

Evaluation of the FTIR technique for the linearity assessment of commercial soda-lime glass irradiated with gamma radiation

Lucas N. de Oliveira^{1,4}, Eriberto O. Nascimento², Marcello R. B. Andreeta³, Yasmim Y. Yamagushi³, Jeanini Jiusti³, Patrícia L. Antonio⁴ and [Linda V.E. Caldas](mailto:lcaldas@ipen.br)⁴

¹Departamento de Física, Instituto Federal de Educação, Ciência e Tecnologia de Goiás-IFG, Rua 75, nº 46, 74055-110, Goiânia, GO, Brazil

²Departamento de Engenharia Mecânica, Universidade Federal do Paraná-UFPR, Centro Politécnico, 81531-990, Curitiba, PR, Brazil.

³Departamento de Engenharia de Materiais, Universidade Federal de São Carlos-UFSCar, 13565-905, São Carlos, SP, Brazil.

⁴Instituto de Pesquisas Energéticas e Nucleares, Comissão Nacional de Energia Nuclear-IPEN/CNEN, Av. Prof. Lineu Prestes, 2242, 05508-000, São Paulo, SP, Brazil

lcaldas@ipen.br

Introduction

High dose dosimetry is one of the most important branches of everyday activities related to medical and industrial applications. Nevertheless, the use of materials that respond in a linear manner has advantages over nonlinear materials, since the dose calculation procedure in linear materials relies solely upon direct proportions to the delivered dose. The evaluation techniques are also important to identify the possible linear ranges, and the new Fourier-transform infrared spectroscopy (FTIR) technique has been used to this objective. This work aims to investigate the linearity response and its sensitivity, using mainly the FTIR technique.

Methods

Cubic samples of a soda-lime glass type with composition of $\text{Li}_2\text{O} \cdot 2\text{B}_2\text{O}_3 + 10 \text{ mol\% of } (0.25\text{Li}_2\text{O} + 0.25\text{La}_2\text{O}_3 + \text{TiO}_2)$ were irradiated with doses from 1 kGy to 12 kGy, using a ^{60}Co Gamma-Cell system 220. The response was evaluated using the FTIR technique.

Results

The sensitivity and linearity characteristics were evaluated with the absorbed profiles of the multivariate calibration Partial Least Square Regression (PLSR), with its loadings performing a linear regression; from the slope value, the sensitivity of the glass at the absorbed dose range was obtained. The PLSR technique showed, on the range of 1-12 kGy, that the soda-lime glass type presents linearity value of 0.8532 using just three components. The results of the linearity test were obtained for the FTIR technique.

Conclusions

The FTIR technique was applied to assess the linear behavior based of the glass spectrum, showing its usefulness to identify possible linear dose regions and also the overall sensitivity of the glass samples to dose. Therefore, the results obtained indicate a good linear response, showing therefore a potential use of this glass-soda lime type for radiation dosimetry in high doses.