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Linearity of Radiophotoluminescence Glass Dosimeter Based on Monochromatic X-ray

Tomohiro Shimozato, Katsuyoshi Tabushi, Tadashi Tamiya, Shuji Koyama, Norihiko Narita, Setsu Yoshioka, Masatoshi Tsuzaka, Yasunori Obata[1)], Tomoya Uruga, Hajime Tanida[2)], Shuichi Ban, Yoshihito Namito[3)]

1)Nagoya University School of Health Science, 2)Japan Synchro. Radi. Insti., 3)High Energy Accel. Res. Org.

INTRODUCTION

Recently energy ranging from 20keV-30MeV has been used for personal radiation monitoring with radiophotoluminescence glass dosimeter[1, 2] specified in JIS (Japan Industrial Standard). Low energy X-ray (about 15keV) applied for mammography, however, is suspected to have potential risk of medical exposure. We evaluated linearity between photon fluence and H(1cm):dose equivalent at 1cm depth, H(3mm):dose equivalent at 3mm depth, H(70 μ m):dose equivalent at 70 μ m depth.

METHOD

In this study, radiophotoluminescence glass dosimeter GD-403 consisting of glass element (40mm x 10mm x 2mm) was used for exposure of low energy photon, and investigated on the characteristics using monochromatic X-ray obtained from synchrotron radiation from beam line of Spring-8 at Harima and KEK at Tsukuba. Focusing on the low energy ranging 8keV-20keV, we studied the linearity of the GD-403 stuck on the Tough water phantom using X-ray beam.

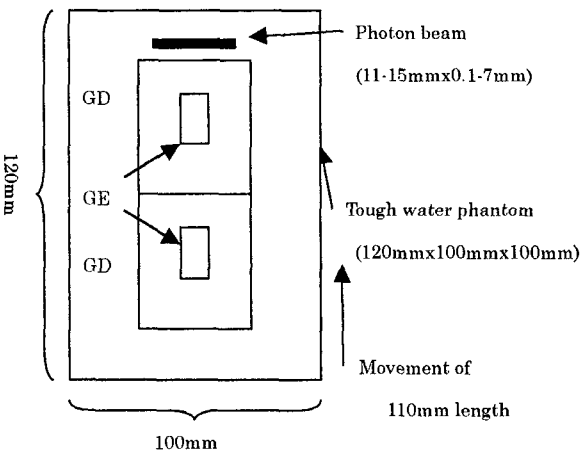

Fig.1 Schematic of GD irradiation using X-ray of beam line
GD: glass dosimeter, GE: glass element

The GD-403 was irradiated using X-ray of 11-15mm x 0.1-7mm for the moderation of photon fluence with the movement of Tough water phantom in 110-150mm length by stepping motor to irradiate glass element as shown in Fig.1. The size of Tough water phantom was 120mm x 100m x 100mm. The speed of moving Tough water phantom was regulated according to the number of pulse per second of stepping motor.

RESULTS

Fig.2 shows linearity between photon fluence and dose equivalent (H(1cm) or H(3mm)). Though H(1cm) indicates proper linearity for all monochromatic X-ray energies, H(3mm) has insufficient linearity with large variation in low energy region (8 to 10keV). Fig.3 indicates the relation between photon fluence and the ratio of dose equivalent (H(1cm) or H(3mm)) to photon fluence. H/Ψ corresponds to leaning of straight line in Fig.2 and is constant in arbitrary fluence shown in the figures. Fig.4 shows the relation between monochromatic X-ray energy and the ratio of dose equivalent (H(1cm) or H(3mm)) to photon fluence. H(70 μ m) also represented same tendency as H(3mm).

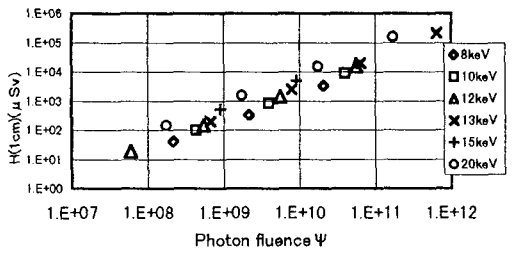

Fig.2-1 Photon fluence and H(1cm)

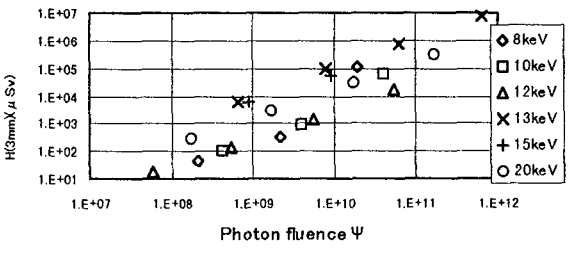

Fig.2-2 Photon fluence and H(3mm)

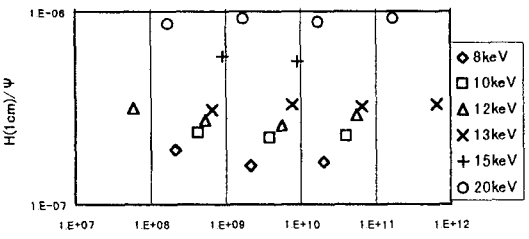

Fig.3-1 Photon fluence and H(1cm)/Ψ

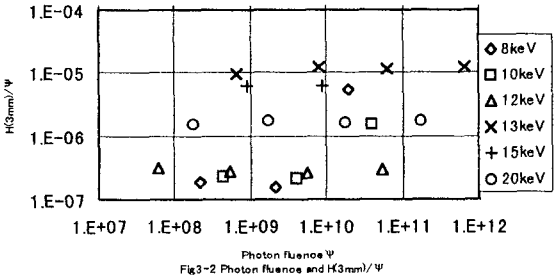

Fig.3-2 Photon fluence and H(3mm)/Ψ

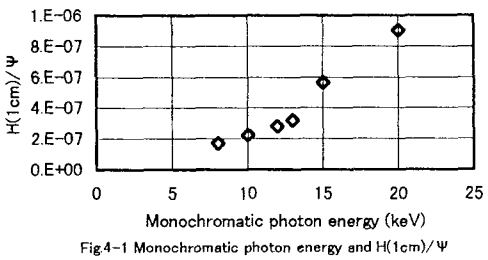

Fig.4-1 Monochromatic photon energy and H(1cm)/Ψ

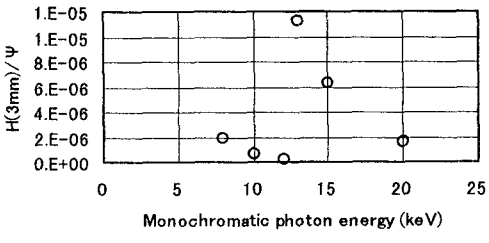

Fig.4-2 Monochromatic photon energy and H(3mm)/Ψ

DISCUSSION

The ratio of H(1cm) to energy fluence (Ψ) at the surface of dosimeter became large as the energy changes from 8 to 20keV, while the ratios of H(3mm) and H(70 μ m) to Ψ became small as the energy increased and took the maximum value in 13keV. H(3mm)/Ψ and H(70 μ m)/Ψ became small when energy absorption coefficient decreased to about 10 percent in 10 to 20keV. Therefore, low energy X-ray does not affect very much deep seated tissues because of diminishment but affects skin surface.

CONCLUSION

Glass dosimeter has been widely used in various fields such as radiation protection dosimetry as well as film and thermoluminescence. For as a consequence, further investigation on the characteristics of radiophotoluminescence glass dosimeter is required particularly in low energy X-ray (8keV, 10keV).

REFERENCES

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