Measurement of ECF for $CaSO_4$:Dy TL dosimeter

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1. Introduction

$CaSO_4$:Dy TL dosimeter and Teledyne System 300 automatic TLD reader is being used for the external radiation exposure dosimetry in KAERI. Dosimeters contain eight TLD elements. Primary four elements are mainly used for dosimetry, secondary four elements are spare that is used in case of failure in primary elements reading. Figure 1 shows an exterior view of dosimeter. These are made from a homogeneous blend of 30% $CaSO_4$:Dy and 70% PTFE as a binding material. Irradiated TL dosimeter is heated to about 300 ℃ in the TLD reader, and it emits luminescence in proportion to irradiated dose. Emitted luminescence is transferred to Photo Multiplier Tube (PMT) through light cable, and is multiplied to about 10^5-10^6 in the PMT. Temperature vs. TL luminescence curve is called glow curve. (Fig. 2) TL response was calculated as follows.

$$\text{TL response} = \frac{TLraw \times RCF \times LSav}{LS}$$

TLraw : TL raw counts (integration of glow curve)
RCF : Reader calibration factor
LSav : Light source average stored during calibration
LS : Light source value for the dosimeter

TL response of $CaSO_4$:Dy is gradually degrade due to multiple readings and physical abuse. It must be calibrated periodically. ECF (Element Correction Factor) is the ratio of average TL response of reference dosimeters to TL response of field or control dosimeter for each element. Reference dosimeters are used only for the production of ECFs for the control and field dosimeters, and stored at environmentally safe and adequate place. TL response of reference dosimeters is assumed to be not change. 31 reference dosimeters were used. The control dosimeters are used for calibration of TLD reader, and field dosimeters are used for routine monitoring of radiation workers.

Figure 1. Exterior view of dosimeter

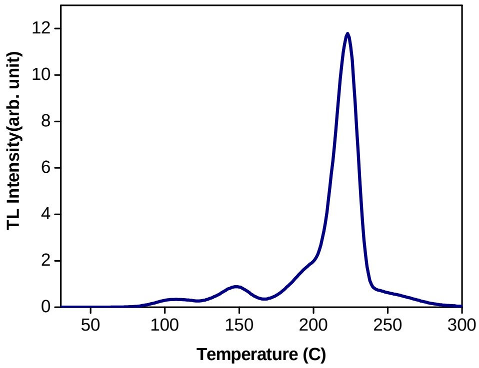

Figure 2. Typical TL glow curve

2. Methods and Results

Reference, control and field dosimeters were annealed at 260 ℃ for 2 hrs at annealing oven to emit residual response, and were uniformly irradiated to 500 mR free in air from Cs-137 gamma source. Irradiation was performed at adequate distance and for sufficiently long time to satisfy uniform irradiation. Figure 3 shows an irradiation view from Cs-137 gamma source. After irradiation, about 3 days were allowed to permit initial fading to occur. After initial fading occurred, these dosimeters were read by automatic TLD reader. During dosimeter readout, all ECFs were set to 1.00. Firstly, average TL response for reference dosimeters were calculated for each element. ECFs of field and control dosimeters were calculated as follows.

$$ECF(i, j) = \frac{EM\ (i)}{e(i,\ j)} \qquad (1)$$

Where,
ECF (i, j) = ECF of i element, j dosimeter
EM (i) = average response of reference dosimeters for i element
e (i, j) = response of i element, j dosimeter

For example, average response of reference dosimeters for P4 element is 446 mR, and response of P4 element for dosimeter A000109 is 417 mR. Therefore, ECF of P4 element, A000109 dosimeter is calculated as

$$ECF\ (P4, A000109) = \frac{446mR}{417mR} = 1.07$$

The ECFs derived from equation (1) are multipliers. The response of a given element is multiplied by its ECF to obtain a corrected response.

Distribution of ECFs for field dosimeters is shown in Fig. 4, and it shows an reasonable distribution. Average ECF for reference dosimeters was 1.0, and 1.15 for field dosimeters. Large ECF value means much degradation.

Dosimeters that have abnormally large ECF values are advised to be not used. In this practice, dosimeters that have ECF values of greater than 1.50 were abandoned.

Figure 3. Irradiation view from Cs-137 gamma source

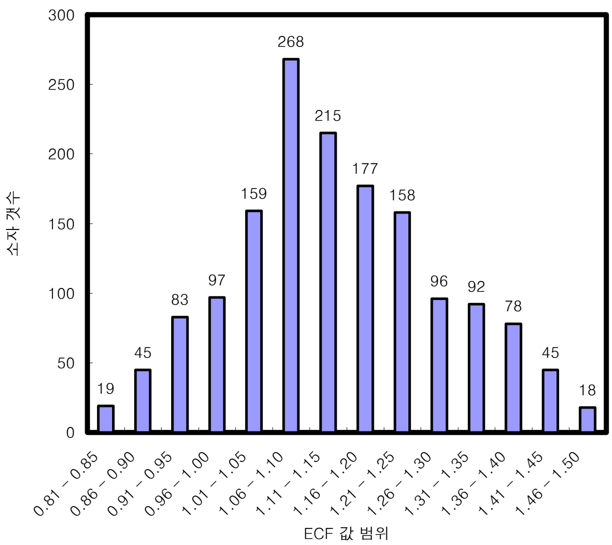

Figure 4. Distribution of ECFs for field dosimeters

3. Conclusion

It can be inferred from the ECF distribution that ECFs were reasonably well produced. ECF provide an excellent tool to examine new dosimeters and to monitor the reliability of old dosimeters. The frequency for generating new ECF for old dosimeters depends entirely how the dosimeters have been treated. Rather than setting an arbitrary schedule (for example biannually) for generating new ECFs, a rational schedule should be developed based on observed changes in the ECFs of a small sampling of dosimeters.

REFERENCES

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