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Measurement of Radiation Dose using Radiochromic Film*

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ABSTRACT

We have irradiated samples of radiochromic film to doses between 0.005 and 1Mrad in a Co^{60} facility at ANL. The doses computed using the manufacturer's calibration curves for the absorption at 600 and 510 nm have been compared with the dose obtained from ion chamber measurements. Excellent agreement is obtained and high precision can be maintained by baseline measurement of the films prior to irradiation, appropriate choice of film and wavelength used.

1. Introduction

Many groups , both inside SDC and elsewhere , have been using radiochromic film to monitor radiation dose. In general these groups have decided to use films supplied by Far West Technologies. We here at Argonne have used these films in our radiation damage measurements to plastic scintillator and as a result of discussions with collaborators in FSU decided to verify the manufacturer's calibration curves. For these experiments we used a Co^{60} facility at Argonne with uniform radiation fields and the capability to perform both low and high dose irradiation (varying from 2100 to 62000 Rad/min). The facility has in the past been used for biological experiments and with field maps and ion chamber measurements provided the accumulated dose to absolute accuracy of 3% . The absorbed energy was corrected to absorbed dose using human tissue factors.

2. Film Measurements

To cover the full dose range from 0.005 to 1 MRad, we evaluated two types of radiation sensitive film supplied by Far West Technologies : radiochromic film(FWT 60-00) and GaFchromic film (DM 100). FWT 60-00 yields sensitivity in the range 0.4 to 60 Mrads and DM 100 yields sensitivity in the range 0.004 to 0.2 MRad. The optical absorption in these films is proportional to the absorbed dose. The radiation induced absortion absorption was measured by subtracting the observed absorption before irradiation from that observed after irradiation on a sample by sample basis at two wavelengths (600 and 510 nm) using a simple photometer (FWT-92 Radiochromic Reader). This was converted to absorbed dose using calibration curves provided by the manufacturer since these calibration curves vary somewhat with film batch due to thickness variations and in addition include effects from non-linear response near the ends ot the ranges of sensitivity. Typically 4 films of approximately 1×1 cm^2 were measured at each dose value. Errors in reading the optical density were within the reading accuracy of the photometer (1 part in 1000). The

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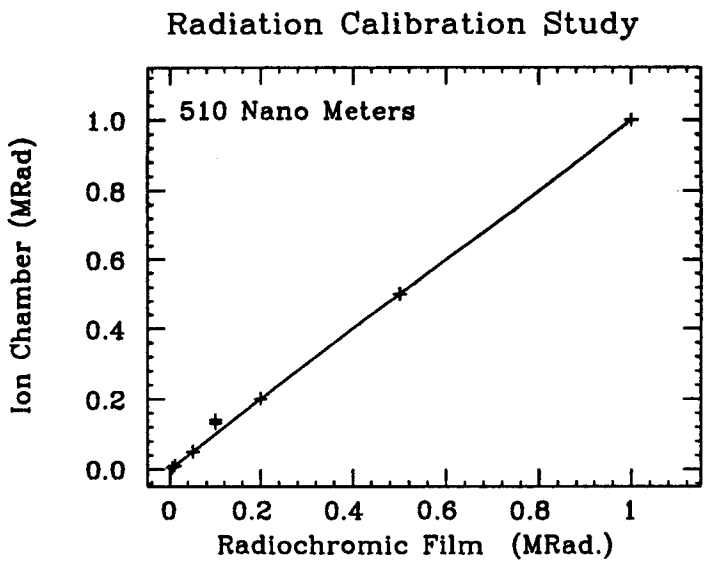

Figure 1: Absorbed Co^{60} dose measured using optical absorption at 510nm in radiochromic film compared to that obtained from ion chamber data. The points below 0.4 Mrad were obtained using GaFChromic Film.

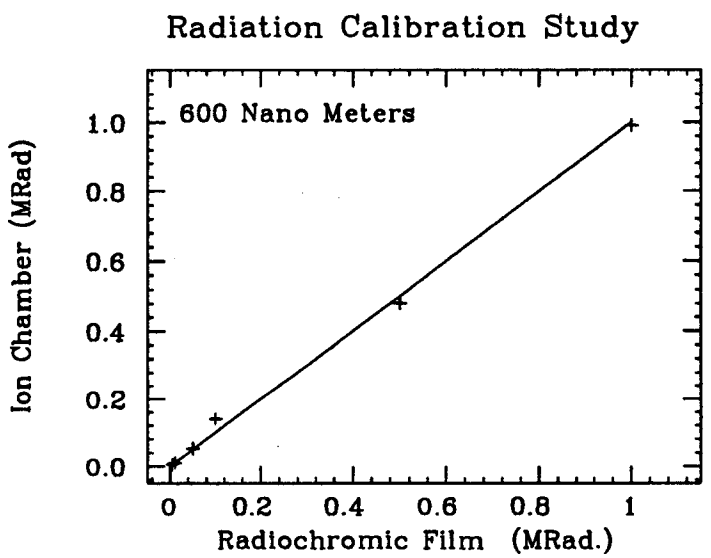

Figure 2: Absorbed Co^{60} dose measured using optical absorption at 600nm in radiochromic film compared to that obtained from ion chamber data. The points below 0.4 MRad were obtained using GaFChromic film.

point by point reproducibility was approximately 1% contributing a corresponding error in the predicted dose. Figures 1 and 2 show the dose given by the film densities compared to that provided by ion chamber measurements for readout wavelengths of 510 and 600nm respectively. The errors shown are a combination of photometer reading reproducibility and calibration graph reading error and were characterised by the rms of the set of individual measurements made at each point. For both wavelengths we see good agreement between the two different estimates of absorbed dose.

3. Conclusions

We have the precision with which two types of radiation sensitive film supplied by Far West Technologies measure absorbed dose by comparing the dose given by optical density measurements on the films with that from ion chamber measurements.The two methods are in excellent agreement and we can conclude that,with appropriate choice of wavelength and film material,the films can provide a measurement of absorbed dose to within 5%.