# Nature of Intrinsic Luminescence of the Undoped Borate Glasses

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The intrinsic luminescence of a series of the undoped borate glasses has been investigated by optical spectroscopy (absorption, photoluminescence, decay kinetics, time-resolved luminescence) as well as electron paramagnetic resonance (EPR) and thermally stimulated luminescence (TSL). The undoped nominally-pure borate glasses of high chemical purity and optical quality with $Li_2B_4O_7$ ($Li_2O$–$2B_2O_3$), $LiKB_4O_7$ ($0.5Li_2O$–$0.5K_2O$–$2B_2O_3$), $CaB_4O_7$ (CaO–$2B_2O_3$), and $LiCaBO_3$ ($0.5Li_2O$–CaO–$0.5B_2O_3$) compositions were obtained from corresponding polycrystalline compounds in the air atmosphere using standard glass synthesis technology described in [1].

The optical absorption spectra show that investigated undoped borate glasses are high transparent in the 330 – 2500 nm spectral region. Three types of the intrinsic luminescence have been observed in the investigated borate glasses at room temperature under UV excitation. Possible nature and mechanisms of the intrinsic luminescence are considered and discussed.

The investigated borate glasses upon excitation at 310 – 340 nm (3.6 – 4 eV) exhibit luminescence band with maximum in the 360 – 400 nm (3.1 – 3.4 eV) spectral range. The position and shape of excitation band well correlates with the edge of fundamental absorption. The luminescence decay curves are satisfactory described in the framework of single exponential approximation with lifetimes about 30 ns. Basing on obtained results it is concluded that first type of intrinsic luminescence is related to band-to-band electron-hole recombination process.

The intrinsic luminescence of second type is exited about 380 nm (3.2 eV) and emits about 440 nm (2.8 eV). The energy of excitation bands shows very good correlation with optical band gaps. The luminescence lifetimes, which approximately equal 1 and 4 ns were obtained in the framework of two-exponential approximation. Basing on experimental results, one can propose that the second type of intrinsic luminescence belongs to the luminescence of excitons.

The undoped borate glasses upon excitation about 260 – 270 nm (4.6 – 4.7 eV) exhibit broadband intrinsic luminescence with extended maximum in the 470 – 490 nm (2.5 – 2.6 eV) spectral range. The luminescence decay curve of this band is strongly non-exponential and can be satisfactory described by decay kinetics of the hyperbolic type. The average lifetime value equals about 130 μs. The EPR spectra and TSL glow curves of the $X$ - and $\gamma$ - irradiated undoped borate glasses show presence of the $O^-$ hole centres, which are stable at room temperature and characterised by trap depth about 1.0 eV. The third type of intrinsic luminescence is caused by recombination of electrons with $O^-$ hole centres, which are created upon the UV excitation. In this case, electrons before recombination were trapped and re-trapped by shallow electronic traps at room temperature that result in luminescence kinetics of the second order.

[1] B.V. Padlyak, S.I. Mudry, Y.O. Kulyk, A. Drzewiecki, V.T. Adamiv, Y.V. Burak, I.M. Teslyuk, *Mater. Sci. Poland* **30** (2012) 264–273.