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PLASTIC BOTTLE CAPS AS RADIATION DETECTORS FOR HIGH GAMMA RADIATION DOSES

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Introduction: Plastic detectors represent an important role in radiation dosimetry [1]. They have been used in a variety of applications, such as portal monitors, and for solar, cosmic, UV, thermal and gamma radiations. Dosimetric evaluation is indicated for material characterization seeking to identify possible applications; proper preprocessing techniques are critical features of this process. This work aimed to determine the linearity response of plastic samples exposed to gamma radiation, using the Fourier Transform Infrared (FTIR) measurements technique.

Material and method: Plastic bottle caps were used as sample detectors. They were composed of a hollow cylindrical shape with a 14 mm radius, 0.05 mm thickness, 28 mm height and 3.1 g mass, and they were made of polyethylene (F217). These samples were irradiated in triplicates, with absorbed doses of 0.01 kGy, 0.05 kGy, 0.10 kGy, 0.25 kGy, 0.50 kGy, 1.0 kGy, 5.0 kGy and 10.0 kGy using a ^{60}Co Gamma Cell-220 system (dose rate of 1.089 kGy/h at the Radiation Technology Center of IPEN). Afterwards, each sample absorbance spectrum was acquired on a Fourier Transform Infrared (FTIR) Spectrometer (Frontier/Perkin Elmer) from 400 cm^{-1} to 4000 cm^{-1}, with 1 cm^{-1} spectral resolution.

The preprocessing was performed in the raw data composed by the broadband source interferogram with a +/- 0.04 cm-1 (2σ) precision for each absorbed dose profile. Subsequently, applying the Fast Fourier Transform (FFT), FTIR was generated. Then, the derivates in the frequency (wavenumber) space were calculated seeking to assess high-order effects.

The complex FFT coefficients were explicitly obtained for peak regions, which provided localized information regarding the spectrum approximate shape from the FTIR evaluations to obtain linearity estimatives.

The resulting FTIR spectra for each peak was to numerical differentiation at the 1st, 2nd and 3 rd orders (D1, D2 and D3, respectively). The derivates obtained were useful in achieving the spectra shapes and the linearity of response.

Results: Figure 1 presents the results after the application of the PCR method: Predicted absorbed dose *versus* absorbed dose, for: I, II and III regions (from spectrum). The results of the PCR method are the maximum values for linearity, 1.000 for all regions. This result demonstrates that the PCR method is more robust than the linear method, and the preprocessing *via* PCA provides the information pertinent to the evaluated plastic detector.

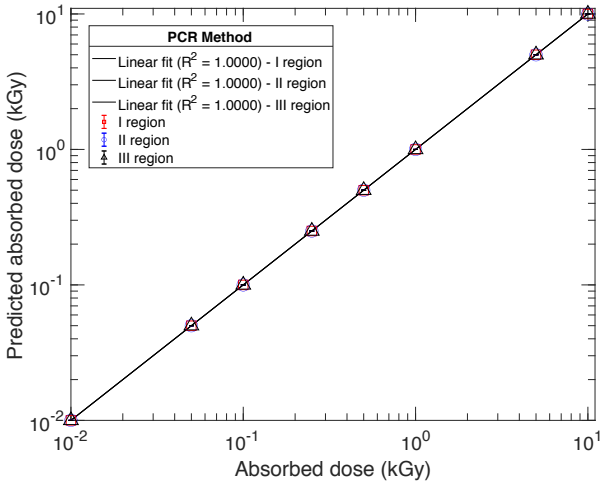

Figure 1: Predicted absorbed dose *versus* absorbed dose; for I, II and III regions. The uncertainty obtained was lower than 1%, not visible in the figure.

Conclusion: The results on linearity of response show that plastic bottle caps represent potential radiation detectors for high gamma radiation doses.

Reference:

1. L. Madden, J. Archer, E. Li, U. Jelen, B. Dong, L. Holloway and A. Rosenfeld, *Physica Medica* **73**, 111–116 (2020).