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Production and dosimetric properties of silver doped borate glasses

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Introduction: A variety of glasses are currently investigated as radiation dosimeters, mainly for high exposure measurements using thermoluminescence [1-3].

Low sensitivity and rapid fading are often reported as limitations presented by the glasses. The possibility of prepare fibers, ease of preparation, and the possibility to produce a wide range of compositions are among the advantages presented by glasses. Borate glasses, in particular, are appealing for their effective atomic number close to the human tissue.

The main goal of our research is to characterize the dosimetric properties of a particular type of a borate glass using Optically Stimulated Luminescence (OSL).

Materials and Methods: The glasses we investigated in this research were produced by the melt quenching method. Different amounts of silver were added to a glass matrix composed by $20Li_2CO_3$ - $15K_2CO_3$ - $65B_2O_3$ [$1Al_2O_3$ - **x**Ag] (x = 0,1; 0,2; 0,3; 0,4; 0,5 mol%). After production, glasses were milled (granulometry between 150 and 75 µm) and mixed with Teflon to form pellets of 6 mm diameter and ~ 50 mg mass (of which 12.5 mg was Teflon).

X-ray diffraction (XRD) and differential thermal analysis (DTA) were performed to examine the basic characteristics of the glass (absence of cristallinity and glass transition temperature). OSL glow curves were measured with a Risø TL/OSL reader to characterize the dosimetric properties of the samples. The irradiations were done at a dose rate of 0.1 Gy/s with a $^{90}Sr/^{90}Y$ beta-particle source.

Results and Discussion: XRD and DTA measurements confirmed the glass nature of our samples. Differences in the signal emitted by the samples, depending on the amount of added silver, were clearly visible. Fig. 1 and Fig. 2 ilustrate these differences. It is easy to recognize the higher intensity of the signal from $20Li_2CO_3$ - $15K_2CO_3$ - $65B_2O_3$ [$1Al_2O_3$ - 0,5Ag].

Fig. 1 shows an OSL reponse comparison between the L15KB - 1Al formulation, exposed to 1 Gy of beta irradiation, and formulations containing various proportions of silver, exposed to 0,3 Gy. Responses to three different doses of beta irradiation (0,1 Gy, 0,2 Gy, and 0,3 Gy) are shown in Fig. 2.

The OSL signal tends to improve with silver content starting from 0,3 Ag. The impact of smaller proportions of Ag will be analyzed with other techniques, such as electron paramagnetic rasonance.

Conclusions: Our results indicate a great improvement in the OSL intensity of glass produced with the addition of 0,5 mol%Ag. A broader dose analysis and new dose-response measurements are in progress, in an attempt to clarify aspects such as saturation and supralinearity. Although we know that the addition of aluminum makes our glasses more resistant to moisture, an assessment of the higroscopicity of the samples, which is important for some applications, will also be done.

References:

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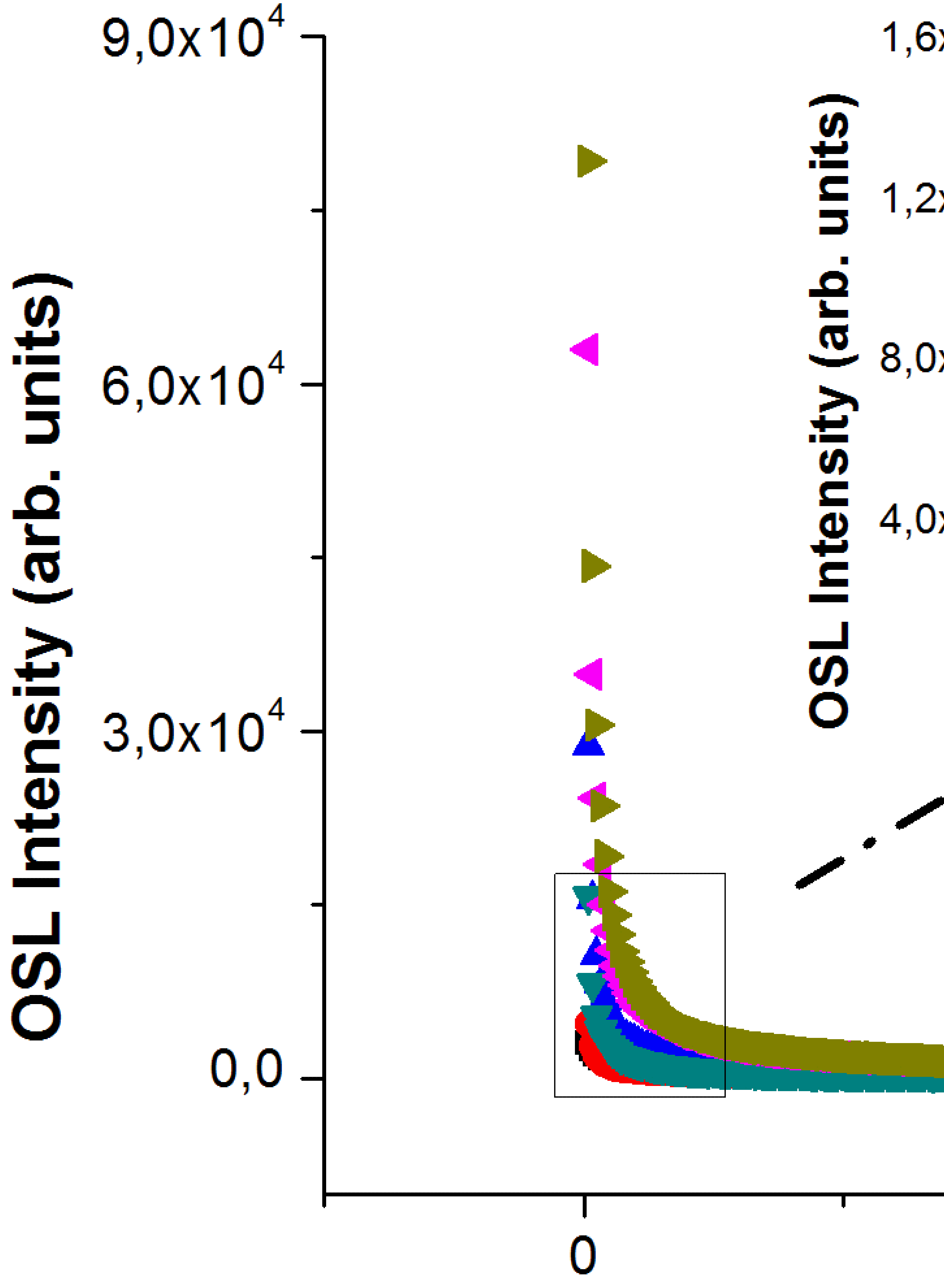
Figure 1



9,0x10^4
6,0x10^4
3,0x10^4
0,0
OSL Intensity (arb. units)
0
OSL Intensity (arb. units)

Figure 2

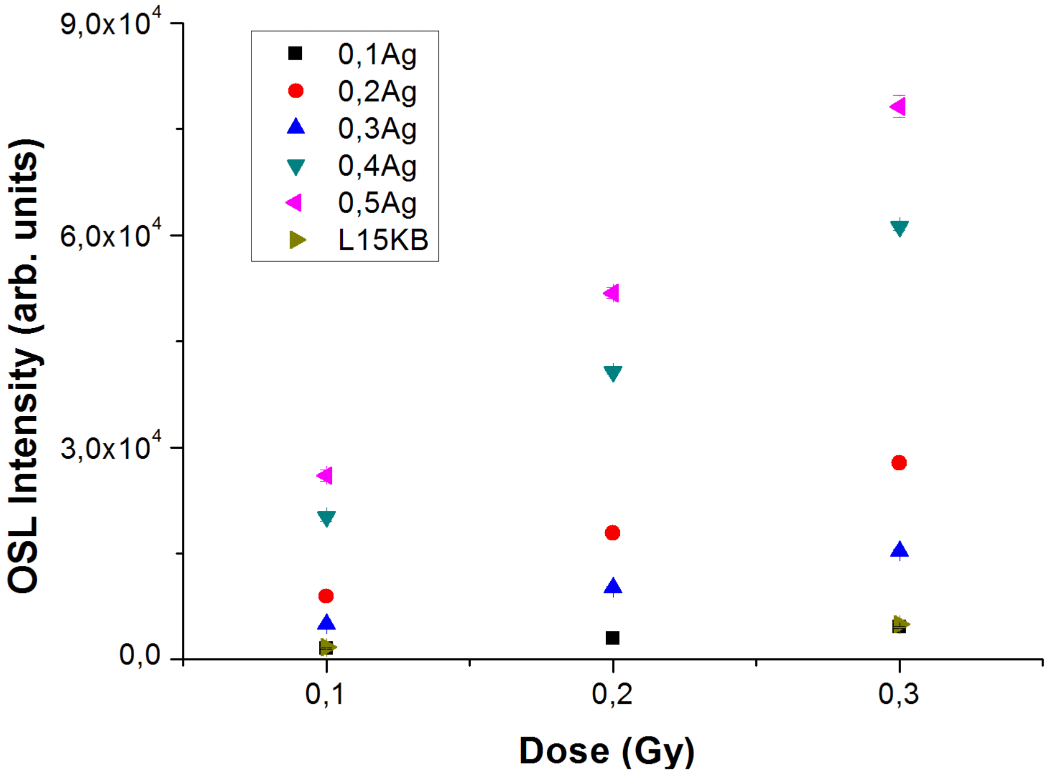


Fig. 2. Dose-response curve for the composition with silver added and for the composition without any silver and aluminum.