

An Evaluation of Characteristics of Film Badge using Monochromatic X-ray

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INTRODUCTION

Personal radiation monitoring is performed using film badge (FB), radiophotoluminescence glass dosimeter, TLD and pocket dosimeters. In particular the FB is appropriate for measurement of accumulated dose equivalent and has been widely used at present. These dosimeters are recommended for utilization in energy range of 20 keV to 3 MeV which is higher than that of ordinary monitoring for mammography. We have investigated mainly the characteristics of the FB in the energy region of 8 to 15 keV, moreover, up to 20 keV. The linearity between photon fluence and dose equivalent, as well as energy characteristics based on mixed irradiation with two energies, were studied using monochromatic X-rays of SPring 8 at Harima and KEK at Tsukuba.

METHOD

The FB, stuck on Tough-water phantom, was irradiated with $1E8$ to $1E12$ photon fluence of monochromatic X-ray obtained from synchrotron radiation. The beam size of $11-15 \times 0.1-7 \text{ mm}^2$ was used to moderate photon fluence with the movement of the Tough-water phantom in 110-150 mm length by stepping motor. For the investigation of energy characteristics, FB1 and FB3 were irradiated with X-ray of energy E1, and then FB2 and the FB3 with X-ray of energy E2. Since the FB3 is distinguished as an effective energy E3, we will endeavor to clarify the synthesizing process from energies E1 and E2 on the basis of the photon fluence.

RESULTS

Fig.1 shows linearity between dose equivalent and fluence in photon beams of 8, 10, 12, 13 and 20 keV, which are represented graphically in three patterns of depth; (a)1 cm, (b)3 mm, and (c)70 μ m. Each figure shows good linearity except for several experiment points. Fig 2 shows dose equivalents based on mixed irradiation with 10 and 20 keV, which describes how the mixed irradiation affects dose equivalent as the

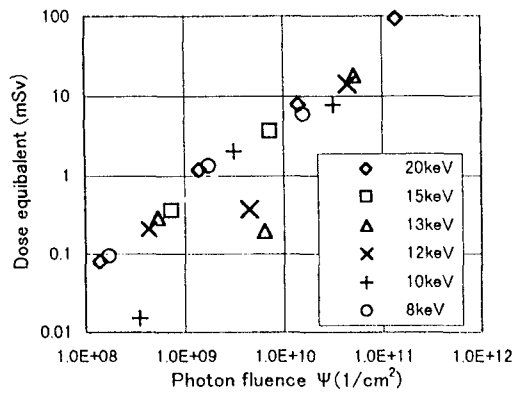


Fig. 1(a) Photon fluence and dose equivalent at 1cm depth

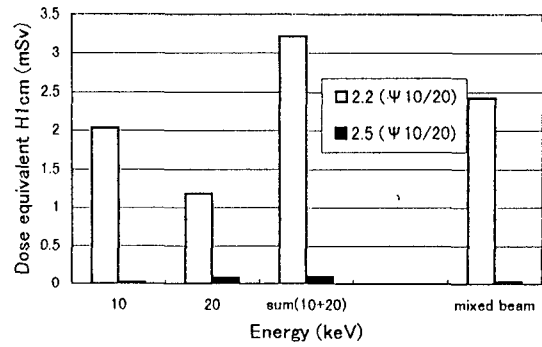


Fig. 2(a) Sum and mixed irradiation dose by 10, 20keV

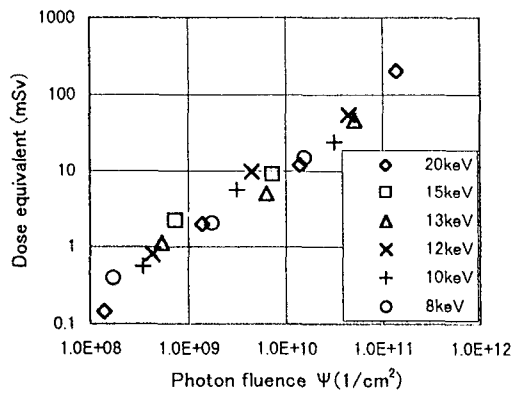


Fig. 1(b) Photon fluence and dose equivalent at 3mm depth

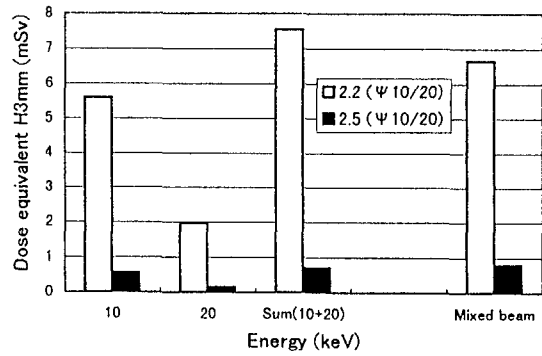


Fig. 2(b) Sum and mixed irradiation dose by 10, 20keV

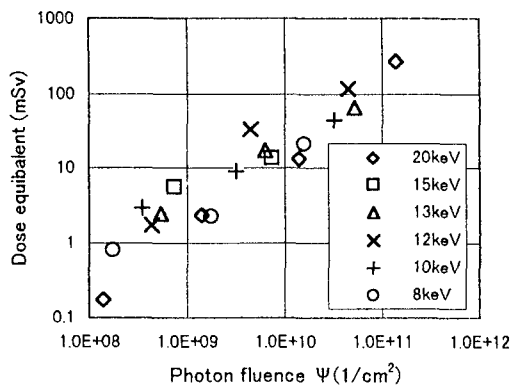


Fig. 1(c) Photon fluence and dose equivalent at 70 μm depth

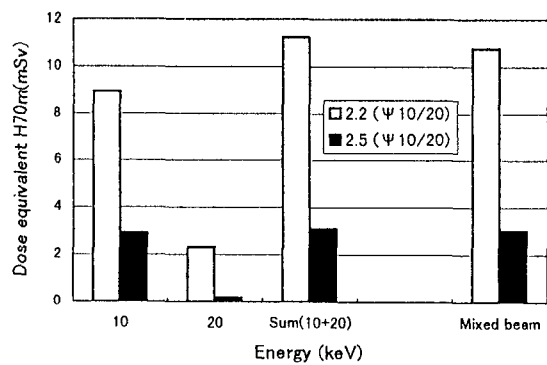


Fig. 2(c) Sum and mixed irradiation dose by 10, 20keV

ratio of fluence of 10 keV to that of 20 keV was changed. Effective energies obtained from mixed irradiation consisting of monochromatic X-ray were 14 and 15 keV.

DISCUSSION

Linearity represents relationship between dose equivalent and photon fluence. Namely, ratio of dose equivalent to photon fluence should be constant at a specific photon fluence in favorable conditions of linearity. Although we could obtain satisfy linearity in this experiment, but not be familiar with energy characteristics. Therefore, much more accurate data is required for analysis of the characteristics especially in low energy range.

CONCLUSION

We have obtained proper linearity of the FB between dose equivalent and photon fluence and are planning to continuously investigate energy characteristics using monochromatic X-ray from now on.