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AN EVALUATION OF SUNLIGHT UV-RAYS VOLUME BY TLD

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ABSTRACT; In order to observe and evaluate the UV-rays volume brought about by the the destruction of ozon layer, this paper examines an evaluation of the sunlight UV-rays volume, using TLD and centering on the relationship between the exposure time for a fixed period time and TL intensity. The contents are as follows: (1)It was recognized that the sunlight UV-rays volume is proportional to the exposure time (2)The sunlight UV-rays volume measured for periods of 4 months(May~August, 1993) is reported. (3)Experimental procedure, result and examination are mentioned, and an evaluation of the sunlight UV-rays volume is conducted.

KEYWORDS; sunlight UV-rays volume, TLD(Thermoluminescence dosimeter), destruction of ozone layer(ozone hole), monitoring of environment

1. Introduction

In recent years, destruction of the ozone layer as one of the global environmental issues has recently been noticed. Ozone hole protects the life on the earth from the harmful sunlight UV-rays. It is known that if sunlight UV-rays e.g., UV-wave(UV-ray B: 280~320nm) in sunlight pours on the ground, a photosynthesis of plants is restrained, and a gene structure material of the human body is destroyed.

As the study with respect to the effectiveness of measurement of sunlight UV-rays have just started, there is a study using a thermoluminescence dosimeter(TLD) as one of the method to approach the study. For instance, I.Aguirre de Carcer et al have presented[1)~3)] that the sintered Nacl with Eu ion is an effective TLD for measuring the UV-C 波(UV-rays below 280nm). However, It is open to question in view of the practical use.

In order to find out the possibility with respect to both practical use and its application, we made the sintered CaF_2 with Tb, and used it as a TLD device. And, it can be seen from a result of examining the TLD characteristics to the sunlight UV-rays that the examined sintered is effective for the measurement of UV-rays volume as well as the Nacl with Eu ion.

In the present paper, we report the result of measurement of UV-rays volume using the sintered CaF_2:Tb mentioned above in the periods of 4 months(May~August, 1993).

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2. Experimental

The samples were prepared by the solid state reaction. The starting materials, CaF_2 (purity 99.99%) and Tb_4O_7 (99.99%) were mixed in the desired ratio and pressed into the pellets (diameter: ≒ 7mm; thickness: 0.7mm). The mixture was heated at 1100 ℃ for 1 hrs in air. we keeped the CaF_2 pellets with Tb ion in both the sunshine and shade place, and the exposure of the samples to the sunlight was carried out without any filters.

3. Results and discussion

Fig.1 shows the TL glow curves of the samples, $CaF_2:Tb_4O_7$ (0.06wt%) exposured to the sunlight in the sunshine. The peak temperature of the glow curves were located at about 180 ℃ and 200 ℃. The TL intensity was increased with increasing the exposure time. In order to examine the relationship between the TL intensity and exposure time, the areas in the temperature range from 153 ℃ to 241.5 ℃ of the TL glow curves were tentatively plotted against the exposure time. The result given in Fig.2 showed the propotional relationship between the TL intensity and the exposure time to the sunlight.

The TL observed after the exposure of sunlight is considered to be due to the UV radiation included in the sunlight. In previous paper[4], we confermed the presence of the proportional relationship between the TL intensity and the UV irradiation time using low pressure Hg lamp.

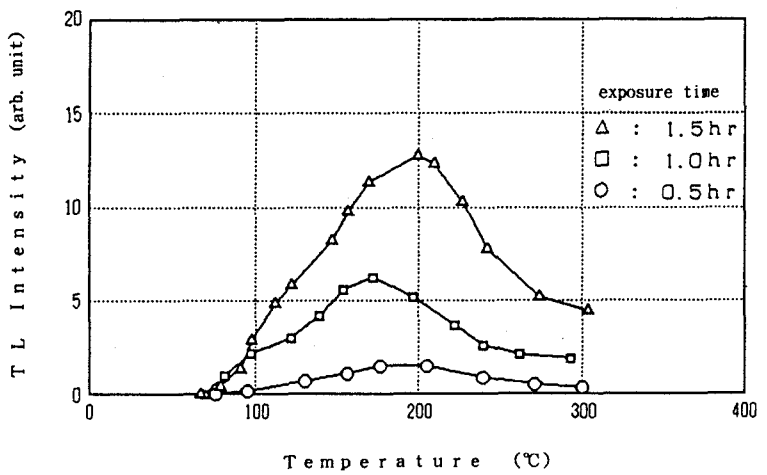

Fig. 1 T L glow curve.
(direct exposure to the sunlight)

Fig. 2 shows the relationship between the volume of UV-ray and the time exposured to the sunlight. It is seen from this fugure that the UV-rays volume is proportional to the irradiation time. Table 1 shows the weather condition and the sunlight UV-rays volume measured in both the sunshine and shade place for periods of 4 months(May 11 ~ August 31, 1993). Fig.3 shows the variation of the UV-rays volume (assuming that May 11 is 100) which is shown in Table 1. It can be seen from the Table that the sunlight UV-rays volume decreases at the end of May, and also the same condition at July. The volume at the latter half of August is almost the same value as that at May. Figs. 4 and 5 show the variation of the UV-rays volume in both fine and cloudy weathers, respectively. Fig.6 shows the relationship between the sunlight UV-rays volume and the temperature in the weather conditions mentioned above. It can be seen from this figure that in spite of the conditions, the UV-rays volume increases with the temperature, and its rate of increase remains constant throughout the examined period. It is understood from Table 1 that the atmospheric pressure is almost the constant throughout the measured period, and that the differences of the TL intensity is based on the conditions such as fine/cloudy weathers, temperatures and other weather conditions. It has turned out from Figs.3~5 that the sunlight UV-rays volume is minor in the duration from the end of May to the end of July(July 26). It can be seen from Fig.6 that this is related to the phenomenon in which the temperature in this period is low. This period measured the variation of UV-rays volume at Osaka(35 degree) for the periods of 4 months (May~August,1993) coincides with a crucial period for a rice crop. It is said in general that the year of 1993 is in the bad crop which is for once in 100 years. It seems that this bad crop is related to the lowness of Uv-rays volume for the periods from May to July. From the measurement we have had lately, we recognize the possibility of the forecasting with respect to the growth of the crops by means of the monitoring of UV-rays volume. It is thought that the mechanism of the luminescence of the sintered CaF_2 with Tb ion is based on the Tb ion because the TL emission spectra due to the Tb ion is observed by the luminescence spectra based on the irradiation of UV-ray. TL emission was considered to follow the reactions.

$$Tb^{4+} + \text{electron} \longrightarrow Tb^{3+*} \longrightarrow Tb^{3} + h\nu \ (545\ nm) \qquad (1)$$

$$Tb^{2+} + \text{hole} \longrightarrow Tb^{3+*} \longrightarrow Tb^{3} + h\nu \ (545\ nm) \qquad (2)$$

When irradiating the X ray to the sintered CaF_2:Tb, the material takes the color of brown. This coloring might be due to the Tb^{4+} ions. Therefore, it is considered that the observatin of TL is based on the Eq.(1), and that the irradiation of UV-ray is also due to Eq.(1)[4]. It is necessary to examine whether this sintered CaF_2:Tb has a TL characteristics for UV-C or UV-B, and to measure a UV-ray volume by using better TLD with high sensitivity is also very important in view of monitoring of environment in the near future.

Table 1 Observation of UV-Rays Volume.

	5/11	5/17	5/24	5/31	6/7	7/5	7/12	7/19	7/26	8/23	8/30
Temperature(℃)	26.1	26.6	26.1	24.0	23.8	25.1	26.4	29.3	32.0	34.3	33.5
Humidity(%)	49.5	46.5	41.5	48.5	59.5	74.0	75.0	58.0	49.5	51.0	46.5
Atmospheric pressure(HPa)	1002.3	1001.9	1001.0	993.2	994.1	1001.5	998.0	998.4	1001.3	998.2	996.6
Sunshine(0.5hr)		17.3	38.6	26.3		7.0	7.7	15.7	26.1		
Sunshine(1.0hr)		71.0	49.8			8.6		4.0	31.2	23.4	
Sunshine(1.5hr)		310.5	73.6	52.5				3.2	3.2		
Shade(0.5hr)	100.2	102.5	62.3	62.3	28.7	31.8	34.3	45.2	27.6	104.7	103.7
Shade(1.0hr)	39.2	42.8		39.0	41.5	50.4			33.3	37.6	50.2
Shade(1.5hr)	121.0	153.3	31.3	156.8	25.8	80.7		10.9	24.2	47.3	118.8
Weather	fine	fine	fine	fine	cloudy	cloudy	cloudy	cloudy	fine	cloudy	cloudy

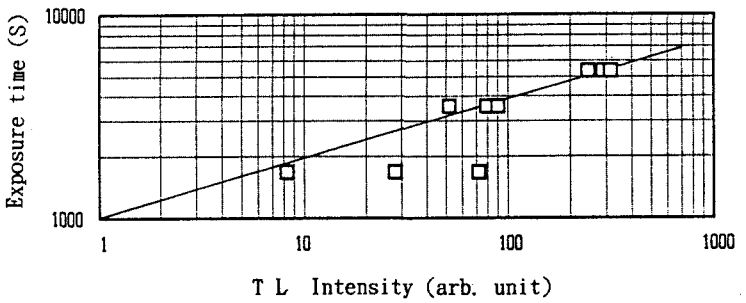

Fig.2 Relationship between T L Intensity and Exposure time.

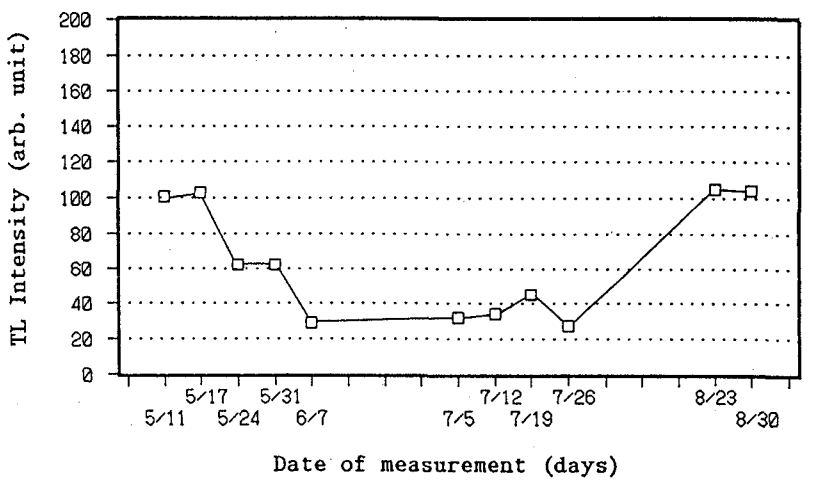

Fig. 3 TL Intensity versus date of measurement.

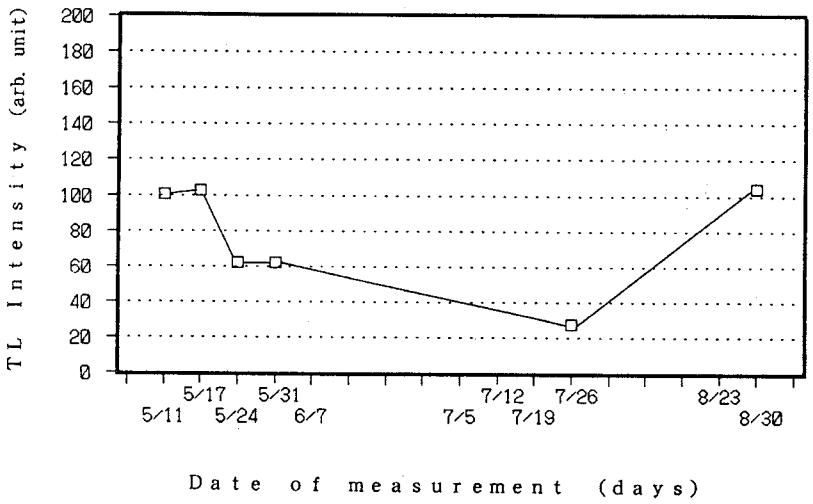

Fig. 4 Relationship between TL Intensity and Date of Measurement (Fine weather).

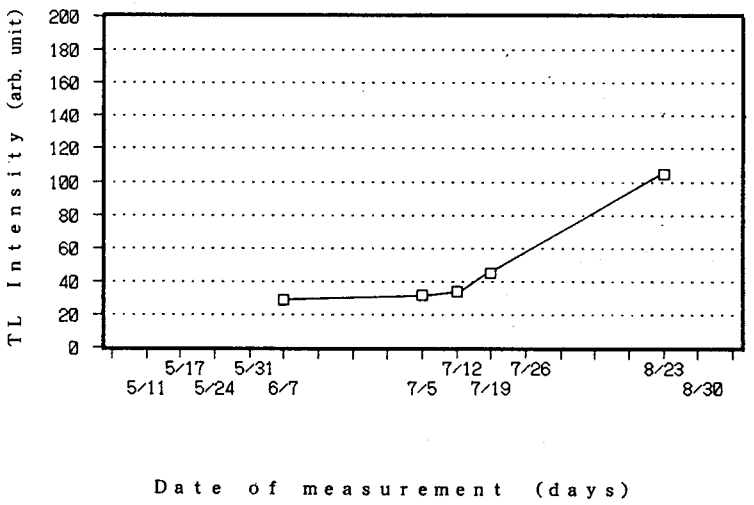

Fig. 5 Relationship between TL Intensity and Date of Measurement (Cloudy weather).

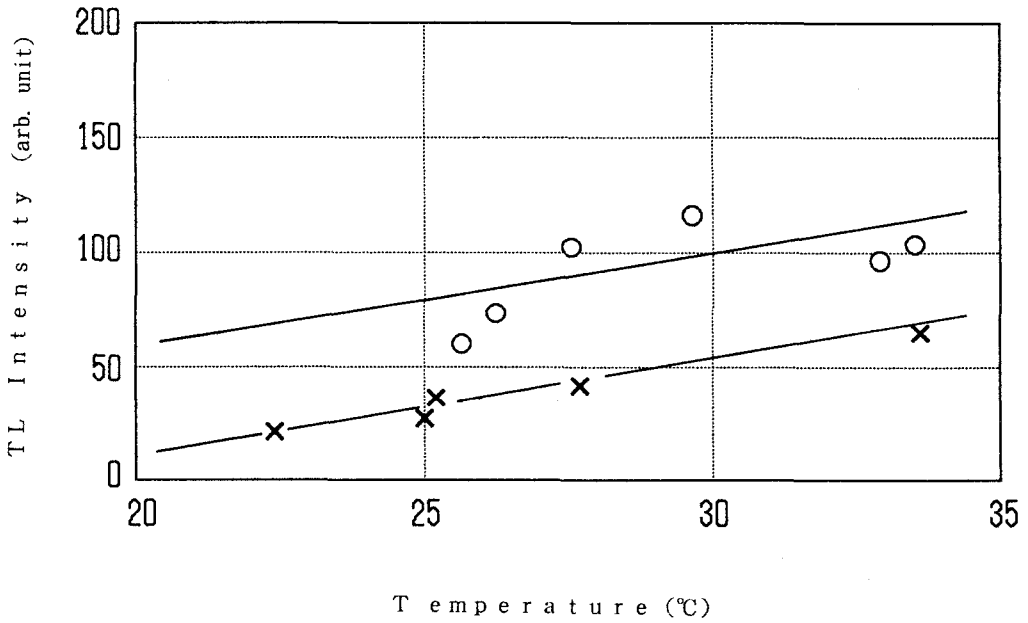

Fig. 6 Relationship between TL Intensity and Temperature.

4. Conclusion

From the results of the sunlight UV-rays volume, using TLD and centering on the relationship between the exposure time for a fixed period and TL intensity, the following conclusions are obtained:

(1)Seasonal change of the UV-rays volume of sunlight is almost the same as the irradiation volume of the sunlight in which the data is based on Rika Nenpyo. Therefore our data can be use for evaluating sunlight UV-rays volume

(2)It would be expected to facilitate the use of TLD at the citizen level because of the reasons for its facility for operation and cheap.

Refererences

1)I.Aguirre de Carcer, G.Lifante, F.Cusso and F.Jaque: Applied Physics Letters, 58 (1991), 1825.

2)I.Aguirre de Carcer, F.Cusso and F.Jaque: Phys. Stat. Solid(b) 166 (1991) K117.

3)E.Espana, T.Calderon, F.Cusso and G.Lifante, Proc. XII Int. Conf., Defects in Insulating Materials, Vol.2 (1993) 877.

4)Environmental Systems Research, 21 (1993) 114.