gafchromic™ md-v3 films

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

description

Gafchromic™ MD-V3 film is a radiochromic dosimetry film designed for the quantitative measurement of absorbed dose of high-energy photons. As a self-developing film, MD-V3 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: 1 Gy to 100 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 25µm;
- proprietary new technology incorporating a marker dye in the active layer
  - enables non-uniformity correction using triple-channel dosimetry[1]
  - decreases UV/visible light sensitivity;
- matte-polyester substrate to eliminate Newton's Rings artifacts on flatbed scanners
- improved uniformity of response

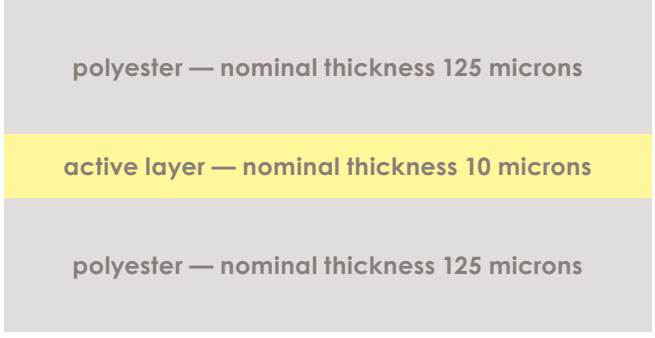

figure 1. structure of Gafchromic™ MD-V3 dosimetry film

The structure of Gafchromic™ MD-V3 radiochromic dosimetry film is shown in Figure 1. The film is comprised of an active layer, nominally 10µm thick, containing the active component, marker dye, stabilizers and other components that give 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.

The most important feature of Gafchromic™ MD-V3 compared to the previous MD-V2 and MD-55 films is the incorporation of a yellow marker dye. Used in conjunction with an rgb film scanner and FilmQA Pro™ software, the marker dye in MD-V3 film enables all the benefits of triple-channel dosimetry[1]. Using the marker dye feature is not mandatory as dosimetry 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 FilmQA Pro™ software and multi-channel film dosimetry, visit https://www.ashland.com/industries/medical/filmqa-pro-software.

performance data & practical user guidelines

The Gafchromic™ MD-V3 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 be kept in the dark when it is not being handled and should not be exposed to room light indefinitely. When the active component in MD-V3 film is exposed to radiation, it polymerizes to form a blue chromophore with absorption maximum at approximately 635 nm.

Gafchromic™ MD-V3 radiochromic dosimetry film may be measured with transmission densitometers, film scanners or spectrophotometers. As can be inferred from Figure 3, the response of MD-V3 is enhanced when measured with red light. For spectrophotometer measurements the greatest response is obtained at the peak absorbance wavelength. Most densitometers measure over a band

specifications

property	Gafchromic™ MD-V3 Film
configuration	active layer on 5 mil (125 µ) matte polyester substrate
size	5" x 5", 8"x10", other sizes available upon request
dynamic dose range	1 to 100 Gy
energy dependency	<5% difference in net density when exposed at 1 MeV and 18 Mev
dose fractionation response	<5% difference in net density[1] for a single 100 Gy dose and five cumulative 20 Gy doses at 30 min. intervals
dose rate response	<5% difference in net density[1] for 10 Gy exposures at rates of 3.4 Gy/min. and 0.034 Gy/min.
stability in light	<5x10^{-3} change in density per 1000 lux-day
stability in dark (preexposure)	<5x10^{-4} 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 FilmQA Pro™ software and triple-channel dosimetry

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* 10000XL,11000XL, and 12000XL Photo scanners 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 MD-V3 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 dx(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:

- it is simple to invert and determine density as a function of dose, or dose as a function of density
- it has a rational behavior with respect to the physical reality that the density of the film should increase 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.

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

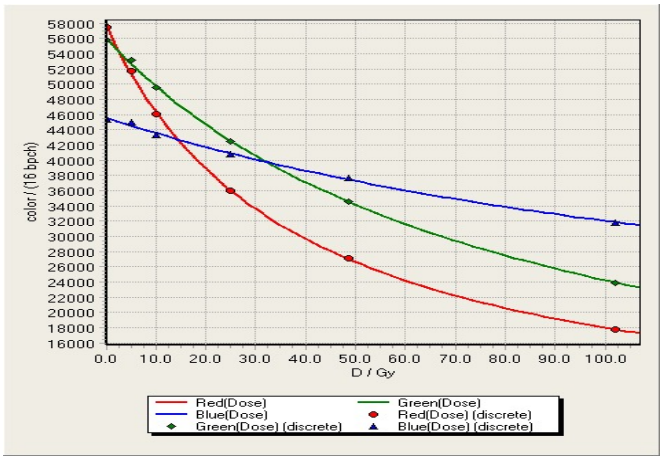

figure 2. response of Gafchromic™ MD-V3 in all color channels

references

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

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