ELECTRON BEAM DOSE MEASUREMENTS WITH ALANINE/ESR DOSIMETER

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When the aminoacid alanine, CH_3-$CH(NH_2)$-COOH, is exposed to radiation field, stable free radicals are produced. The predominant paramagnetic specie found at room temperature is the CH_3-$C^{\cdot}H$-COOH. Electron Spin Resonance - ESR is a technique used for quantification and analysis of radicals in solid and liquid samples. The evaluation of the amount of produced radicals can be associated with the absorbed dose . The alanine/ESR is an established dosimetry method employed for high doses evaluation, it presents good performance for X-rays, gamma, electrons, and protons radiation detection [1].

The High Doses Dosimetry Laboratory of Ipen developed a dosimetric system based on alanina/ESR that presents good characteristics for use in gamma fields such as: wide dose range from 10 to 10^5 Gy, low fading, low uncertainty (<5%), no dose rate dependence and non-destructive ESR signal readout. The detector is encapsulated in special polyethylene tube that reduces the humidity problems and improves the mechanical resistance [2].

The ESR spectrum of the Ipen DL-alanine dosimetry system irradiated with ^{60}Co gamma radiation is showed in Fig. 1. It is composed of five main lines. The peak-to-peak height measurement of the central line is used for dose evaluation.

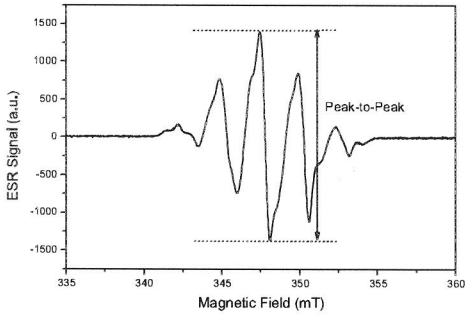

FIG. 1. ESR spectrum of Ipen DL-alanine dosimetry system exposed to gamma radiation of ^{60}Co.

The evaluation of the absorbed dose is given by the expression [1,3]:

$$D(Gy) = f_c.(PaP - PaP_0).\prod_i k_i \qquad (1)$$

where f_c is the calibration factor obtained from the linear region of the calibration curve, PaP is the peak-to-peak height of the principal line signal of irradiated dosimeter, PaP_o is the background signal of the non-irradiated dosimeters and k_i are correction factors for variations in the irradiation

conditions, such as irradiation temperature, thermal fading, instability of the spectrometer, radiation quality or other factors.

In the present work, the Ipen dosimeter was investigated for application in electron beam fields dosimetry.

Electron beam irradiations were performed using a Dynamitron II accelerator of the CTR/Ipen, with 1.459 MeV and dose rates between 1.2 and 22.4 Gy/s. Gamma irradiations were performed using a ^{60}Co source of 18TBq at electronic equilibrium conditions.

The obtained ESR spectrum is similar to the observed for gamma fields. The results for dose response of the dosimeter in the dose range between 0.5 to 2.10^2 kGy for 1.459 MeV are presented in Fig. 2.

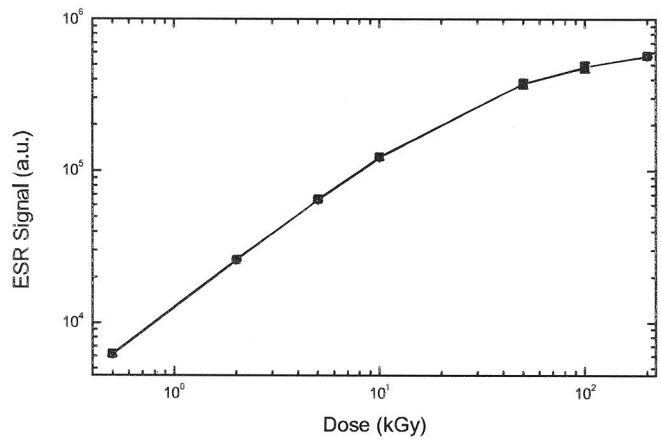

FIG. 2. ESR signal amplitude for alanine irradiated with electron beam of 1,459MeV.

The useful linear dose range is from 0.5 to 10^2 kGy. Results for doses below 0.5 kGy presented uncertainties greater than 5%. This increasing in the uncertainty occurs due to the high dose rate of the accelerator and elevated uncertainty for very small irradiation times. Considering the dose range involving electron beam industrial applications, tha Ipen alanine/ESR dosimetry system presents good results to be used in quality assurance programs. Using special procedures and adequate parameters sets for ESR spectrometer, the overall uncertainty obtained can be ±4%. For electrons beams of higher energy but with lower dose rate, as found in radiotherapy level, the background signal and lower signal-to-noise ratio, it is necessary special cares during the measurement and use of numerical techniques for the handling of the signal.

REFERENCES

[1] REGULLA, D. F., DEFFNER, U. "Dosimetry by ESR Spectroscopy of Alanine" Appl. Radiat. Isot., Vol. 33, pp. 1101-1114, 1982.

[2] GALANTE, O. L., RODRIGUES JR., O., CAMPOS, L. L. "Standardization of the method of high doses dosimetry using electronic paramagnetic resonance technique" XIIth International Meeting on Radiation Processing creating a bridge to the 3rd millennium, march 25th to 30th, 2001, Avignon, France.

[3] BERGSTRAND, E. S., HOLE, E. O., SAGSTUEN, E. " A simple Method for Estimating Dose Uncertainty in ESR/Alanine Dosimetry" Appl. Radiat. Isot., Vol. 49(7), pp. 845-854, 1998.