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Borate and silicate glasses as high-dose linear response dosimeters

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The search for new sensor materials is a continuous effort in materials engineering field. Aspects such as lower production costs and better sensitivity response, are of great technological importance and the main goals on this quest. The food and medical industries are the ones that benefit most from this research. In the food industry, for example, one of the processes that have been widely used is the application of high doses of gamma radiation in fruits and vegetables. Ionizing radiation destroys bacteria and fungi, increasing the shelf life of foods. In this way, there is the need for the development of dosimeters to monitor the dose used which can reach up to 20,000 times of the lethal ones for humans. Glasses are being considered for high-dose dosimetry applications, since its production costs are lower compared to other materials. However, it must fit another desirable characteristic, which is the linear response with respect to the radiation dose exposure. When glasses are exposed to high-dose gamma radiation, their optical absorption spectra changes. Although there is not a full agreement on the cause of that change in the optical spectra, it is believed that this is a combination of color centers produced by the entrapment of either electron-hole generated and/or due to some oxidized transition metal impurities. In this work, small rectangular pieces (1 x 1 x 4) mm3 of commercial soda-lime glasses, lithium and sodium diborates were irradiated with doses up to 10000 Gy, using a 60Co Gamma Cell-220 system. The samples were characterized by UV-Vis and Fourier Transform Infrared (FTIR) spectrometry. The dose-response data showed good linear relationships at 250 nm (R2=0.9972). The highest linearity was shown for lithium diborate, sodium diborate and commercial soda-lime glass, respectively. Based on the data presented, it is also shown that these glasses may be used as Yes/No in situ detectors. Acknowledgments to FAPESP (Proc. 2013/07793-6).