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SYNTHESIS AND CHARACTERIZATION OF SILVER DOPED ALUMINUM BORATE GLASS

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Introduction: The search for new universally available materials that can be used as dosimeters has become a relevant research issue. A luminescent dosimeter made of glass has several advantages compared to others of this type, among which is an effective atomic number similar to that of soft biological tissue (Zeff = 7.42). Therefore, this paper presents a study on the luminescent properties and the structural and dosimetric characteristics of borate glass prepared wiht boron oxide (B_2O_3) doped with silver nitrate (AgNO3). The dosimetric characteristics of the glass were studied by the optically stimulated luminescence (OSL) technique.

Material e methods: The glassy matrix $69B_2O_3$-$30LiF$-Al_2O_3:$0.05AgNO_3$ was produced by the fast cooling method; subsequently, the material was heat-treated at 600 ºC for different times (3 h, 6 h 9 h and 12 h). The spectroscopic and dosimetric characterization of the samples was performed using X-ray diffraction (XRD), photoluminescence and OSL techniques. The OSL responses were studied after the glasses were irradiated with beta radiation ($^{90}Sr+^{90}Y$). The effective atomic number of the samples was estimated with a program for calculation of radiation parameters and mathematical calculations (WinXCom). For this, the study of Bootjomchai and Laopaiboon (1) was used as reference. The samples that were heat-treated for 3 hours were named BNA3, those for 6 hours BNA6, for 9 hours BNA9, and for 12 hours BNA12.

Results: The OSL of the irradiated glasses revealed the presence of metastable state in the matrix. The OSL emission of the irradiated glasses was analyzed and dosimetric characteristics such as linearity, energy dependence, fading, and repeatability were studied as a function of dose. The Zeff of the glass as a function of photon energy varied between 7.55 and 7.67 for an energy range of 1.0 MeV- 105 MeV (Figure 1). The samples are not hygroscopic and show a good sensitivity to ionizing radiation and potential to dosimetric application.

Conclusions: The Zeff of the samples are close to the one of tissue equivalent (Zeff = 7.42), demonstrating that the composition adopted for the production of the samples is satisfactory for use in OSL dosimetry. The OSL signal of the samples are proportional to the dose in the studied range (1 mGy to 40 Gy). The BNA3 samples presented OSL signal behavior more linear to the dose received than the others. The samples showed stability of the OSL signal after seven days of irradiation; a minimum fading of 18.30% of the OSL was observed for sample BNA12 and a maximum of 46.12% for BNA9. The OSL fading of the BNA3 and BNA6 glasses were 20.77% and 22.03%, respectivally. Subsequent readings indicated no further OSL signal loss after this period. The samples faithfully display signal reproducibility in at least four subsequent irradiation and reading procedures.

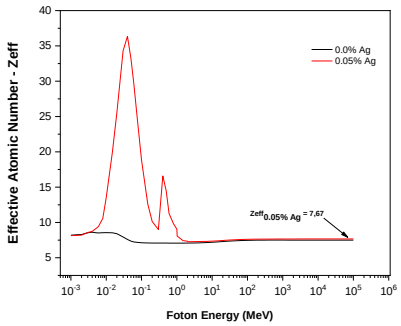

Figure 1: Effective atomic number for samples doped with 0.05% AgNO3 as a function of radiation energy.

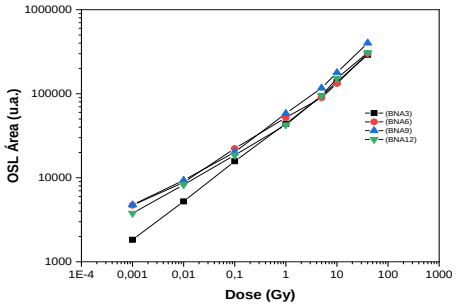

Figure 2: OSL dose-response curve of AgNO3-doped samples in the dose range of 1.0 mGy to 40 Gy ($^{90}Sr+^{90}Y$).

Referênce:

1. BOOTJOMCHAI, C., LAOPAIBOON, R., Thermoluminescence dosimetric properties and effective atomic numbers of window glass, Nuc. Inst. Met. Phys. Res. Sec. B, v.323, p. 42-48, 2014.