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Product Application Literature
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ABSTRACT

This PAL discusses the use, handling, and calibration of the FWT series of Opti-chromic Dosimeters.

I. GENERAL

A. Dosimeters

This sheet contains information on the FWT-70 series of dosimeters (also known as optical waveguides). This includes:

FWT-70-40M	for doses from 0.01 to 1 kGy
FWT-70-83M	for doses from 0.1 to 20 kGy

B. Manufacturing

The FWT-70 series of dosimeters are manufactured in a multi step process by Far West Technology (FWT) at its factory in Goleta, California, USA. The manufacturing process is proprietary. Each step of manufacturing is closely monitored for quality including manufacturing of the dye, dosimeter manufacture and product packaging.

C. Chemical Composition

The FWT-70 dosimeters are composed of hexa(hydroxyethyl) pararosaniline nitrile. The dosimeter solution has a density of approximately 0.90 g/cm^3 and a composition (by mass) of 49.5% C, 26.1% N, 3.3% H, 12.4% O and 8.7% S depending on the formulation.

D. Dosimeter lot numbering

The lot numbers are four digit numbers that are sequential according to product production run numbers, thus Opti-chromic dosimeter lots will not necessarily have consecutive numbers.

II. HANDLING THE DOSIMETERS

A. Physical handling

The dosimeters are made with rugged tubes of FEP. We suggest that you handle the dosimeters by hand. Do not bend the dosimeters and do not touch the glass beads.

B. Ambient light

The dosimeters will change color from penetrating radiation and UV light below 370 nm. If the area uses fluorescents or has some daylight, then the area will probably need UV filters. Exposing the dosimeters to visible light for prolonged periods (on the order of days to weeks) may cause a decrease in sensitivity. FWT sells Opti-chromic tube holders (FWT-87) that will protect the dosimeters from light.

C. Packaging

The dosimeters may be protected during exposure. Use of FWT-87 Opti-chromic tube holders (2 inches long by ½ inch diameter) is recommended, if applicable.

D. Dimensions

The dosimeters are approximately 3mm in diameter and 50mm long.

E. Storage

We recommend storing the dosimeters at 4°C. Under optimum conditions the dosimeters typically have a storage life of at least 2 years.

III. USING THE DOSIMETERS

A. Temperature and Humidity

The dosimeters may have some temperature dependence, but are humidity independent.

B. Color development

The dosimeters may take some time to develop full color. This time will vary depending on conditions such as temperature, exposure time, and radiation energy. Typical times are from a few minutes to a few hours. At 24 hours all the color will be developed.

IV. READING DOSIMETERS

A. Wavelengths of interest

The dosimeters wavelengths of interest for color change at 600 nm and 656nm, the reference wavelength used is 750 nm. The two wavelengths are used for different dose ranges.

B. FWT readers

FWT-200 was specifically designed for reading the Opti-chromic dosimeters in units of Optical Density (OD) and is easy to use.

V. CALIBRATION

The dosimeters are manufactured in lots and each lot will need to be calibrated separately. Each reader, if more than one reader is used, will also need to be calibrated. The general procedure for calibration is as follows.

1. Determine how many calibration absorbed dose values are needed.
2. For each absorbed dose value we recommend a minimum of three dosimeters.
3. The initial absorbance is A_0. Measure A_0 on each reader you are calibrating.
4. Send all the dosimeters to an irradiation facility whose dose-rate is traceable to national or international standards.

5. Measure the post-irradiation absorbance, A_f, of each dosimeter (on each reader) and calculate the specific net absorbance, k, for each dosimeter: $k = (A_f - A_0)$. This will also correspond to the dose.
6. Plot the response curve versus absorbed dose. Examine the calibration for goodness of fit. Repeat the calibration procedure at intervals not to exceed 12 months or after repair of the reader if the manufacturer recommends it.
7. Calibrate all alternate and backup readers.
8. Keep your dosimeters.

VI. OPTICAL DENSITY

To measure the amount of light transmitted through a colored material requires a photometric sensor to change light energy to electrical energy. If the original light intensity is I_o and the intensity with an Opti-chromic dosimeter in the light path is I then the transmittance T is:

$T = I / I_o$

The optical density is given by:

$$OD = \text{Log}\,(1/T) = \text{Log}\,(I_o/I)$$

Note: Due to the waveguide property of the Opti-chromic dosimeters, a reference wavelength also is used. Light intensity is actually a ratio of intensity at the analysis wavelength to the intensity at the reference wavelength.

The typical response curve known for the Opti-chromic dosimeters indicates that the change in optical values is proportional to the absorbed dose.

Figure 1 below is a typical curve for the Opti-chromic Dosimeters. The net absorbance was read in an FWT reader and shows the approximate Optical Density (OD) expected for absorbed dose. Background has been subtracted from these readings.

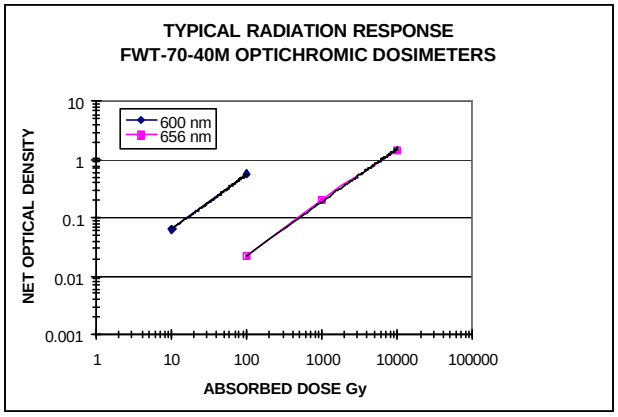

Figure 1 Typical Response Curve in Various Units

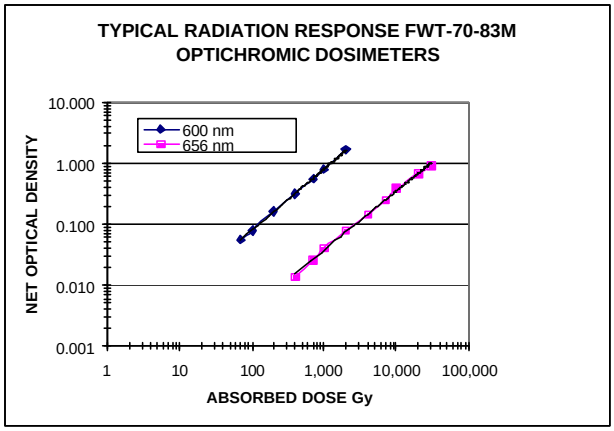

Figure 2 Typical Response Curve in Various Units