GAFCHROMIC™

DOSIMETRY MEDIA, TYPE HD-V2

WARNING: Store below 25ºC
Store away from radiation sources
Do not expose film to sunlight
Handle film carefully, creasing may cause damage
Do not expose to temperatures above 50ºC

CONTENTS: 5 sheets, 8” x 10”

GAFCHROMIC™ HD-V2 Dosimetry Film

GAFChromic HD-V2 is a radiochromic dosimetry film designed for the quantitative measurement of absorbed dose of high-energy photons. As a self-developing film, HD-V2 is a perfect fit for the processorless environment. Since radiochromic film requires no post-exposure processing, there are no chemicals to dispose of and the film can be handled and used without need of a darkroom.

Key technical features of GAFCHROMIC® H-VD2 include:

- Dynamic dose range: 10 Gy to 1000 Gy
- Develops in real time without post-exposure treatment;
- Energy-dependence: minimal response difference from 100keV into the MV range;
- Near tissue equivalent;
- High spatial resolution – can resolve features to 5µm, or less;
- Active coating exposed for detection of low energy photon and electron

- Proprietary new technology incorporating a marker dye in the active layer:
    - Enables non-uniformity correction by using triple-channel dosimetry
    - Decreases UV/light sensitivity;
- Stable at temperatures up to 60°C;

The most important feature of GAFChromicC HD-V2 compared to the previous generation HD810 dosimetry film is the incorporation of a yellow marker dye. Used in conjunction with an rgb film scanner and FilmQAPro™ software[1], the marker dye in HD-V2 film enables all the benefits of triple-channel dosimetry[2]. Using the marker dye feature is not mandatory asdosimetry can still be done using a single color channel (preferably the red channel), but you give up all the advantages of the triple-channel method that compensates for thickness differences of the film's active layer.

To learn more about FilmQAPro software and triple-channel film dosimetry, visit www.FilmQAPro.com.

As shown in Figure 1, the structure of GAFChromic® HD-V2 film is asymmetric. The film is comprised of an active layer, nominally 12µm thick, containing the active component, marker dye, stabilizers and other components giving the film its energy-independent response. The thickness of the active layer may vary slightly from batch-to-batch. The active layer is coated on a clear, 97 µm polyester substrate.

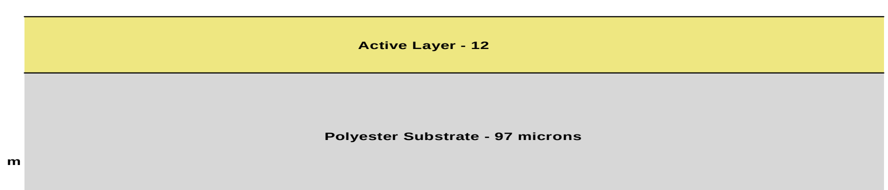

Figure 1: Configuration of GAFChromic® HD-V2 Dosimetry Film

There have been indications that the response measurements made with a scanner or densitometer may be dependent on which side of the film is facing the light source. While the difference may be very small it is advised to be consistent with which side of the film faces the light source.

To help distinguish between the sides, sheets of GAFChromic HD-V2 film are marked with a small slit near one corner. When film is viewed in landscape orientation with the slit in the top right corner as shown in Figure 2, the active layer is on the side facing the viewer.

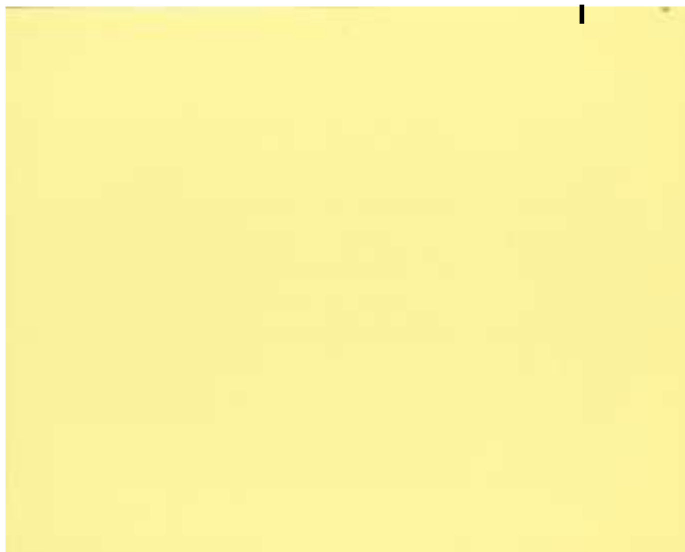

Figure 2: GAFChromic HD-V2 film in landscape view showing slit in top right corner.

SPECIFICATIONS

Property	GAFChromic® HD-V2 Film
Configuration	Active layer on 3.8 mil (97 µ) clear polyester substrate
Size	8" x 10", other sizes available upon request
Dynamic dose range	10 to 1000 Gray
Energy dependency	<5% difference in net density when exposed at 1 MeV and 18 Mev
Dose fractionation response	<5% difference in net density[2] for a single 100 Gy dose and five cumulative 20 Gy doses at 30 min. intervals
Dose rate response	<5% difference in net density[2] for 10 Gy exposures at rates of 3.4 Gy/min. and 0.034 Gy/min.
Stability in light	$<5x10^{-3}$ change in optical density per 1000 lux-day
Stability in dark (pre-exposure	$<5x10^{-4}$ optical density change/day at 23 °C and $<2x10^{-4}$ density change/day refrigerated
Uniformity	Better than 3% in sensitometric response from mean; dose uniformity better than ±2% with FilmQAPro and triple-channel dosimetry

PERFORMANCE DATA AND PRATICAL USER GUIDELINES

When the active component in GAFChromic HD-V2 film is exposed to radiation, it reacts to form a blue colored polymer with absorption maxima at approximately 670 nm as shown in Figure 3.
Note: The active component in HD-V2 is chemically the same as that in EBT3, EBT-XD and MD-V3, but the crystalline form is different. Hence the absorbance maximum is about 670 nm rather than 635 nm. .

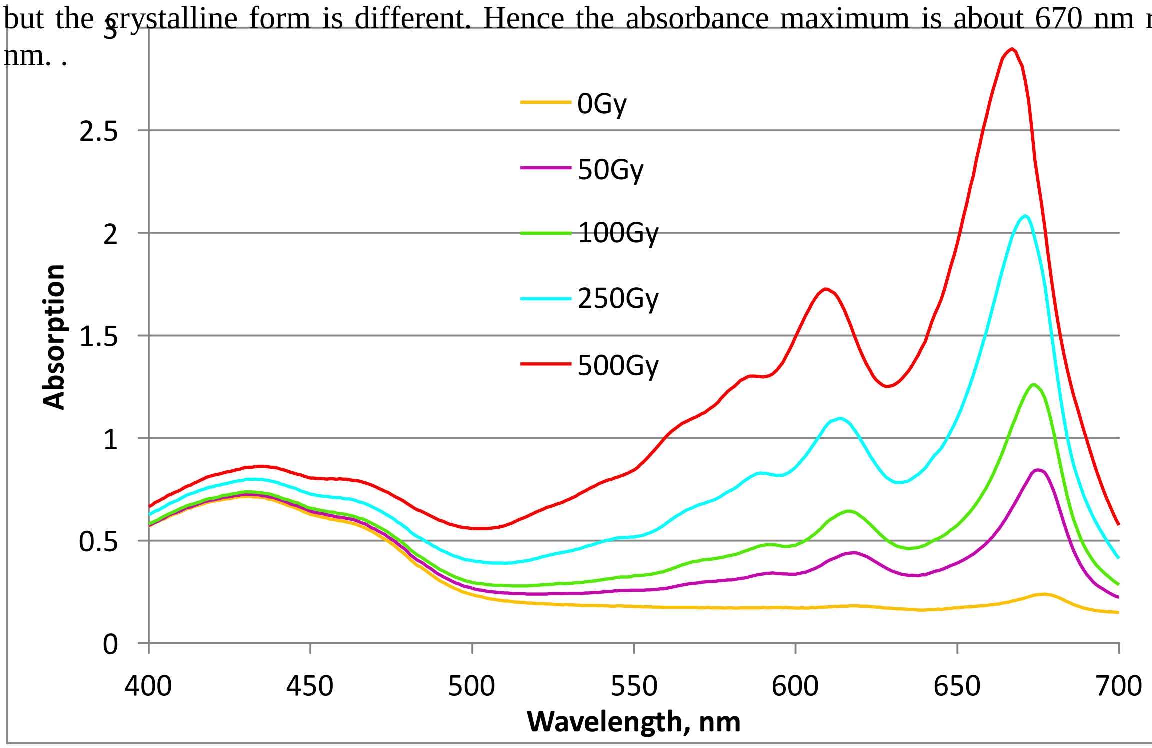

Figure 3: Spectra of GAFChromic HD-V2 as a function of adsorbed dose

GAFChromic HD-V2 radiochromic dosimetry film may be measured with a transmission densitometer, a film scanners or a spectrophotometer. As can be inferred from the spectra in Figure 3, the response of the film is enhanced when measured with red light. For spectrophotometer measurements, the greatest response is obtained at peak absorbance wavelengths. Most densitometers measure over a band of wavelengths. Black/white densitometers measure over the entire visual band while color densitometers measure over various narrower red, green and blue bands within the visible spectrum.

For two-dimensional measurement over a large film area the most efficient process is to use a 48-bit (16-bit per channel) flatbed color scanner.
The EPSON Expression 11000XL Photo scanner, and the now discontinued model 10000XL Photo scanner are the recommended models. These are color scanners and measure the red, green and blue color components of light transmitted by the film at a color depth of 16 bit per channel. These EPSON scanners are particularly recommended due to their large scanning area.

The typical dose response of HD-V2 film on an Epson color scanner is shown in Figure 4.
We recommend to fit the calibration data to a function having the form

$$d_x(D) = a + b/(D-c)$$

where $d_x(D)$ is the optical density of film in scanner channel x at dose D, and a, b, c are the equation parameters to be fitted. The advantages of this type of function are:

- They are simple to invert and determine density as a function of dose, or dose as a function of density;
- They have rational behavior with respect to the physical reality that the density of the film increases with increasing exposure yet approaches a near constant value at high exposures. Polynomial functions characteristically have no correspondence to physical reality outside the data range over which they are fitted;
- Since these functions have the described rational behavior, fewer calibration points are required saving time and film: A typical case would use 6-8 points (including unexposed film) with the doses in geometric progression.

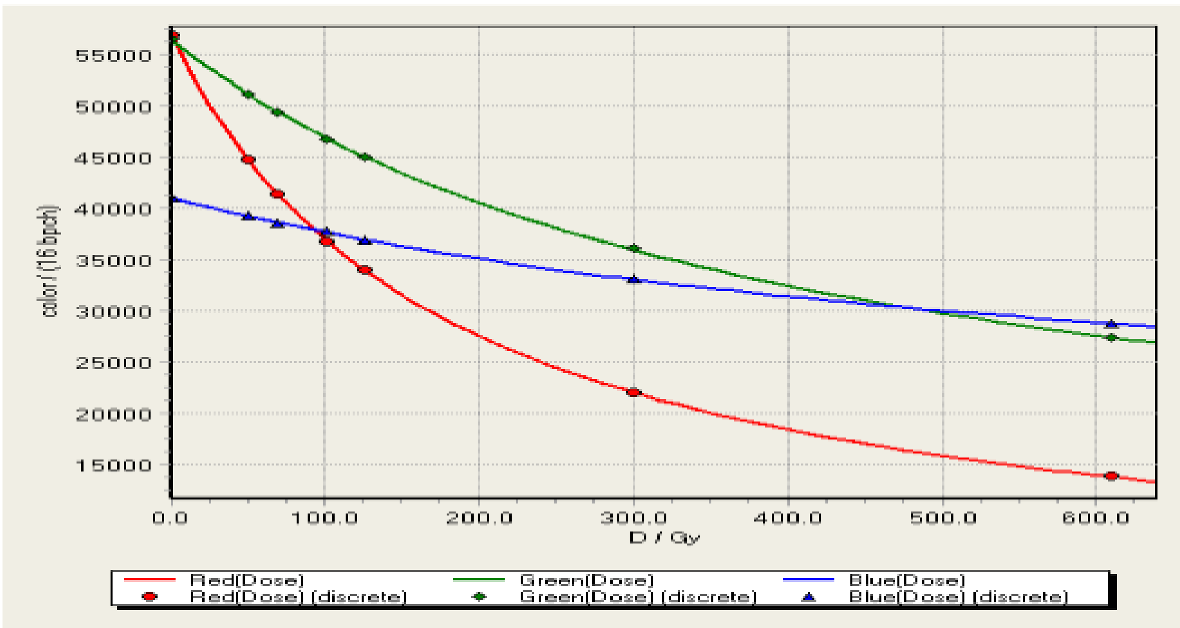

Figure 4: Response of GAFChromic HD-V2 in all Color Channels

Detailed instructions defining the optimum procedure for scanning radiochromic film, establishing a calibration curve using FilmQAPro software and obtaining dose measurements from an application film are contained in the document Efficient Protocols for Calibration and Dosimetry Films on this web site. The procedures described have been thoroughly validated and are in widespread use in the medical physics community providing dose measurement uncertainty well below 2%.

References

1. FilmQA Pro 3.0 software can be downloaded at www.Filmqapro.com

Micke, A., Lewis, D.F., Yu, X. "Multichannel film dosimetry with non- uniformity correction," *Med Phys*, 38(5), 2523-2534 (2011).