dosimetry media

gafchromic™ EBT4
dosimetry film

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gafchromic™ EBT4 dosimetry film

Gafchromic™ EBT4 is designed for the measurement of absorbed doses of ionizing radiation. It is particularly suited for high-energy photons. The dynamic range of this film is designed for best performance in the dose range from 0.2 to 10 Gy, making it suitable for many applications in IMRT, VMAT and brachytherapy. For measurement of doses substantially greater than 10 Gy EBT-XD or MD-V3 are preferred while the use of HD-V2 is indicated for still higher dose measurement.

The structure of EBT4 film is shown in Figure 1. The film is comprised of an active layer, nominally 28 µm thick, sandwiched between two 125 µm matte-polyester substrates. The active layer contains the active component, a marker dye, stabilizers and other components giving the film its near energy-independent response. The thickness of the active layer will vary slightly between different production lots.

figure 1: structure of gafchromic™ EBT4 dosimetry film

matte surface clear polyester base, 125 µm
active layer, 28 µm
matte surface clear polyester base, 125 µm

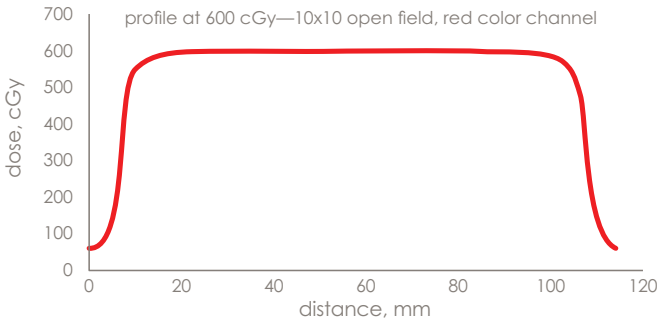
key technical features of gafchromic™ EBT4 include:

- optimum dose range: 0.2 Gy to 10 Gy, best suited for applications such as IMRT and VMAT
- develops in real time without post-exposure treatment
- energy-dependence: minimal response difference from 100 keV into the MV range
- near tissue equivalent
- high spatial resolution – can resolve features down to 25 µm, or less
- proprietary new technology incorporating a marker dye in the active layer
  - enables non-uniformity correction by using multi-channel dosimetry
  - decreases UV/visible light sensitivity
- stable at temperatures up to 60 °C

The yellow marker dye incorporated in EBT4, in conjunction with an RGB film scanner and FilmQAPro™ software,[1-3] enables the dosimetry process to benefit from the application of triple-channel dosimetry.

To learn more about FilmQAPro™ software and triple-channel film dosimetry, visit https://www.ashland.com/industries/medical/filmqa-pro-software.

figure 2: Improved signal-to-noise ratio reduces uncertainty in dosimetry measurement for better dosimetry results



specifications

property	gafchromic™ EBT4 film
configuration	active layer (28 µm) sandwiched between 125 µm matte-surface polyester substrates
size	8" x 10", other sizes available upon request
optimum dose range	0.2 Gy to 10 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	<5 x 10^{-3} change in optical density per 1000 lux-day
stability in dark (pre-exposure stability)	<5 x 10^{-4} optical density change/day at 23 °C and <2 x 10^{-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 practical user guidelines

Like all other gafchromic™ films, EBT4 dosimetry film can be handled in interior room light for short periods without noticeable effects. However, it is suggested that the film should not be left exposed to room light for hours, but rather should be kept in the dark when not in use. When the active component in EBT4 film is exposed to radiation, it reacts to form a blue colored polymer with absorption maxima at approximately 633 nm.

Gafchromic™ EBT4 dosimetry film is recommended to be used with a 48-bit (16-bit per channel) flatbed color scanner. The EPSON Expression 12000XL Photo scanner, and the now discontinued models 11000XL Photo and 10000XL Photo scanner are the recommended models. These are color scanners that 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 EBT4 film on an Epson 12000/10000/11000XL scanner is shown in figure 3. We recommend to fit the calibration curve to a function having the form

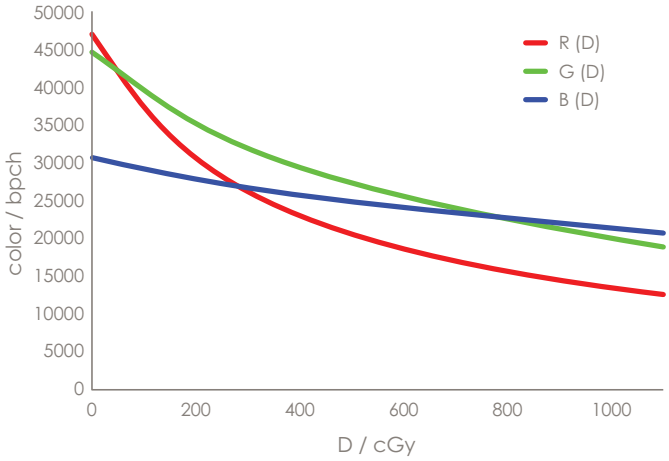
$$d_X(D) = a + b/(D-c)$$

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 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 exposure. 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.

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%.

figure 3: typical dose response curve of gafchromic™ EBT4 film



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