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TRANSIT DOSE MEASUREMENTS USING ALANINE AND DIODE-BASED DOSIMETERS

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Introduction: The growing interest in low-dose (≤ 100 Gy) radiation processing applications has raised concerns about accurately measuring the absorbed dose in irradiated materials. Depending on the irradiator design, the transit dose due to the radioactive source movement (or the product itself) until the stable irradiation position might affect the predicted absorbed dose. The contribution of the transit dose is usually neglected in most routine processes covering doses of tens kGy [1], but it is likely to be significant to low-dose processes. This work aims to evaluate the transit dose of a Gamma Cell irradiator using alanine and diode-based dosimeters.

Materials and methods: A house-made dosimetry system used in this work is based on an unbiased photodiode (SFH 206K), capable of operating in either current (online) or charge (offline) mode [2]. Under irradiation, the output current readings are performed by a Keithley 6517B electrometer. For analysis, the data is sent to a personal computer via the GPIB interface controlled by software developed in LabView. Irradiations are performed at room temperature (16.5º C) using a ^{60}Co Gammacell 220-Nordion at a dose rate of ≈ 447.90 Gy/h. Reference standard alanine dosimeters are also irradiated together with the diodes. The alanine spectrum acquisition is performed with an MS400 ESR spectrometer (Magnettech, Berlin) equipped with the AerEDE dosimetry software (Aerial, France).

The experimental approach is to acquire the output current of the diode during its downward and upward movement. It allows the transit time to be directly assessed and, therefore, the transit dose via the current signal integration. Outputs currents are acquired at twenty sequential product fall and rise cycles for, in addition to improving measurement accuracy, also achieving an accumulated dose that is within the operational dose range of alanine.

Results: The output current signals online recorded at the first five cycles of the diode movement are shown in Fig.1. They all exhibit the same gaussian pattern: the current increases as the diode descends towards the source, reaches its maximum value (85 nA) in the irradiation position, and decreases when rising to its initial position. Analysis of the rise and fall times of the twenty current signals leads to a total transit time of (7.20 ± 0.02) s. The dose-response of the diode, characterized by a charge sensitivity of (0.694 ± 0.007) µC/Gy, and the average charge delivered by the diode during each movement cycle, enable the transit dose (0.40 ± 0.01) Gy to be determined. This value agrees with that assessed by alanine dosimeters (0.38 ± 0.01) Gy, within the experimental error.

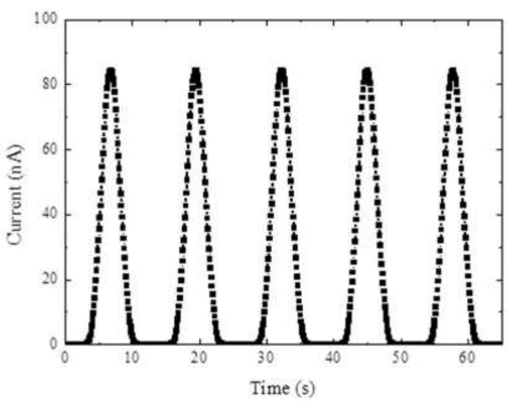

Figure 1: Output current signals online recorded at the first five cycles of the diode movement.

Conclusions: The proposed method for real-time measurements of transit dose of gamma irradiators using diode-based dosimeters proved to be suitable and accurate. This is assured by the good agreement between the transit dose values achieved with the diode and alanine dosimeters.

References:

1. ISO/ASTM 51702:2013, *Standard Practice for Dosimetry in a Gamma Facility for Radiation Processing*, 3rd ed., 2013, pp. 1-8.
2. J. A. C. Gonçalves et al., *Rad.Phys. Chem.* **167**, 108276 (2020).