 5 under the condition of indirect exposure. When 0.5 hr passed after the start of measurement, the direct rays were a little bit weak, and the difference between the two experimental conditions did not appear. When 1.5 hr passed, the large difference was observed between them because the two TLD devices were fully exposed to the direct rays.

In the other data, although 0.5 hr exposure did not give any clear difference, the differences clearly appeared when 1.0 hr and 1.5 hr passed. Fig. 6 shows the relationship between the exposure time and irradiation volume of sunlight. It can be seen from the Fig.6 that the clear propotional relationship is obtained. And, Fig. 7 shows the relationship between the TL intensity and the exposure time in case of using the Hg-lamp (13.5 W of low pressure Hg-lamp). In this figure, the part of straight line is from 5 to 1 5 seconds, and when the exposure time goes up to over 30 seconds, the curve shows the saturation condition. As this phenomenon is also seen in other instruments which can measure the UV-rays volume, the range of temperature for calculating the area of luminous volume is proper for that.

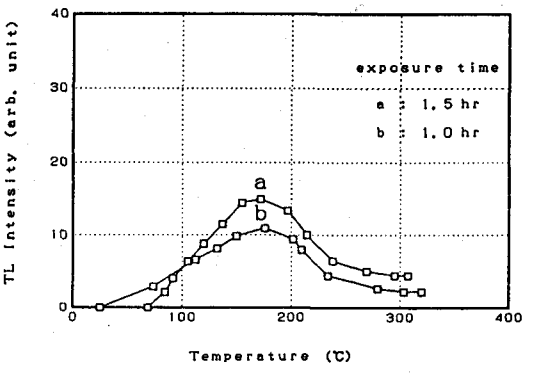

Fig 5. TL glow curve.
(indirect exposure to the sunlight)

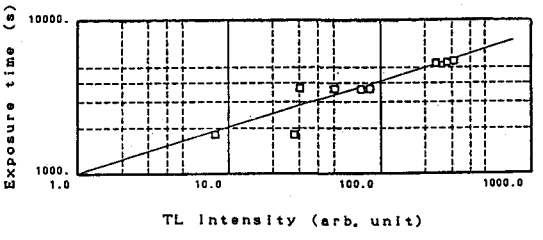

Fig 6. Relationship between TL intensity and exposure time.
(after irradiating sunlight)

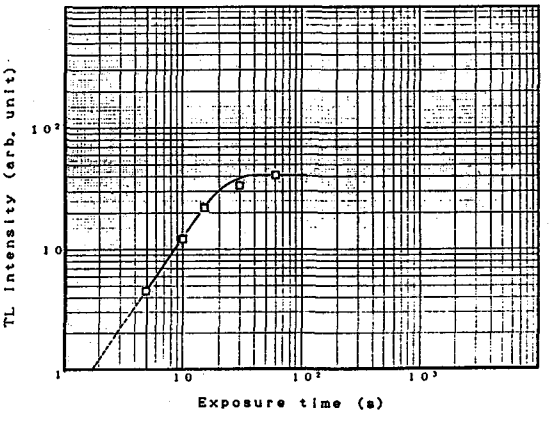

Fig 7. Relationship between TL intensity and exposure time.
(after irradiating Hg-lamp)

5. Conclusion

In order to observe and evaluate easily the UV-rays volume brought about by the formation of the ozone holes, we tried to examine a possibility of observation of UV-rays volume included in sunlight, using TLD and centering on the relationship between exposure time and TL glow peak intensity. As a result, a possibility of the observation of UV-rays volume can be confirmed. This method has several features, that is, 1) to be able to measure UV-rays at several points at the same time and 2) to carry out the measurement without filter. Therefore, the application is expected in the future.

Toward the practical use, 1) the influence of the fading, 2) the up of sensitivity using the other impurities and 3) the quantitative evaluation using the radiation(ex: ^{60}Co or γ rays) which will become a common international standard etc. will be considered in the near future. If we can decide the standard UV-rays volume as a new environmental index, it will be possible for every citizen to predict and evaluate the UV-rays volume by way of the comparison of the standard UV-rays volume and that measured by this method.

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