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Product Application Literature
PAL-3 December 2009

ABSTRACT

This PAL discusses the use, handling, and calibration of the FWT series of Radiachromic Dosimeters.

I. GENERAL

A. Dosimeters

This sheet contains information on the FWT-60 series of dosimeters for routine dosimetry. This includes:

FWT-60-00	1 cm x 1 cm square
FWT-60-20	15 cm x 15 cm square
FWT-60-810	8-12 μm thick

Dose range: 0.5 to 200 kGy; Dose rate independent to 10^{12} Gy s^{-1}

B. Manufacturing

The FWT-60 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, solvent casting and product packaging.

C. Chemical Composition

The FWT 60 dosimeters are composed of hexa(hydroxyethyl) pararosaniline nitrile. The matrix that holds the dye is a specific grade/composition of nylon. The film has a density of approximately 1.15 g/cm^3 and a composition (by mass) of 63.7% C, 12.0% N, 9.5% H and 14.8% O.

D. Dosimeter lot numbering

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

II. HANDLING THE DOSIMETERS

A. Physical handling

The dosimeters are strong soft nylon films. We suggest that you handle the dosimeters with round end tweezers.

B. Ambient light

The dosimeters will change color from penetrating radiation and UV light below 370 nm. If the area uses fluorescent lights or has some daylight, then the area will probably need UV filters. FWT sells both paper envelopes and pouches to protect the dosimeters when they are in use during irradiation.

Exposing the dosimeters to visible light for prolonged periods (on the order of days to weeks) may cause a decrease in sensitivity.

C. Packaging

The dosimeters should be protected during exposure. Abrasion, UV light and dirt may all affect the final OD reading and thus the calculated dose. Use of FWT-81 aluminized pouches is recommended for most applications.

D. Thickness gauge

The dosimeters can be measured for thickness using a thickness gauge. The dosimeters are sorted into the following average thicknesses 0.0420 to 0.0530 mm in a 0.001 mm range. Thus 0.0425 mm thickness would include all the thicknesses from 0.0420 to 0.0429 mm.

E. Storage

We recommend storing the dosimeters at 35-55% RH and 15-30°C. Under optimum conditions the dosimeters should have a storage life of 3 to 5 years.

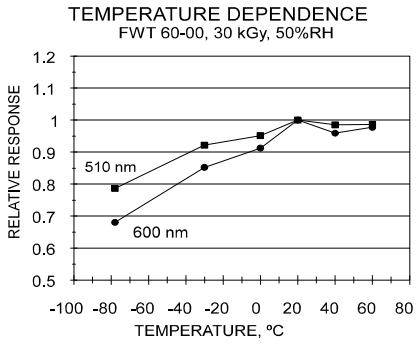
F. Conditioning

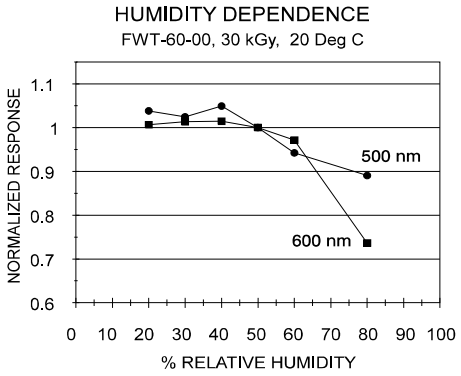
For best dosimetry results the film should be conditioned to a tight temperature and relative humidity range for 24 hours prior to irradiation. We condition film at 47-53% RH and 65-70 °F. Conditioning at a processing facility should be based on the calibration conditions and the ambient conditions.

III. USING THE DOSIMETERS

A. Temperature and Humidity

The dosimeters have some temperature and humidity dependence (See the following graphs). For critical and often routine uses, the dosimeters should be placed in hermetic pouches to stabilize the humidity during irradiation.





CONDITIONS	EFFECTS
HUMIDITY EFFECTS	
0-10% RH	Possible permanent change in sensitivity
35-55 % RH	Best storage condition
47-53 % RH	Typical pre-irradiation conditioning
70% RH	Film sticks together
90-100 % RH	Possible permanent change in sensitivity
TEMPERATURE EFFECTS	
5° C	Water may condense on film
15-30° C	Best storage condition
60° C	Heat treatment for color development 5-15 minutes at this temperature
90° C	Heat treatment for color development 2-3 minutes at this temperature

Table 1 Temperature and Humidity Ranges and Their Effects

B. Color development

The dosimeters may take some time to develop full color. This time will vary depending on the humidity, 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. Generally lower humidity and/or higher dose rates during irradiation will cause the dosimeters to take longer to develop color.

The color change can be speeded up by heat treatment. Expose them to 90°C for 2 to 3 minutes or 60°C for 5 to 15 minutes for complete color development.

IV. READING DOSIMETERS

A. Wavelengths of interest

The dosimeters have a peak wavelength for color change. This peak is centered on 605 nm. The wavelengths to use for reading the film are 510 nm and 600 or 605 nm. The two wavelengths are used for different dose ranges.

WAVELENGTH	DOSE RANGE
510 nm	10-200 kGy
600 nm or 605 nm:	1-30 kGy

B. FWT readers

The FWT readers are designed for reading the FWT dosimeters Optical Density (OD, equivalent to Absorbance) and are easy to use.

C. Using a spectrophotometer

If you want to use a spectrophotometer there are several points that you should consider. **The holder will need to be modified to accommodate the dosimeters** and should hold them in the same position for each reading. The wavelengths in common use are 510 nm and 600 or 605 nm. Photometers use 600 nm bandpass filters and spectrophotometers are set to 605 nm with a narrow bandpass. **Whatever the wavelength or bandpass, it is important that it be the same for both calibration and reading the routine dosimeters. Beware of contamination from UV or IR light.**

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 you need a minimum of five 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: $k = (A_f - A_0)/t$, where t is the thickness of the film.
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.

Figure 1 below is a typical curve for the Radiachromic Dosimeters. The absorbed dose is shown in both kGy and Mrads.

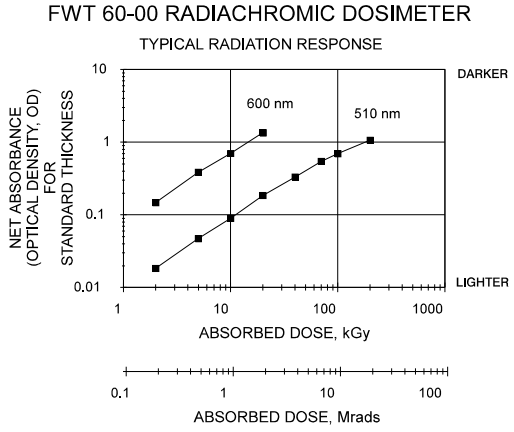


Figure 1 Typical Response Curve in Various Units