

A vertical bar on the left side of the page, transitioning from dark green at the top to yellow at the bottom.

# GAFCHROMIC<sup>TM</sup>

## DOSIMETRY MEDIA, TYPE EBT-XD

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

CONTENTS: 25 sheets, 8" x 10"

## GAFCHROMIC™ EBT-XD Dosimetry Film

GAFCHROMIC™ EBT-XD is designed for the measurement of absorbed doses of ionizing radiation particularly suited for high-energy photons. The dynamic range of this film is specifically designed for best performance in the dose range from 0.4 to 40 Gy which makes it best suited for applications such as SRS and SBRT. The structure of GafChromic™ EBT-XD radiochromic film is shown in Figure 1. The film is comprised of an active layer, nominally 15µm thick, containing the active component, marker dye, stabilizers and other components giving the film its near energy-independent response. The thickness of the active layer may vary slightly from batch-to-batch. The active layer is sandwiched between two 125 µm matte polyester substrates.

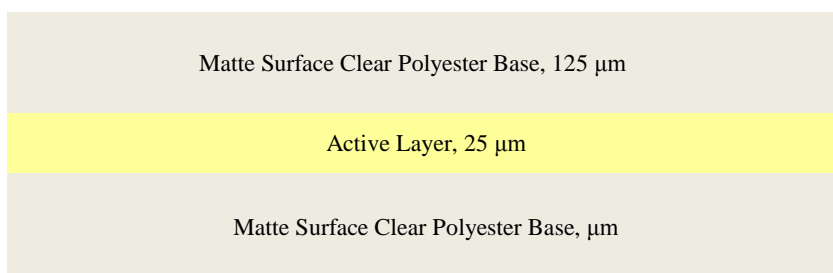


Figure 1: Structure of the GafChromic™ EBT-XD Dosimetry Film

Key technical features of GafChromic EBT-XD include:

- Dynamic dose range: 0.1 Gy to 200 Gy
- Optimum dose range: 0.4 Gy to 40 Gy, best suited for applications such as SRS and SBRT
- 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 at least 5µm
- Proprietary new technology incorporating a marker dye in the active layer:
- Enables non-uniformity correction by using multichannel dosimetry
- Decreases UV/light sensitivity;
- Excellent uniformity
- Stable at temperatures up to 60°C;

The incorporation of a yellow marker dye, when used in conjunction with an RGB film scanner and FilmQAPro™ software<sup>1,2,3</sup>, the EBT-XD film enables all the benefits of multi-channel dosimetry.

To learn more about FilmQAPro™ software and multi-channel film dosimetry, visit [www.FilmQAPro.com](http://www.FilmQAPro.com).

## SPECIFICATIONS

Property	GAFCHROMIC™ EBT-XD Film
Configuration	Active layer (25 μm) sandwiched between on 5 mil (125 μm) matte surface clear polyester substrate
Size	8" x 10", other sizes available upon request
Dynamic Dose Range	0.1 to 200 Gy
Energy dependency	<5% difference in net optical density when exposed at 100 keV and 18 MeV
Dose fractionation response	<5% difference in net optical density for a single 25 Gy dose and five cumulative 5 Gy doses at 30 min. intervals
Dose rate response	<5% difference in net optical density for 10 Gy exposures at rates of 3.4 Gy/min. and 0.034 Gy/min.
Stability in light	<5x10 <sup>-3</sup> change in optical density per 1000 lux-day
Stability in dark (preexposure)	<5x10 <sup>-4</sup> optical density change/day at 23 °C and <2x10 <sup>-4</sup> density change/day refrigerated
Uniformity	Better than 3% in sensitometric response from mean

## PERFORMANCE DATA AND PRATICAL USER GUIDELINES

Like all other Gafchromic™ films, EBT-XD dosimetry film can be handled in normal room light for at least several hours without noticeable effects. However, it is suggested that the film should not be left exposed to room light indefinitely, but rather should be kept in the dark when it is not being handled. When the active component in GafChromic™ EBT-XD film is exposed to radiation, it reacts to form a blue colored polymer with absorption maxima at approximately 633 nm.

Gafchromic™ EBT-XD radiochromic dosimetry film is recommended to be digitized to obtain two-dimensional information in speedy fashion using 48 bit color depth flatbed color scanners. The commonly available professional photo scanners such as EPSON Expression 11000XL, V750, V700 and 1680 flatbed color scanners can be used. These scanners are color scanners and measure the red, green and blue color components of the film at a color depth of 16 bit per channel. EPSON Expression 11000 XL is particularly recommended due to its large scanning area that allows the least amount of lateral effect.

A typical dose response of EBT-XD film on an RGB color scanner is shown in Figure 2. We recommend to fit the calibration curve to a function having the form

$$\bar{d}_x(D) = -\log\left(\frac{a+bD}{c+D}\right),$$

where  $d_x(D)$  is the optical density of the film in scanner channel  $x$  at dose  $D$ , and  $a$ ,  $b$ ,  $c$  are the equation parameters to be fitted. The advantages of these functions 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 should increase with increasing exposure yet approach 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.

## PERFORMANCE COMPARISON BETWEEN EBT3 AND EBT-XD FILM

As mentioned earlier, Gafchromic™ EBT-XD is specifically designed to obtain optimum results for the applications of SRS and SBRT. The high dose associated with these applications poses many challenges when EBT2/3 films<sup>4,5</sup> are used. The two main problems are the increased uncertainty at high dose and potentially unacceptable lateral scan effect.

Due to the chromatic nature of Gafchromic™ film, it does not have clear color saturation points. This is especially important when FilmQA Pro software is used for the analysis, since it takes advantage of all available color channels that effectively extend the dynamic range of the film. However, a shallow slope for the dose response curve can cause causes increased dosimetric error for high dose region. As seen in Figure 2, for the dose range between 10 and 20 Gy, EBT-XD film provides a more desirable calibration than EBT3.



Figure 2. Comparison of Calibration Curves of GAFCHROMIC™ EBT3 (left) and EBT-XD (right) Films

As noted by many users, flatbed scanners used for film measurement exhibit a lateral scan effect, i.e., the color value measured can vary depending upon the location of the film placement relative to the center of the scanner. Typically, film scanned away from the center location will have lower color pixel values which result in higher calculated doses. The variation (lateral effect) increases with color density of the film as results of the increased dose<sup>6,7</sup>.

As shown in Figure 3, the active particles in EBT-XD film are significantly smaller than those in EBT2/3 film. The smaller particle size reduces light scattering and polarization and, in combination with lower color density when compared to EBT2/3 films exposed to the same dose, is believed to reduce the lateral effect.

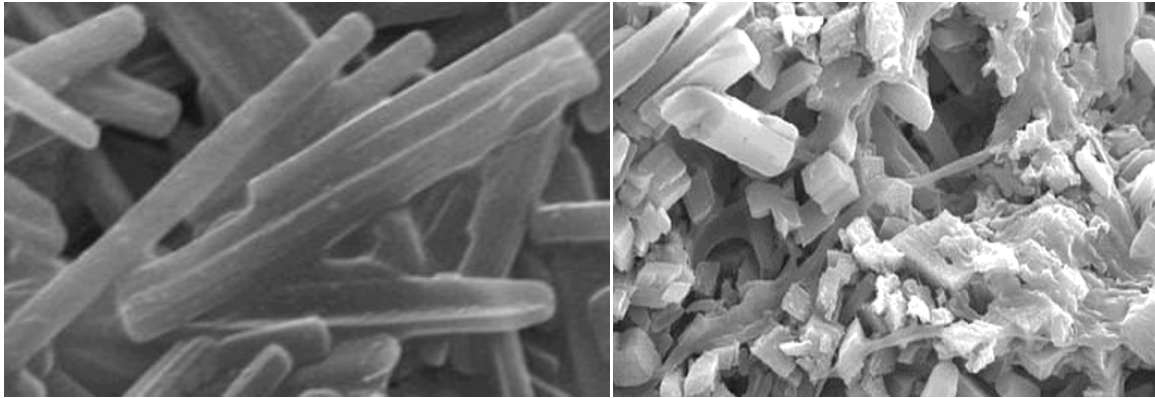


Figure 3 Active particles in EBT2/3 films (left) and in EBT-XD films

## REFERENCES

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