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Thermoluminencence using soda lime aluminosilicate glasses

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Abstract – This paper discusses the application potential of the soda lime aluminosilicate (SLAS) glasses in the field of gamma radiation dosimetry using thermoluminescence technique (TL). The EPR and TL studies of gamma-irradiated samples of the SLAS glass system xAl_2O_3 (1 − x)(50 SiO_2. 25 CaO . 25 NaO) mol%, where x = 0, 5, 10, 15, 20, are reported and the nature of the electron-hole radiative recombination mechanisms is analyzed. The shift of the TL peak with increasing aluminum content is explained in terms of the lower electropositivity of Al ions as compared with the Si glass-former ions. The optimum SLAS glass composition, as well as the gamma radiation dose response and the thermal stability the materials were determined in order to establish the best conditions of the SLAS glasses for use as gamma radiation dosimeters.

Glasses were prepared in two different compositions by taking the starting materials as reagent grade calcium carbonate ($CaCO_3$), sodium carbonate (Na_2CO_3), aluminum oxide (AlO_3) and silicon dioxide (SiO_2). The mould was then placed back into the annealing furnace for 1 h and left to cool slowly to room temperature in order to remove residual stress. The grains within the selected range of sizes were mixed with powdered Teflon™ (in open atmosphere of nitrogen. The mixture was pressed to 1.6 x 10^{11} N/m^2 and SLS glasses-Teflon pellets of 50 mg with dimensions of 6.0 mm diameter and 2.0 mm thickness were produced. The pellets were sintered at 300 ^{0}C/30 min + 400 ^{0}C/1h, followed by a 300 ^{0}C/1 h thermal treatment and slowly cooled.

The ratio of the peak height is different between the two types of samples, with relatively more deep (higher temperature) traps generated in the sample A. It is possible to consider that are three different centers contributing to the peaks observed in Figure 1, that are related to the presence of metastable energy levels in the glass that are occupied by the charge carriers releases during irradiation. The lifetime of the charge carrier in these energy levels is temperature dependent. However, annealing experiments can lead to an overlapping of defects that contribute to the peaks.

The decrease in TL peak at 210 ^{0}C and 195 ^{0}C as a function of storage time after exposure to 5 kGy of rays was studied. Measurements were made at room temperature and at 30-50 % relative humidity. The decrease was 20% after irradiation (6 months). The fading effect can be attributed to the annihilation of induced defect centre formed by irradiation due to the release of trapped electrons and their recombination with trapped holes [1,2].

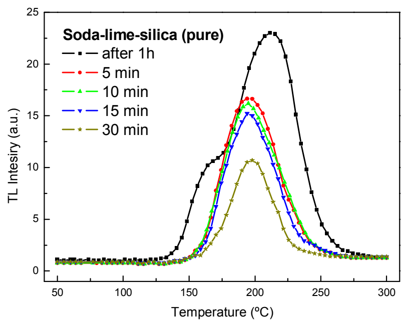

Figure 1: TL glow curves.

References

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