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Investigation of polymer composite for high dose dosimetry

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ABSTRACT

Introduction: This paper presents the efficacy evaluation of PVDF and nanocomposites of the PVDF films for high gamma dosimetry. Our scope in this first part of our studies is the selection of the most promising film for future dosimetry trials, where the proportionality of response of the selected material will be investigated over a large range of doses and dose rates. **Methods**: Was prepared nanocomposites made by mixing Poli(vinilidene fluoride) (PVDF), zirconium oxide (ZrO_2) and multi–walled carbon nanotubes (MWCNTs) aiming to find dosimetric properties for applications in high dose dosimetry. The samples were irradiated with a Co-60 source at constant dose rate (16.7 kGy/h), with doses ranging from 100 to 2750 kGy. The UV-Vis and FTIR spectrophotometry have been used to monitor the appear-

ing of C=C conjugated bonds and radio-oxidation of carbon (C=O). **Results**: FTIR spectrometry has that the absorbance intensities at 1715 cm^{-1} and 1730 cm^{-1} can be used for high dosimetry purposes for gamma doses ranging from 400 to 2750 kGy. In this range, it is possible to observe a linear relationship between *Abs & Dose.* Fading of signal was evaluated for one month and reproducibility in 2000 kGy dose. **Conclusion**: FTIR spectroscopic data revealed two optical absorption bands at 1715 cm^{-1} and 1730 cm^{-1} whose intensities are unambiguously related to gamma delivered dose ranging from 400 kGy to 2750 kGy.

Palavras-chave: High Dose Dosimetry, PVDF, ZrO_2, MWCNT.

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1. INTRODUCTION

The use of dosimetric systems based on polymers has several advantages such as atomic composition, which can be closer to the material of interest for radiation processing industry, among others. We have been evaluating the efficacy of PVDF and nanocomposites of the PVDF films for high gamma dosimetry. Poly(vinylidene fluoride) (PVDF) $–(CF_2–CH_2)_n$ – is a very attractive ferroelectric semi-crystalline polymer, exhibiting high permittivity, extraordinary piezo-, and pyroelectric properties and other excellent physical properties [1]. In recent years, many researches carried out many relative studies in fabrication and application of carbon nanotubes/polymer composites [2]. In this study PVDF/ZrO_2/MWCNT composites were prepared using a solution method with dimethylacetamide (DMAc) as the solvent. FTIR and UV-Vis showed radiation degradation induced by process in the nanocomposite. The results show PVDF/ZrO_2/MWCNT composite as the promising for application to high dose dosimetry using the FTIR techniques.

2. MATERIALS AND METHODS

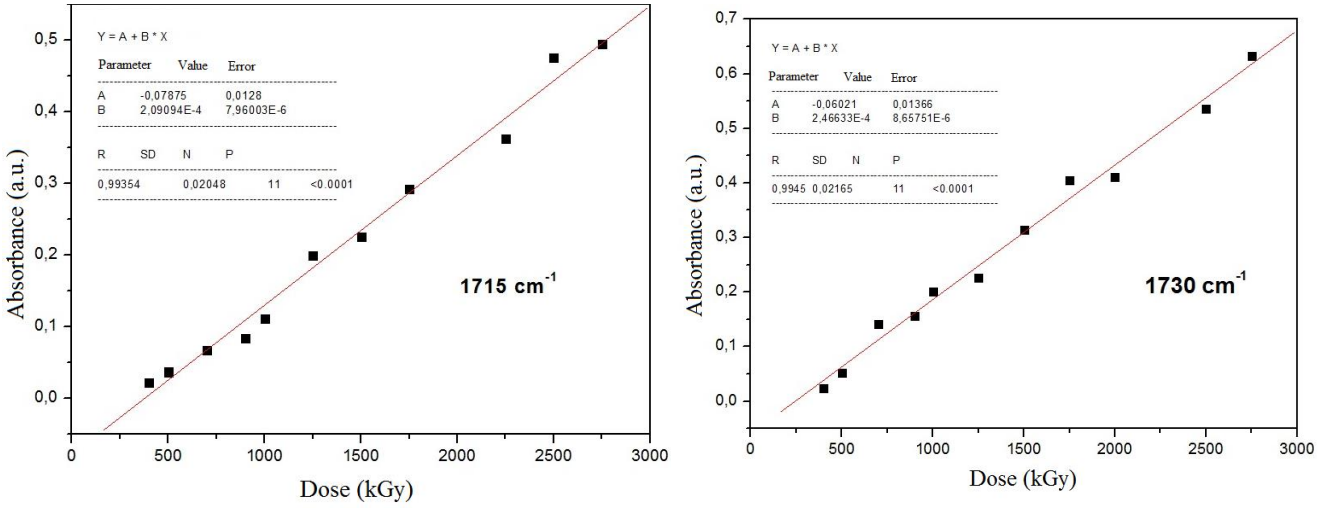
PVDF homopolymers were supplied by ATOCHEM (France). Nanocomposites were produced by mixing solved PVDF in DMAc with 0.08 mg of ZrO_2 dispersed in an aqueous solution, and 0.125 mg of MWCNTs dispersed by mechanical agitation assistance. Samples were irradiated in Gamma

Irradiation Laboratory (LIG) of CDTN using a Co-60 source at constant dose rate (12 kGy/h), for doses ranging from 100 to 2750 kGy. Optical transmission measurements were taken in a Shimadzu UV-2401 PC spectrometer, for wavelengths ranging from 190 to 900 nm. The FTIR spectra, each collected with 32 scans each, were measured at a BOMEM 100 spectrometer for wavenumbers ranging from 300 to 4000 cm^{-1}.

3. RESULTS AND DISCUSSION

The FTIR spectra of the PVDF/ZrO_2/MWCNT samples shows increasing absorption peak around 1715 and 1730 cm^{-1}, for increasing doses. In Fig.1a) and b) we plot the absorbance intensities at this wavenumber, measured directly in the spectrogram, as a function of the delivered dose. It is very clear that it is possible to drawn a linear relationship between 400 and 2750 kGy that can be used for dosimetric purposes. By measuring UV-VIS shows absorption increase and 194, 223 and 274 nm can be attributed formation of C=C conjugated [3].

Figura 1: *a) Plot of the absorption intensities measured at 1715 cm^{-1} versus the delivered gamma and b) Plot of the absorption intensities measured at 1730 cm^{-1}*



a) b)

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4. CONCLUSIONS

The effect of high gamma doses in PVDF/ZrO_2/MWCNT nanocomposites has been investigated using FTIR and UV-VIS techniques. FTIR spectroscopic data revealed two optical absorption bands at 1715 cm^{-1} and 1730 cm^{-1} whose intensities are unambiguously related to gamma delivered dose ranging from 400 kGy to 2750 kGy. Because of their linear behavior with dose, these bands, associated to the stretching of $-CF_2-CH=CF-CH_2$ and $-CF_2-CH_2-COOH$ bonds, respectively, can be explored for dosimetric purposes.

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