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Experimental Evaluation of a Radiophotoluminescent Glass Dosimeter in High-Energy Photon Beam

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Introduction

Recently, the radiophotoluminescent (RPL) glass dosimeter (GD) system has been widely used in experimental fields for the purpose of measuring radiation dose. The glass dosimeter can be readout by two measuring modes; one is to use standard dose range (10 μGy- 10 Gy), and the other is to use high-dose range (1 Gy- 500 Gy). While the high-dose range mode is used in radiation therapy, the standard mode is used in the dosimetry of diagnostic x-ray or environmental exposures.[1] The purpose of this study is to investigate the experimental evaluation of characteristics of the glass dosimeter for the dosimetry of clinical use. For this reason, we examine dosimetric properties of the glass dosimeter concerning dose linearity at high absorbed dose, uniformity among GD lots, and reproducibility of reader.

Materials and Methods

A. RPL GD System

The RPL GD system consists of silver-activated metaphosphate glass detecters (model GD-302M) and readout device (FGD-1000 reader, Ashahi Techno Glass Corporation, Shizuoka, Japan). The RPL is based on the formation of fluorescence centers in silver-activated metaphosphate GDs. When exposed to ultraviolet beam light, radiation-induced photoluminescent fluorescence light is emitted, and the intensity of which is proportional to the dose.[2]

B. Dosimetric properties of RPL GD

The dose linearity of the GD is measured by γ-ray from ^{60}Co teletherapy unit (Teratron 780, AECL, Canada). Dose range was from 1 to 500 Gy and each dose point was measured to 3 times and 10 times repeatedly readout, respectively. These measurement were performed with the solid water phantom and 3 cm bolus at 10x10 cm^2 field size.

The uniformity and reproducibility of mutual GD lot were measured for 80 GDs by using ^{60}Co beam. The irradiated dose was 2 Gy at 5 cm depth in water. Each exposed GD was read 10 times consecutively.

To examine the reproducibility of FGD-1000 reader, we made an attempt to reading up to 200 times, repeatedly.

Results and Discussion

Fig. 1 shows the linear response at high dose of

GD. Up to 30 Gy, their difference is within ± 1.4% (1 SD). This result is in agreement with published data[1]. Meanwhile, The more delivered dose is taken in GDs, the larger error represents beyond 100 Gy. Fig 2. represents the uniformity and reproducibility of among GD lots. We evaluated 80 GDs of 4 lots. The deviation of uniformity was measured to be within 3.5%. The reproducibility of FGD-1000 reader is shown in Fig. 3. It represents the average value of 16 GDs. The one SD is approximately ± 0.35% at 10 reading point and ± 1.0% at 200 reading point.

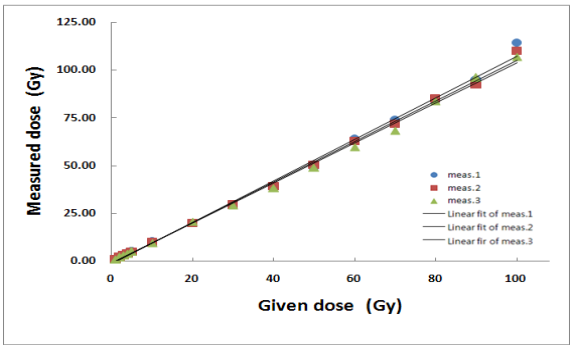

Fig. 1. Dose linearity (measured dose vs. given dose) at high absorbed dose region.

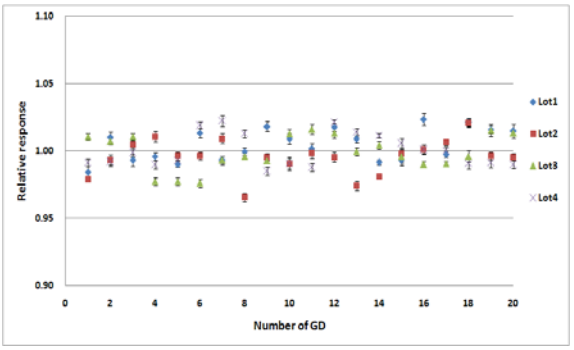

Fig. 2. The uniformity and reproducibility of among GD lots responses for 80 GDs of 4 lots. The relative response of each GD is normalized averaging readout-value of lot 1-4. Error bars show one SD of 10 redout-values of each GD.

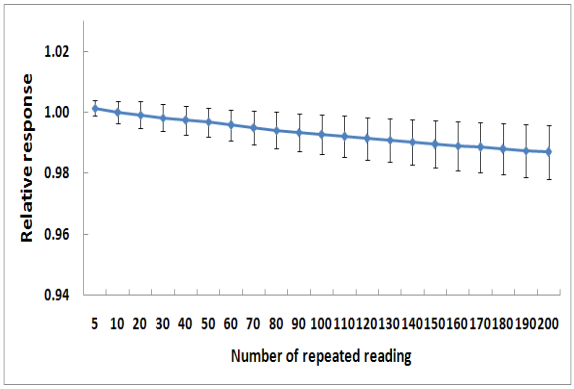

Fig. 3. The reproducibility of FGD-1000 reader. The error bras represent one SD.

Conclusion

This study investigated the experimental properties of GD for high-energy photon beam such as dose linearity at high absorbed dose, uniformity among GD lots and reproducibility of FGD-1000 reader. We found that dose linearity at high absorbed dose is suitable for clinical use. The uniformity among GD lots is small variation and each lot tend to similar deviation. But GD uniformity in same lot is much smaller variation. The reproducibility of FGD-1000 reader shown that the more repeated reading consecutively, the more enlarged standard deviation. Also response tend to decreased gradually. Therefore, the irradiation experiment using the GD system is recommended to be used for GD elements of same lot and small reading times.

Reference

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