MDE-P-10
Lithium Borate Glass for High-Dose Dosimetry using the UV-Vis and FTIR Spectrophotometrics Techniques

Lucas Nonato de Oliveira[1], Fernando Schimidt[2], Patrícia L. Antonio[3], Marcello R.B. Andreeta[4], Linda V.E. Caldas[3]
[1]Instituto Federal de Educação, Ciência e Tecnologia de Goiás, Física , Goiânia, Brazil
[2]Instituto Federal de Educação, Ciência e Tecnologia de Goiás, Física , Áreas Acadêmicas, Inhumas, Brazil
[3]Instituto de Pesquisas Energéticas e Nucleares, Comissão Nacional de Energia Nuclear-IPEN/CNEN, São Paulo, Brazil
[4]Universidade Federal de São Carlos-UFSCar, São Carlos, Brazil

The ionizing radiation induces characteristic absorption bands in the glass samples depending on the irradiation conditions. There is a slight variation in color due to exposure to radiation. The color change is due to the oxidation mechanism which may create color centers that can absorb light. The UV-Vis spectrophotometry is considered a low-cost technique, and specifically in this study, the color centers of the glass samples will not be destroyed. The objective of this research was to expose at the lithium borate glass samples to high doses, and to use the techniques of UV-Vis and FTIR spectrophotometry for the evaluation of the samples. The results demonstrate the feasibility of applying lithium borate glass in high doses of radiation.

The lithium borate glass samples used in this work were composed by small rectangle pieces, with dimensions of 1x1x4 mm^3. The glass samples were irradiated with absorbed doses of 200, 300, 700, 1000, 5000 and 10000 Gy, using a ^{60}Co Gamma Cell-220 system (dose rate of 1.089 kGy/h); then each sample was evaluated and presented an absorbance spectrum acquired on a UV-Visible (UV-Vis) Spectrophotometer (Genesys 10S/Thermo Scientific) and on a Fourier Transform Infrared (FTIR) Spectrometer (Frontier/Perkin Elmer). The spectra were collected on the wavelength range from 200 to 400 nm, spectral bandwidth of 1.8 nm, scan interval of 1 nm, for the 6 doses plus the blank, all in triplicate (total 21acquisitions) for UV-Vis; for the FTIR technique, the spectra were collected on the range of 540 to 1600 cm^{-1}, resolution of 4 cm^{-1}, scan interval of 1 cm^{-1}, and 16 acquisitions. The absorbance peaks were observed for each rubber sample for both techniques.

The spectra show a baseline variation (and maximum absorbance values) proportional to the absorbed dose received by the samples. For the UV-Vis analysis, the total areas under the curves from 200 to 400 nm are also proportional to the absorbed doses, being possible to establish a linear relationship between the integrated area and the absorbed dose of the samples with $R^2 = 0.9972$. For the FTIR analysis, peaks were found at 1320, 870 and 680 cm^{-1} with the proportional to the absorbance absorbed doses, with the highest sensitivity for smaller wavenumbers.

The UV-Vis and FTIR spectra of the lithium borate glass samples were obtained. The area under each spectrum obtained showed an increase with the absorbed dose, the dose-response curve showing a linear relationship. The proportionality of the absorbance with the dose was also checked with the FTIR analysis. The glass samples changed their coloration proportional to the absorbed doses, and they may be used as Yes/No detectors and as high-dose dosimeters.