B9－2

Mixed Low Energy Characteristics of Radiophotoluminescence Glass Dosimeter

Tadashi Tamiya, Katsuyoshi Tabushi, Shuji Koyama,
Masatoshi Tsuzaka, Norihiko Narita, Yoshimune Ogata,
Yasunori Obata[1], Tomoya Uruga, Hajime Tanida[2],
Shuichi Ban, Yoshihito Namito [3], Toru Ikegami [4],
Hiroharu Sakaguchi [5]

1)Nagoya University School of Health Sciences, 2)Japan Synchro. Radi. Insti., 3)High Energy Accel. Res. Org., 4)Asahi Technoglass Co., 5)Nagase Landauer Ltd.

[INTRODUCTION] According to the use of continuous X-rays around 15keV for mammography, radiation exposure seems to be the mixture of various energies.

To measure the radiation exposure, the response characteristics of photoluminescence glass dosimeter (GD) to X-ray energies should be elucidated.

For this purpose, we used low energy monochromatic X-ray below 20keV, which can be obtained from the synchrotron radiation at The High Energy Research Institute, Tsukuba (KEK).

[Method] We exposed GD to monochromatic X-rays of 8,10,12,13 and 15keV in combination with 20keV. Whole GD was irradiated on the tough-water phantom by moving in the beam.

[RESULTS] Data of monochromatic X-ray irradiation, 8 or 20keV each, and the combination of 8 and 20keV at the depths of 1cm, 3mm, and 70 μm are shown in Figs.1, 2 and 3. Dose equivalents at 1cm depth by the irradiation using 8,10,12,13 and 15keV beams with 20keV are shown in Tables 1,2,3,4 and 5. Doses measured by radiophotoluminescence (RPL) at the 4 filter

portions are shown in Table 6. The above mentioned data are demonstrated as X-ray energies of mixed irradiation, sum of two kinds of monochromatic X-ray dose equivalents and the ratio of dose equivalents of sum to those of mixed irradiation. Radiation exposure data of continuous X-ray of ordinary medical X-ray apparatus are shown in Table 7 as measured by using an ionization chamber and GD.

[DISCUSSION] Difference between dose equivalents of the sum and that of mixed of two X-ray energies at 1cm depth stayed within ±20 %. As shown in table 5, the data of irradiation energy of single monochromatic X-rays were relatively reliable in the range above 15keV, but GD did not indicate actual value below 13keV. RPL of the filtered portions of GD, however, showed a good response to exposure, suggesting the possibility of exact indication of dose and energy.

[CONCLUSION] GD used in these experiments showed the capability of exact determination of clinically used X-ray energies above 15keV.

[ACKNOWLEDGMENTS] This study was supported by Science Research Fund from the Ministry of Education.

[REFERENCES]

E Piesch and B Burgkhardt : Photoluminescence dosimetry : The alternative in personnel monitoring. Radioprotection. 1994.Vol.29.P 39-67.

Ishikawa T and Murakami H : Basic characteristics of radiophotoluminescence glass dosimeter. Research Report of the Japan Atomic Energy Research Institute. 1994. P 1-42.

B Burgkhardt, E Piesch, S Ugi, T Ishikawa, T Ikegami, T Omori : New phosphate glass dosimeter systems for routine individual and environmental monitoring. Proceedings Program and Abstracts of the Fourth Conference on Radiation Protection and Dosimetry. October 23-27. 1994. P 141-150.

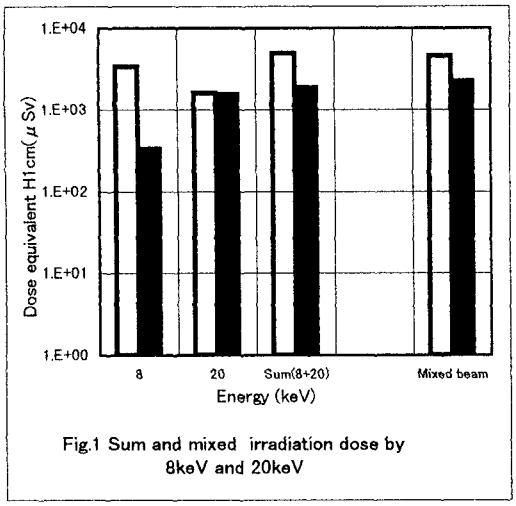

Fig.1 Sum and mixed irradiation dose by 8keV and 20keV

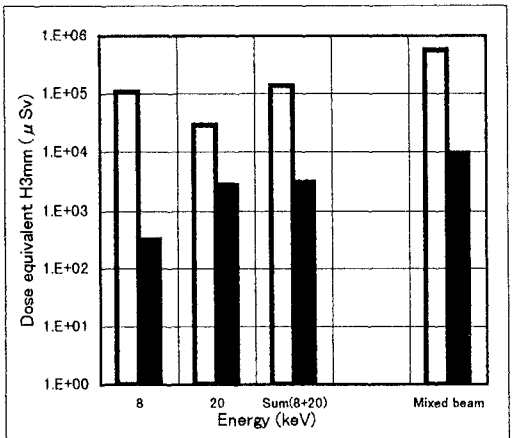

Fig.2 Sum and mixed irradiation dose by 8keV and 20keV

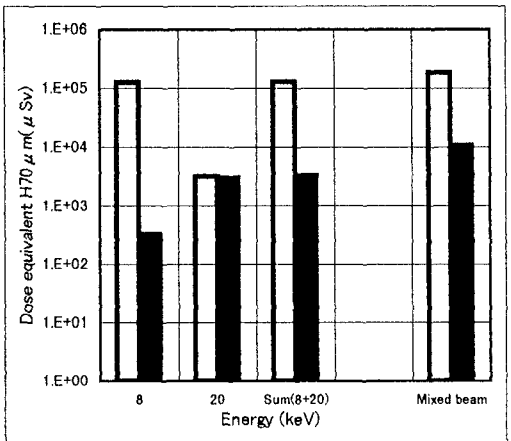

Fig.3 Sum and mixed irradiation dose by 8keV and 20keV

Table 1 Sum and mixed beam(8, 20 keV)

Monochro.	GD		
Energy(keV)	keV	H1cm(μ Sv)	
8	-	3373.8	340.8
20	21	1590.7	1590.7
Sum(8+20)		4964.5	1931.5
Mixed	<12	4547.5	2320.7
Mixed/Sum		0.92	1.20

Table 2 Sum and mixed beam(10, 20 keV)

Monochro.	GD			
Energy(keV)	keV	H1cm(μ Sv)		
10	-	8914.2	859.7	100.2
20	21	15356.7	1590.7	150.5
Sum(10+20)		24270.9	2450.4	250.7
Mixed	15	28941.7	2917.7	303.3
Mixed/Sum		1.19	1.19	1.21

Table 3 Sum and mixed beam(12, 20 keV)

Monochro.	GD			
Energy(keV)	keV	H1cm(μ Sv)		
12	-	15836.7	1419.8	144.3
20	21	15356.7	1590.7	1590.7
Sum(12+20)		31193.4	3010.5	1735.0
Mixed	14	33623.3	3568.5	1998.8
Mixed/Sum		1.08	1.19	1.15

Table 4 Sum and mixed beam(13, 20 keV)

Monochro.	GD			
Energy(keV)	keV	H1cm(μ Sv)		
13	<12	20280.0	2567.3	204.2
20	21	15356.7	1590.7	150.5
Sum(13+20)		35636.7	4158.0	354.7
Mixed	14	35098.3	4235.2	424.0
Mixed/Sum		0.98	1.02	1.20

Table 5 Sum and mixed beam(15, 20 keV)

Monochro.	GD		
Energy(keV)	keV	H1cm(μSv)	
15	15	4945.0	533.2
20	21	15356.7	1590.7
Sum(15+20)		20301.7	2123.9
Mixed	17	22740.0	2347.5
Mixed/Sum		1.12	1.11

Table 6 RPLs at 4 positions with filters

Monochro.	H1cm	1(Sn)	2(Al)	3(PET)	4(PET)
Energy(keV)	(μSv)	1mm	1mm	38μm	250μm
15	4945.0	28	5206	70352	68092
20	15356.7	118	31399	98450	96397
Sum(15+20)	20301.7	146	36605	168800	164483
Mixed	22740.0	160	35498	168768	165034
Mixed/Sum	1.12	1.10	0.97	1.00	1.00

PET: Polyethylene terephthalate

Table 7 Conventional X-ray

	Radcal ionization chamber		GD		
Tube Voltage	Measured(M)	Calculated	Measured(M)		Calculated
kV(Eeff)	H1cm(μSv)	keV	keV	H1cm(μSv)	keV
40(25.8)	700	-	24	812	-
80(33.9)	1040	-	32	923	-
Sum(40+80)	1740			1735	
Mixed (40+80)	700+1010	28.8	28	1772	28.3
Mixed (40+80)	517+269	26.7	26	835	

Table 8 Dose and effective energy calculated from 2 beams

	Energy	Dose equivalent(μSv)	
Beam 1	keV_1	S_1	} Mix
Beam 2	keV_2	S_2	

$keV_{(1+2)}=\{(keV_1 \cdot S_1)+(keV_2 \cdot S_2)\}/(S_1+S_2)$
$S_{(1+2)}=S_1+S_2$