

# Evaluation of the dosimetric characteristics of GD-352M for use in the measurement uncertainty of RPLGD reader system

Jae Seok Kim<sup>1,4\*</sup>, Byeong Ryong Park<sup>1</sup>, Jaeryong Yoo<sup>1</sup>, Wi-Ho Ha<sup>1</sup>, Won Il Jang<sup>1</sup>, Hyun Kim<sup>2</sup>, Insu Chang<sup>3</sup> and Yong Kyun Kim<sup>4</sup>

<sup>1</sup>National Radiation Emergency Medical Center, Korea Institute of Radiological and Medical Sciences, 75, Nowon-ro, Nowon-gu, Seoul, Republic of Korea

<sup>2</sup>Research Center, Dongnam Institute of Radiological and Medical Sciences, 40, Jangan-eup, Gijang-gun, Busan, Republic of Korea

<sup>3</sup>Radiation Safety Management Division, Korea Atomic Energy Research Institute, 111, Daedeok-daero 989beon-gil, Yuseong-gu, Republic of Korea

<sup>4</sup>Department of Nuclear Engineering, University of Hanyang, 222, Wangsimniro, Seongdong-gu, Seoul, Republic of Korea

\*E-mail: kimzgo@kirams.re.kr

**Keywords:** Radiophotoluminescent glass dosimeter (RPLGD), GD-352M, Measurement uncertainty, Dosimetric characteristic

In Korea Institute of Radiological and Medical Sciences (KIRAMS), a physical human phantom was developed to evaluate the various protection quantities based on the Mesh-Type Reference Computational Phantoms (MCRPs) of International Commission on Radiological Protection (ICRP). The physical human phantoms were fabricated to insert a radio-photoluminescence glass dosimeter (RPLGD) to evaluate the absorbed dose in organs. The RPLGD with Tin filter called GD-352M was applied in this research. GD-352M has advantages such as good reproducibility readout values, low energy dependence, outstanding dose linearity and available repeatable readouts. The dosimetric characteristics of GD-352M were evaluated to apply in the measurement uncertainty of RPLGD reader system. The uncertainty factors of GD-352M consist of the reference irradiation, regression curve, reproducibility, uniformity, energy dependence and angular dependence referred from the International Organization for Standardization (ISO). Each factor of measurement uncertainty was evaluated by the Guide to the Expression of Uncertainty Measurement (GUM) method using ISO/ASTM 51261(2013), 51707(2015), and SS-ISO 22127(2019). The uncertainties and level of contributions in GD-352M were calculated according to the dose ranges from 0.005 to 1 Gy and 1 to 10 Gy as the table 1. As the results, the measurement uncertainties of RPLGD reader system with a coverage factors  $k=2$  was evaluated at 9.26% from 0.005 to 1 Gy and 8.16% from 1 to 10 Gy.

Table. 1. Uncertainty of RPLGD reader system according to dose range.

| Dose range                            | 0.005 - 1 (Gy)  |                  | 1 - 10 (Gy)     |                  |
|---------------------------------------|-----------------|------------------|-----------------|------------------|
|                                       | Uncertainty (%) | Contribution (%) | Uncertainty (%) | Contribution (%) |
| Reference irradiation                 | 2.46            | 28.24            | 2.46            | 36.44            |
| Regression curve                      | 2.86            | 38.18            | 1.85            | 20.61            |
| Reproducibility                       | 0.47            | 1.03             | 0.40            | 0.96             |
| Uniformity                            | 1.15            | 6.22             | 1.15            | 8.03             |
| Energy dependence                     | 2.29            | 24.47            | 2.29            | 31.57            |
| Angular dependence                    | 0.63            | 1.85             | 0.63            | 2.39             |
| Combined uncertainty and contribution | 4.63            | 100              | 4.08            | 100              |
| Expanded uncertainty at $k=2$         | 9.26            |                  | 8.16            |                  |

## Acknowledgments

This study was supported by a grant of the Korea Institute of Radiological and Medical Sciences(KIRAMS),

funded by Ministry of Science and ICT(MSIT), Republic of Korea. (No.50535-2020)