FLUKE®
Biomedical

Nuclear Associates

37-040 (HD-810) and 37-041 (MD-55)

GAFCHROMIC® Therapy Dosimetry Media

Users Manual

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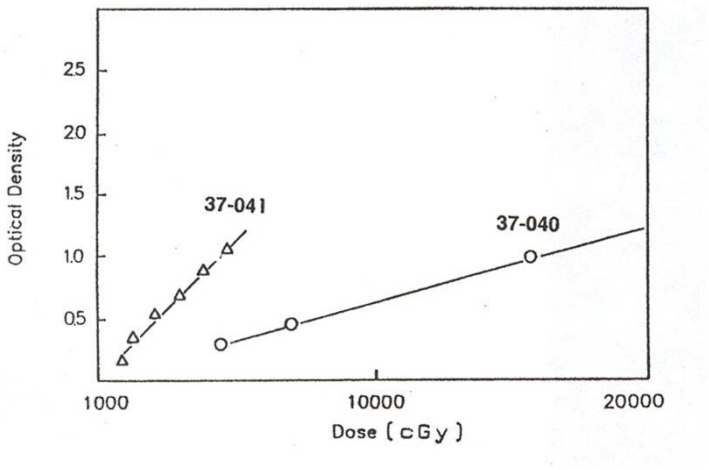
Section 1
Introduction

1.1 GAFCHROMIC™ Dosimetry Media

- Sensitive to Gamma, Electron, X-ray, Deep uv and Ionizing Radiation
- Self developing - no processing
- White light insensitive
- Dose rate independent
- Easy to use



1.2 Description

GAFCHROMIC Dosimetry Media has been developed for use with ionizing radiation. The indicating film does not require any processing to develop or fix the image; the image is available for use immediately after the exposure has been completed.

The GAFCHROMIC Dosimetry Media is particularly useful for routine dosimetry, dose mapping, beam profiling and high-resolution radiography.

Exposed and unexposed dosimetry media has remarkable stability. Nevertheless, since there is no step analogous to the fixing step whereby unexposed silver halide is removed from conventional film, the film remains active indefinitely.

GAFCHROMIC dosimetry media have a 7-micron radiation sensitive layer on a 4-mil polyester base. It is colorless, grainless and transparent before exposure. The color is a function of the radiation exposure; higher exposures result in progressively darker blue. This change can be measured accurately (with a spectrophotometer or other device that measures optical density or absorbance) to calculate applied dosage.

GAFCHROMIC dosimetry media is composed of materials with low atomic numbers and will not alter the radiation fields of most products. Further, the material is insensitive to normal room light.

GAFCHROMIC dosimetry media may be used over a wide range of absorbed doses. Typical dose calibration tables are provided in Tables 1-1 and 1-2 for measurement with a spectrophotometer at 400, 500 and 580 nanometers. (When using a device other than a spectrophotometer the device should be calibrated using reference dosimeters.) Since there is some post-exposure darkening and changes in dose/density response at elevated temperatures, care should be taken to adjust readings using Table 1-4. It is recommended that measurements be taken 24 hours after the end of irradiation. However, Table 1-5 allows for readings made at other times.

These instructions deal with the precautions that should be exercised when using or storing exposed or unexposed dosimeters/dosimetry film. When optimum storage conditions are maintained, it is believed

that the exposed dosimetry media are likely to have archival qualities. This manual also contains specific directions for the labeling of all dosimetry media samples.

1.3 Labeling

Unexposed dosimetry media should always be labeled with the batch number of the product. In addition, a user label to identify the exposure conditions, date, time, etc., should always be used in conjunction with an exposed dosimeter. The batch numbers provide an audit trail whereby process conditions and raw materials can be identified and traced if a problem occurs.

The batch number is to be found printed on the package containing sheets of dosimetry media.

1.4 Handling

Unexposed and exposed dosimetry media should be handled only by the edges. It is recommended that the paper covering the coated side be left on, until immediately prior to reading the dosimeters, to protect the active coating. When writing on the media be careful not to exert pressure on the active area of other sheets of dosimetry media.

Prior to reading the dosimetry media, visually inspect the reading area to ensure that there are no flaws or marks, which might affect the reading. Remove loose particles by light rubbing with a lint-free paper or cloth. If flaws or marks cannot be removed and readings cannot be taken in other areas of the dosimeter, discard the dosimeter.

Unexposed dosimetry media should be handled by the edges or corners, taking care not to place fingerprints in areas of the film that are to be imaged. Wearing cotton gloves while handling film is recommended as the best way to avoid fingerprinting or scratching the film.

1.5 Storage of Unexposed Dosimeters/Dosimetry Media

1.5.1Temperature

Where possible, store below 25°C (77°F). Although experiments have consistently shown that GAFCHROMIC dosimetry media suffer no ill effects at temperatures up to 50°C (122°F), adherence to a maximum storage temperature of 25°C (77°F) will provide the longest life. Never expose dosimetry media to temperatures exceeding 65°C (149°F).

1.5.2Relative Humidity

When the dosimetry media are kept below 25°C (77°F), they should be unaffected by any humidity below 100%. However, a dry storage location at 50% RH, or less, is preferred.

1.5.3Visible Light

Unopened boxes of dosimeters/dosimetry media are adequately protected against all visible light conditions. Although the dosimetry media have almost insignificant sensitivity towards visible light, it is recommended that opened packages of the media be kept away from all unnecessary exposure to light, particularly because visible light sources sometimes have an ultraviolet component that can be deleterious to the dosimeters. Therefore, store unexposed dosimeters/dosimetry media in their packages, with the covers closed.

1.5.4Ultraviolet Light

The dosimetry media have increasing sensitivity to radiation at decreasing wavelengths below the visible region. Therefore, exposure to any source containing an ultraviolet component, including sunlight, is not recommended.

1.5.5Microwave Radiation

Exposure to microwave radiation may cause heating of the dosimetry media and is therefore not recommended.

1.5.6Solvents

The vapors of organic solvents may diffuse into the active layer of the dosimetry media and have adverse effects upon the radiation sensitive component. Incidental contact with such vapors is unlikely to cause harm, but continuous exposure is to be avoided. Neither is it recommended that any liquid solvent, aqueous or nonaqueous, be allowed to contact the surface of the dosimetry media. If an aqueous or non-aqueous solvent were to wet the surface of unexposed dosimeters or media, it is recommended that the contaminated dosimeters or media be discarded.

1.6 Storage Of Exposed Dosimeters/Dosimetry Media

1.6.1Temperature

The normally blue color of exposed dosimetry media rapidly converts to an orange-red color at temperatures above 65°C (149°F). Therefore, never subject exposed dosimeters/dosimetry media to temperatures exceeding 60°C (140°F). For optimum results store exposed dosimetry media in the dark, where the temperature will be below 25°C (77°F).

1.6.2Relative Humidity

Although high relative humidity, i.e. <80%, is not deleterious at low temperatures, i.e. <25°C (77°F), the combination of high temperature, i.e. <60°C (140°F), and high relative humidity can increase the rate at which the blue to red-orange color change occurs.

Therefore, do not subject exposed dosimetry media to high humidity and high temperature, i.e. <85% RH and <60°C (140°F). Where possible, it is recommended that exposed dosimeters/dosimetry media be stored in the dark where the relative humidity is less than 50% and the temperature is below 25°C (77°F).

1.6.3Visible Light

Although the dosimeters/dosimetry media have almost insignificant sensitivity towards visible light, it is recommended that unnecessary exposure be avoided, so that the maximum lifetime may be obtained. This is particularly so because visible radiation sources frequently have an ultraviolet component that will cause more rapid increases in optical density. Therefore, when exposed dosimeters/dosimetry media are not being used, do not leave them laying on a laboratory bench or table, the measurement stage of a densitometer, the sample holder of a spectrophotometer, desktop, etc. Store exposed dosimetry media in the dark. Exposed dosimetry media should be stored in a glassine, plastic or paper envelope, preferably black.

1.6.4Ultraviolet Light

The radiation sensitive component in the dosimetry media has increasing sensitivity to radiation as the wavelength of the radiation decreases below that of visible light. Therefore, exposure to any source containing an ultraviolet component, including sunlight, is not recommended.

1.6.5Microwave Radiation

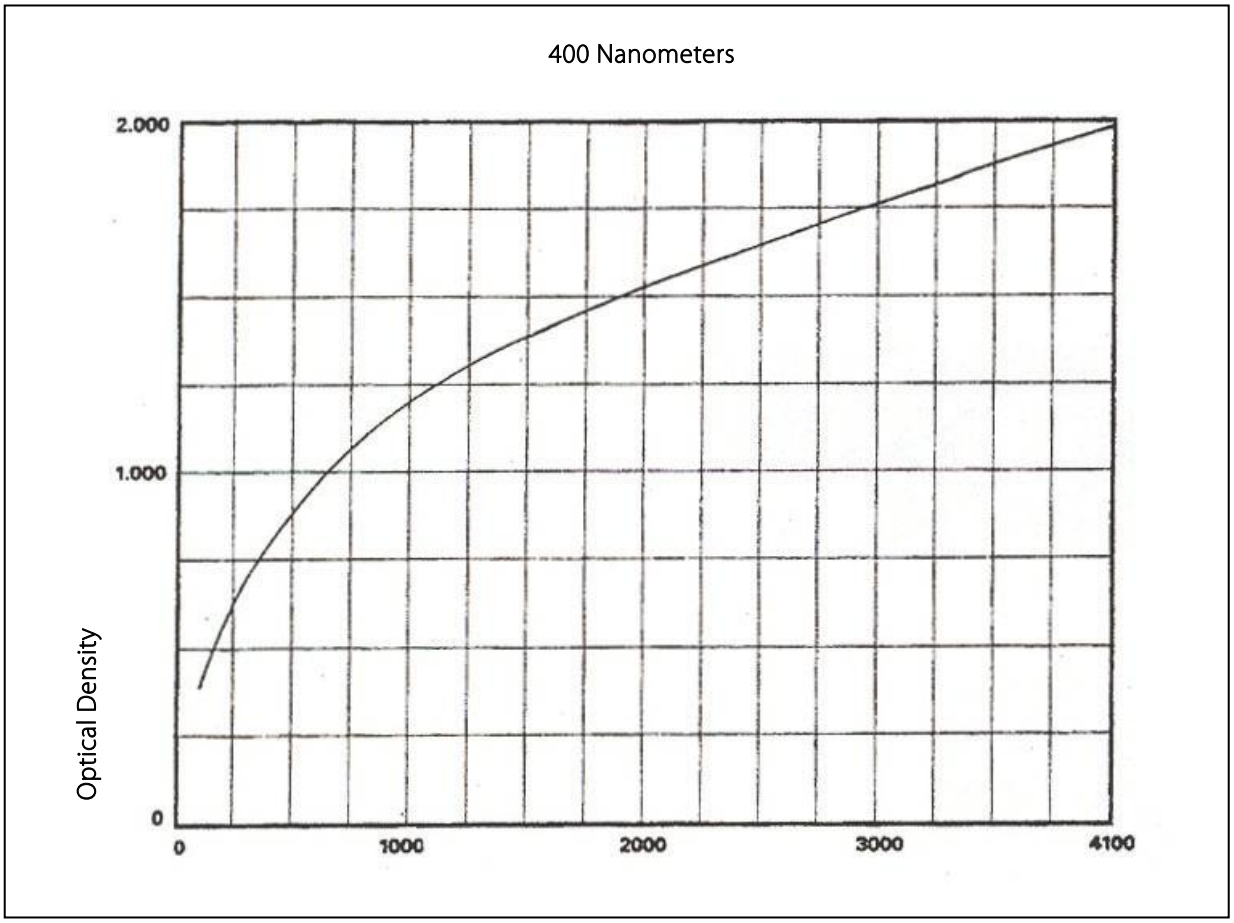
Microwave radiation may cause heating or other deleterious effects in exposed dosimeters/dosimetry media, and exposure to such sources should be avoided.

1.6.6Solvents

Long-term contact with many aqueous and non-aqueous solvents has been found to cause exposed dosimetry media to change irreversibly from blue to red. It is therefore recommended that exposed dosimeters/dosimetry media be kept away from all aqueous and non-aqueous solvents, as well as the vapors of solvents. If a solvent is accidentally spilled on an exposed dosimeter/dosimetry media, the spill should be blotted up with an absorbent, lint-free paper or cloth. If the solvent is volatile, the last traces may be removed by drying in an airstream at ambient temperature (<25°C).

If the liquid is not volatile, it is permissible to quickly rinse the dosimeter/dosimetry media in isopropanol. The excess isopropanol should be immediately blotted dry and the last traces removed by blowing in a cool airstream (<25°C).

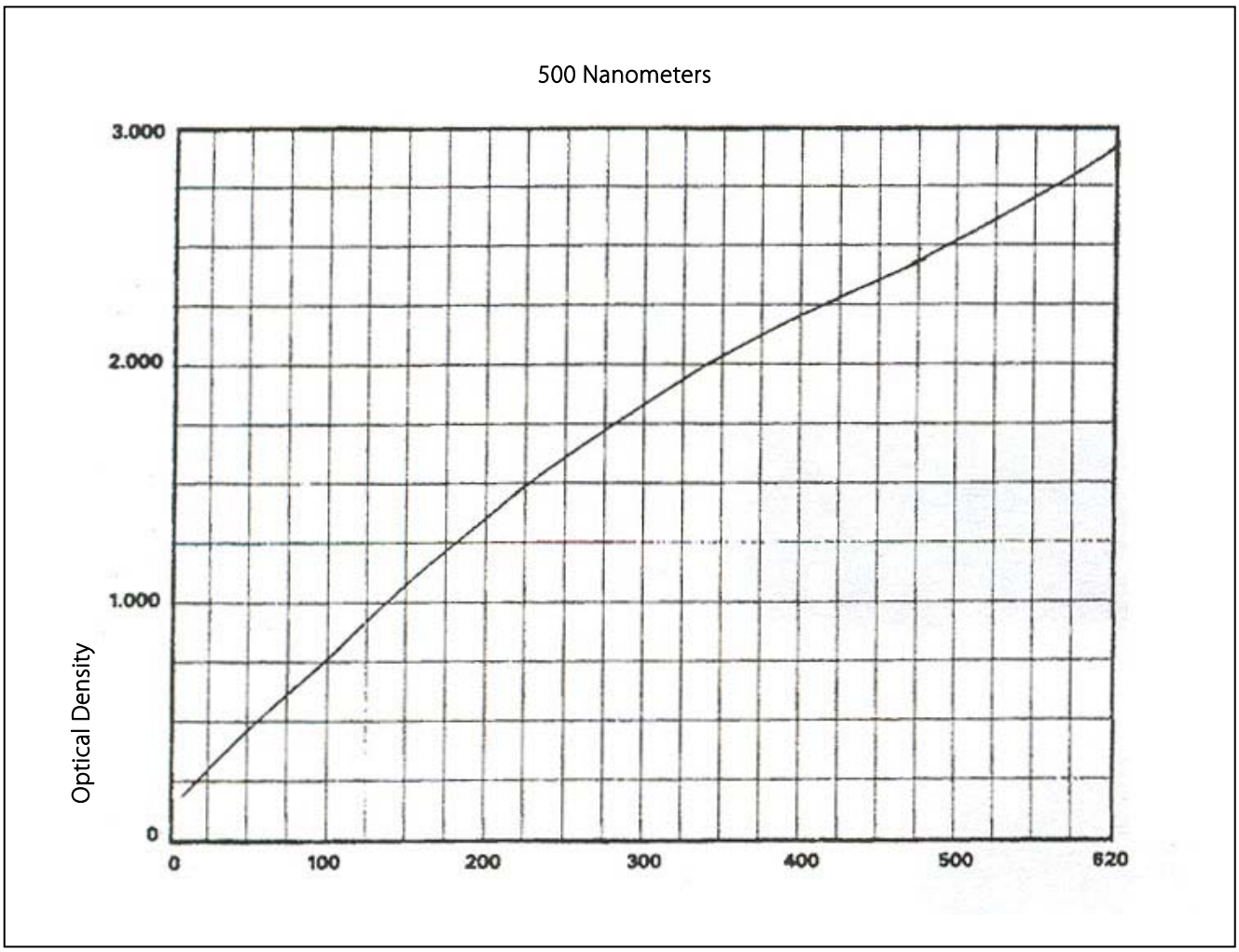
Table 1-1. Typical Dose Calibration Curves with a Spectrophotometer (24 hours after irradiation at 25°C)



Absorbed Dose, kRads

Optical Density	Absorbed Dose, kRads	Optical Density	Absorbed Dose, kRads	Optical Density	Absorbed Dose, kRads
0.370	100	1.025	700	1.460	1,750
0.400	120	1.035	720	1.475	1,800
0.430	140	1.050	740	1.490	1,850
0.465	160	1.060	760	1.505	1,900
0.500	180	1.070	780	1.520	1,950
0.535	200	1.080	800	1.535	2,000
0.570	220	1.092	820	1.562	2,100
0.602	240	1.105	840	1.587	2,200
0.635	260	1.115	860	1.612	2,300
0.662	280	1.125	880	1.637	2,400
0.690	300	1.135	900	1.662	2,500
0.715	320	1.145	920	1.685	2,600
0.737	340	1.155	940	1.707	2,700
0.760	360	1.160	960	1.728	2,800
0.782	380	1.170	980	1. 750	2,900
0.802	400	1.180	1,000	1.770	3,000
0.822	420	1.205	1,050	1.788	3,100
0.837	440	1.225	1,100	1.807	3,200
0.857	460	1.245	1,150	1.825	3,300
0.872	480	1.265	1,200	1.843	3,400
0.890	500	1.285	1,250	1.860	3,500
0.905	520	1.305	1,300	1.877	3,600
0.920	540	1.325	1,350	1.893	3,700
0.935	560	1.342	1,400	1.910	3,800
0.947	580	1.360	1,450	1.925	3,900
0.962	600	1.380	1,500	1.940	4,000
0.975	620	1.395	1,550	1.955	4,100
0.987	640	1.412	1,600		
1.000	660	1.430	1,650		
1.015	680	1.445	1,700		

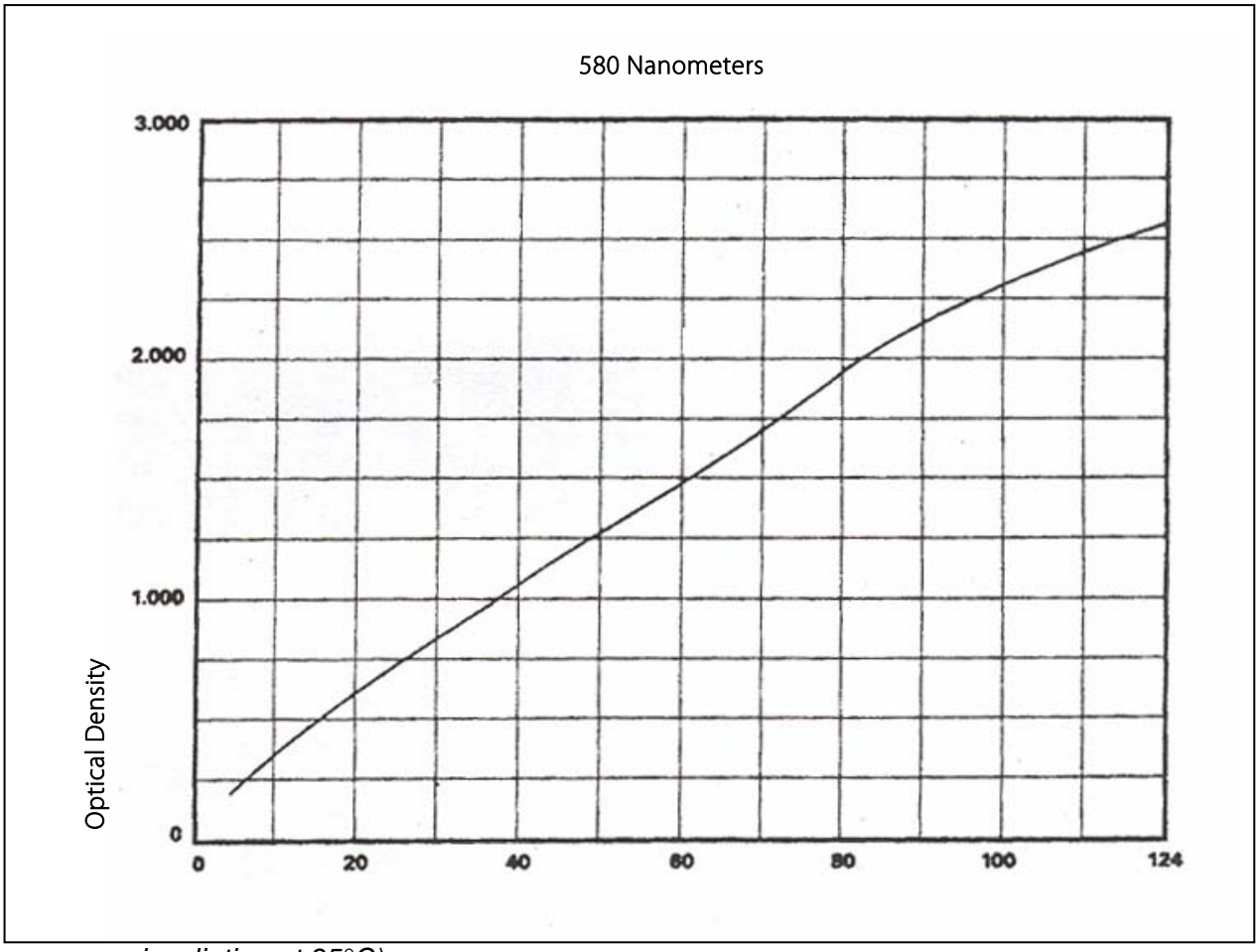
Table 1-2. Typical Dose Calibration Curves with a Spectrophotometer (24 hours after irradiation at 25°C)



Absorbed Dose, kRads

Optical Density	Absorbed Dose, kRads	Optical Density	Absorbed Dose, kRads
0.175	10	0.742	95
0.180	11	0.775	100
0.187	12	0.840	110
1.195	13	0.905	120
0.200	14	0.967	130
0.205	15	1.030	140
0.212	16	1.090	150
0.220	17	1.145	160
0.225	18	1.205	170
0.230	19	1.260	180
0.237	20	1.310	190
0.250	22	1.365	200
0.265	24	1.465	220
0.277	26	1.560	240
0.290	28	1.652	260
0.305	30	1.740	280
0.317	32	1.825	300
0.330	34	1.905	320
0.345	36	1.985	340
0.357	38	2.060	360
0.370	40	2.135	380
0.385	42	2.205	400
0.397	44	2.275	420
0.410	46	2.345	440
0.425	48	2.410	460
0.437	50	2.475	480
0.470	55	2.540	500
0.505	60	2.605	520
0.540	65	2.667	540
0.575	70	2.730	560
0.607	75	2.790	580
0.640	80	2.852	600
0.675	85	2.912	620
0.710	90		

Table 1-3. Typical Dose Calibration Curves with a Spectrophotometer (24 hours after irradiation at 25°C)



Absorbed Dose, kRads

Optical Density	Absorbed Dose, kRads	Optical Density	Absorbed Dose, kRads
0.210	5	1.215	48
0.235	6	1.265	50
0.255	7	1.305	52
0.280	8	1.350	54
0.305	9	1.395	56
0.325	10	1.440	58
0.350	11	1.485	60
0.375	12	1.535	62
0.400	13	1.575	64
0.425	14	1.625	66
0.450	15	1.670	68
0.475	16	1.715	70
0.500	17	1.780	72
0.525	18	1.850	74
0.550	19	1.855	76
0.575	20	1.895	78
0.625	22	1.935	80
0.670	24	2.025	84
0.720	26	2.100	88
0.765	28	2.175	92
0.815	30	2.235	96
0.860	32	2.300	100
0.905	34	2.350	104
0.950	36	2.400	108
0.995	38	2.450	112
1.040	40	2.490	116
1.085	42	2.530	120
1.130	44	2.560	124
1.175	46		

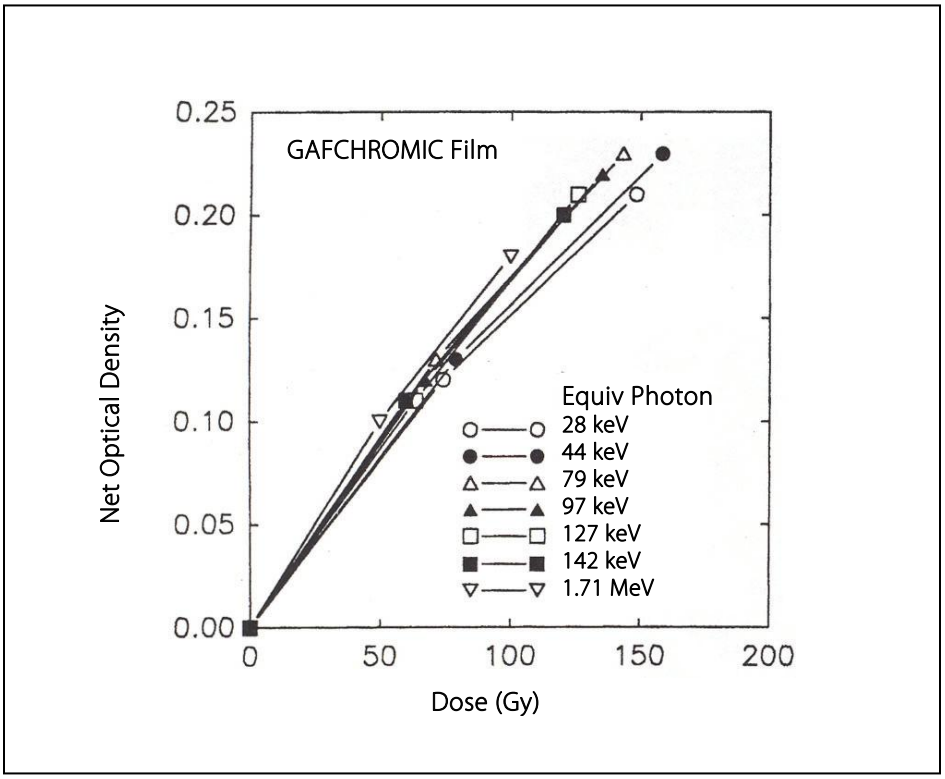
Table 1-4. Optical Density of GAFCHROMIC Media at Various Temperatures*

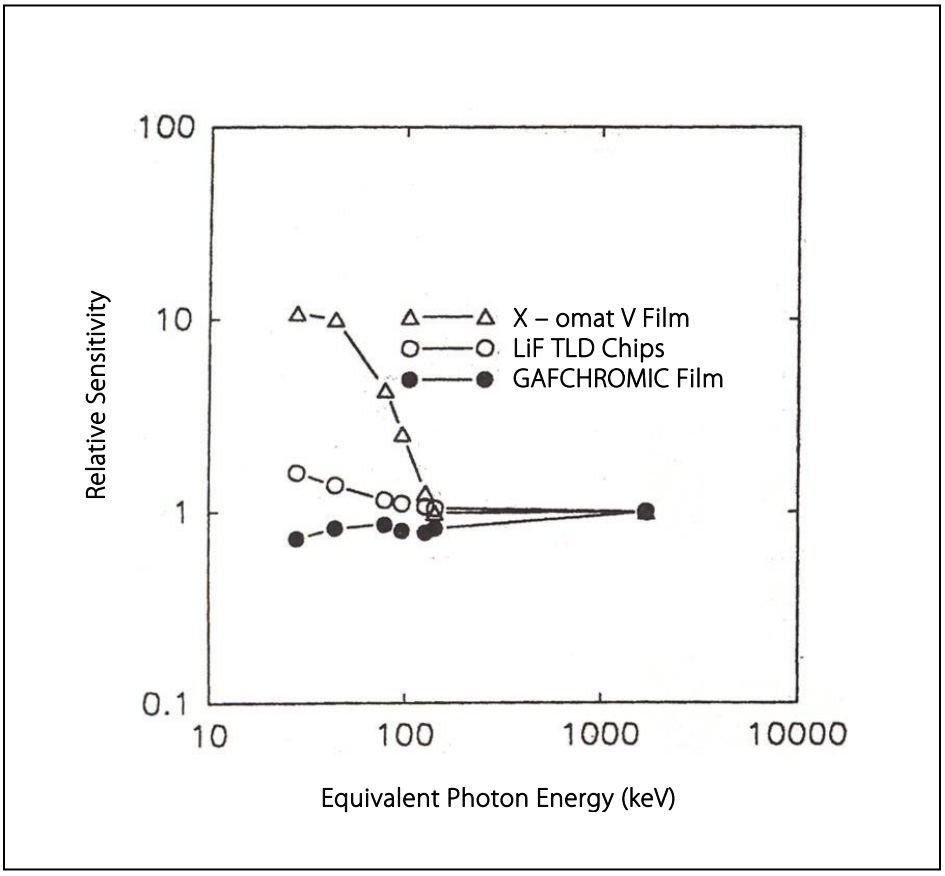
Wavelength	400nm			500nm			580nm		
Absorbed Dose	Temperature			Temperature			Temperature		
	10°C	25°C	40°C	10°C	25°C	40°C	10°C	25°C	40°C
50 kRads	0.257	0.266	0.284	0.416	0.437	0.493	1.190	1.265	1 .453
100 kRads	0.353	0.370	0.408	0.723	0.775	0.895	2.142	2.300	2.659
500 kRads	0.825	.0.890	0.913	2.306	2.540	2.632			
1,000 kRads	1.135	1.180	1.201						

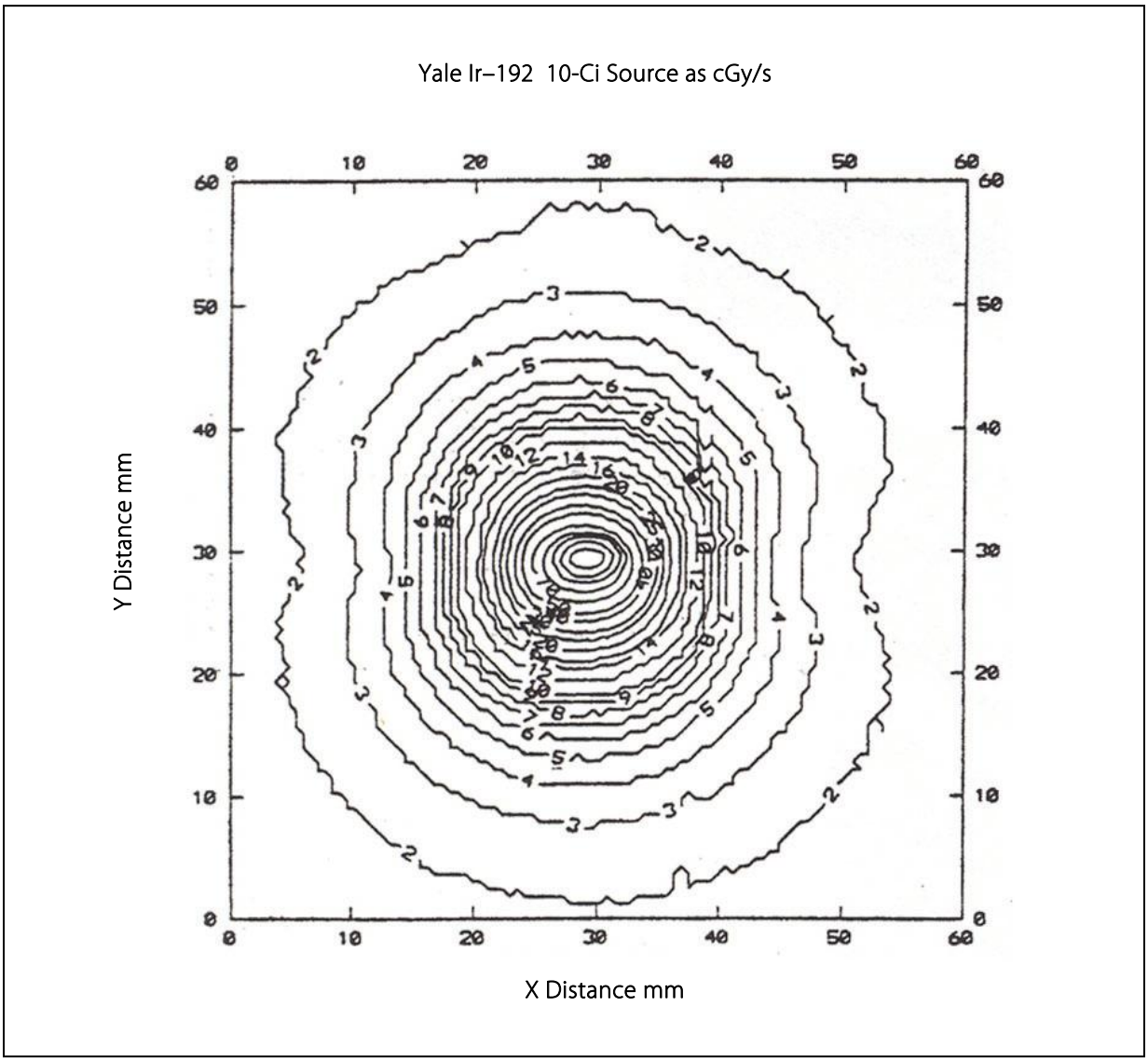
* Data read 24 hours after irradiation.

Table 1-5. Post-Irradiation Density Growth at 25°C

Wavelength	400nm		500nm		580nm	
Absorbed Dose kRads	Time After Irradiation 5 Hrs	24 Hrs	Time After Irradiation 5 Hrs	24 Hrs	Time After Irradiation 5 Hrs	24 Hrs
5.1	0.165	0.166	0.138	0.173	0.208	0.212
10.0	0.177	0.177	0.140	0.175	0.315	0.325
20.0	0.197	0.198	0.232	0.237	0.560	0.575
30.0	0.220	0.221	0.300	0.305	0.801	0.815
40.0	0.239	0.241	0.361	0.370	1.021	1.040
50.0	0.264	0.266	0.427	0.437	1.232	1.265
60.0	0.284	0.286	0.498	0.505	1.464	1.485
70.0	0.306	0.311	0.563	0.575	1.684	1.715
80.0	0.325	0.329	0.629	0.640	1.896	1.935
90.0	0.346	0.351	0.696	0.710	2.097	2.137
100.0	0.363	0.370	0.760	0.775	2.263	2.300
200.0	0.529	0.535	1.346	1.365		
300.0	0.680	0.690	1.791	1.825		
400.0	0.790	0.802	2.166	2.205		
500.0	0.876	0.890	2.487	2.540		
600.0	0.944	0.962	2.791	2.852		
700.0	1.008	1.025				
800.0	1.063	1.080				
900.0	1.114	1.135				
1000.0	1.160	1.180				
1500.0	1.343	1.380				
2000.0	1.494	1.535				
2500.0	1.603	1.662				
3000.0	1.708	1.770				
3500.0	1.783	1.860				
4000.0	1.856	1.940				


GAFCHROMIC Film
Net Optical Density
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
200
Dose (Gy)
Equiv Photon
28 keV
44 keV
79 keV
97 keV
127 keV
142 keV
1.71 MeV


Relative Sensitivity
100
10
1
0.1
10
100
1000
10000
Equivalent Photon Energy (keV)
X – omat V Film
LiF TLD Chips
GAFCHROMIC Film


Yale Ir–192 10-Ci Source as cGy/s
Y Distance mm
X Distance mm
0
10
20
30
40
50
60

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