

# gafchromic™ hd-v2 films

## self-developing film for the quantitative measurement of absorbed dose of high-energy photons

### description

Gafchromic™ HD-V2 film 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 features and benefits

- 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 at least 5µm
- can be handled in room light – eliminates the need for a darkroom
- active coating exposed for detection of low energy photon and electron
- proprietary new technology incorporating a marker dye in active layer:
  - enables non-uniformity correction by using multichannel dosimetry
  - decreases UV/light sensitivity

Gafchromic™ HD-V2 uses a yellow marker dye. When used in conjunction with an rgb film scanner and FilmQA Pro™ software, the marker dye in HD-V2 film enables all the benefits of multi-channel dosimetry. Using the marker dye feature is not mandatory. You can continue to perform dosimetry using only the red color channel, but you give up all the advantages of the multi-channel method that will make your film dosimetry better.

To learn more about FilmQA Pro™ software and multi-channel film dosimetry, visit <https://www.ashland.com/industries/medical/filmqa-pro-software>.

The structure of Gafchromic™ HD-V2 film is shown in Figure 1. The film is comprised of an active layer, nominally 8µm 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.

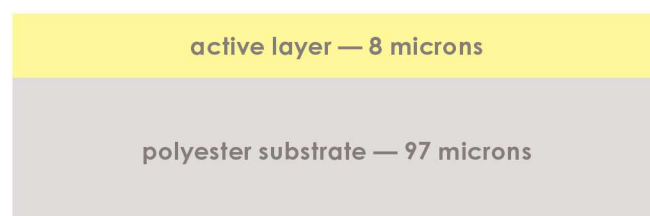


figure 1. configuration of Gafchromic™ HD-V2 dosimetry film



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Gafchromic™ HD-V2 film has an asymmetrical cross section (see Figure 1). Measurements indicate that the response of scanner or densitometer may be dependent on which side of the film is facing the light source. It is advised that HD-V2 film be consistently measured with the same side of the film facing the light source regardless of whether landscape or portrait orientation is used.

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

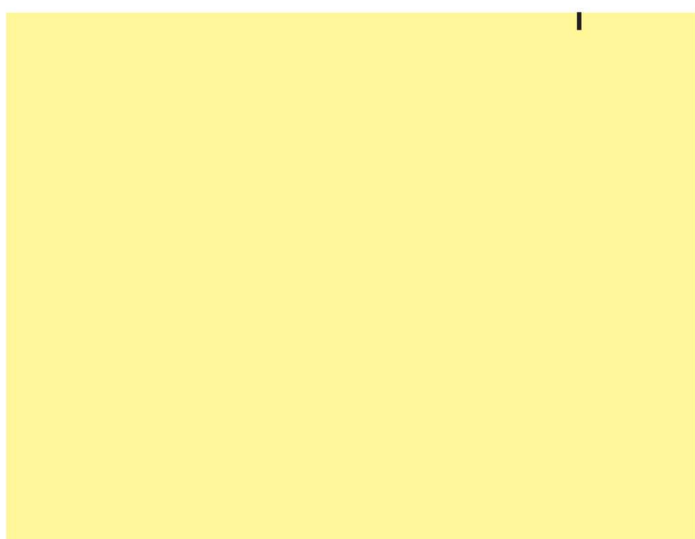


figure 2. Gafchromic™ HD-V2 film in landscape view showing slit in top right corner

## 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 <sub>2</sub> for a single 100 Gy dose and five cumulative 20 Gy doses at 30 min. intervals
dose rate response	<5% difference in net density <sub>2</sub> for 10 Gy exposures at rates of 3.4 Gy/min. and 0.034 Gy/min.
stability in light	<0.005 change in density per 1000 lux-day
stability in dark (preexposure)	<5x10 <sup>-4</sup> 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 practical 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.

Gafchromic™ HD-V2 radiochromic dosimetry film may be measured with transmission densitometers, film scanners or spectrophotometers. As one can infer from the Figure 3, the response of the dosimetry film media is enhanced by measurement with red light. In using a spectrophotometer the greatest response is obtained by scanning the film and using the peak absorbances. Most densitometers measure over a band of wavelengths and transmission densitometers for measuring colored films measure over various narrow color bands within the visible spectrum, e.g. visual, red, green and blue.

Such densitometers are commonly and widely employed in the photographic industry.

To obtain two-dimensional information in speedy fashion, flatbed color scanners are shown to work well with all Gafchromic™ films including HD-V2 films. The commonly available professional photo scanners such as EPSON® Expression 10000XL, 11000XL, 12000XL 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 in a color depth of 16 bit per channel.

A typical dose response of HD-V2 film on an rgb color scanner is shown in Figure 4. We recommend it to fit the calibration curve in function form of  $\bar{d}_x(D) = -\log\left(\frac{a+bD}{c+D}\right)$ , 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 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 asymptote towards 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
  - to cover a dose range of 0 – 1000 Gy requires 6-8 dose points, for example, 0, 25, 50, 100, 200, 400, 800 and 1200 Gy

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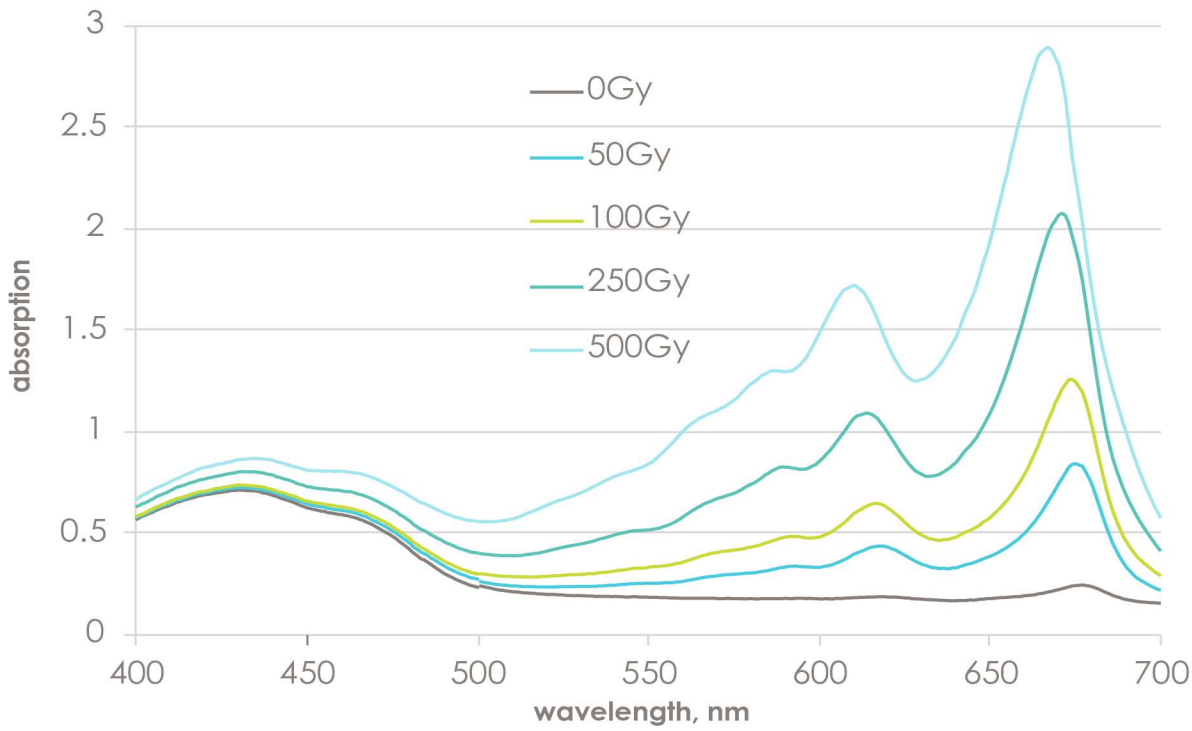


figure 3. spectra of Gafchromic™ HD-V2 as a function of absorbed doses

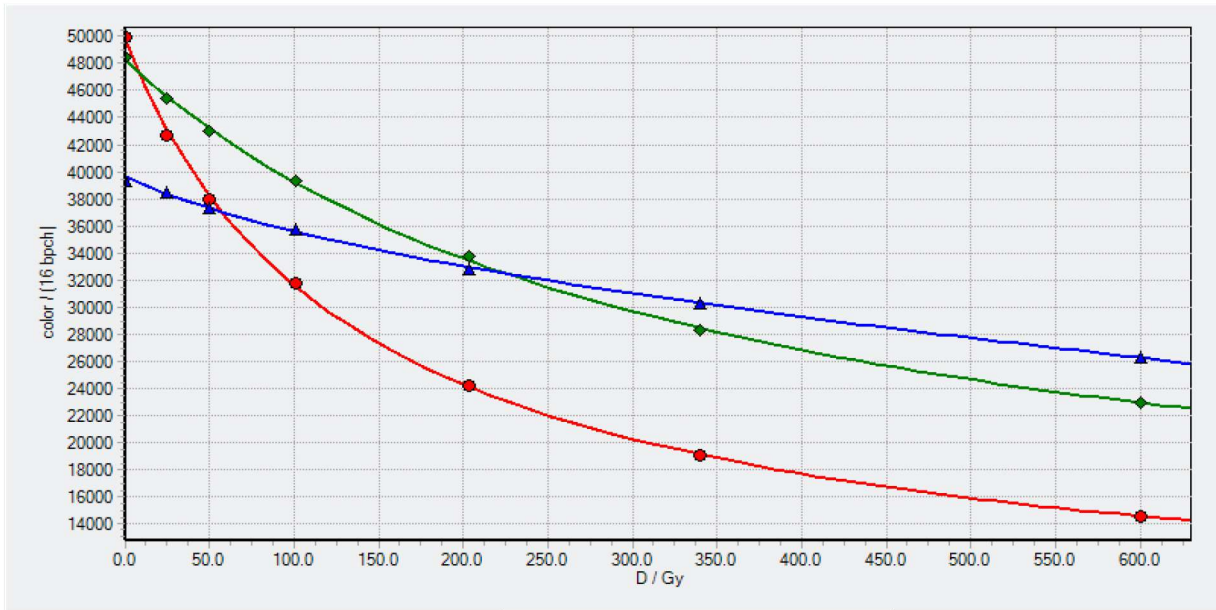


figure 4. response of Gafchromic™ HD-V2 in all color channels