PRODUCTION OF ZINC SULPHIDE- AND SODIUM FLUORIDE-DOPED LITHIUM TETRABORATE AND STUDIES OF ITS PROPERTIES

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Using the vacuum synthesis method the lithium tetraborate (LTB) $Li_2B_4O_7$ alloys have been produced with different dopant percentage content. The optimal synthesis modes and the dopant content (0.005-0.1 mol) have been found. The introduction of NaF and ZnS dopants into the LTB matrix results in the formation of additional trapping levels that stipulate the rise of X-ray luminescence and thermoshimulated luminescence intensities.

$Li_2B_4O_7$ is a promising material for acousto- and optoelectronics, dosimetry and is characterized by a complex chemical and energy structure [1–4]. Under ionizing radiation effect $Li_2B_4O_7$ produces luminescence, while the introduction of dopants changes drastically the luminescence curve shape and the intensity of thermo- and X-ray luminescence.

It is known [5–11] that the introduction of activator impurities Cu^{2+}, Ag^{+}, Cr^{3+}, Mn^{2+}, La^{2+}, Eu^{3+} etc. results in the radiothermoluminescence shape change, and the Cu^{2+} activator appears to be the most effective one. In literature there are no data on LTB doping by I and II group element chalcogenides and halogenides. We have carried out the work on the vacuum synthesis of LTB alloys with different NaF and ZnS content.

The goal of the present work is to study the ZnS and NaF dopant influence on the thermostimulated (TSL) and X-ray (XL) LTB luminescence. A series of vacuum synthesis with different dopant content 0.005-0.1 mol) have been performed with dissociation suppression by argon at the $1 \cdot 10^{-1}$ Torr residual pressure. It has been found that the dopants with >0.05 mol content result in the melt liquation and incomplete interaction at given temperature modes. At the 0.0005 mol dopant concentrations, the volume-homogeneous LTB melts are produced, being transparent and capable of the production of standard elements for study.

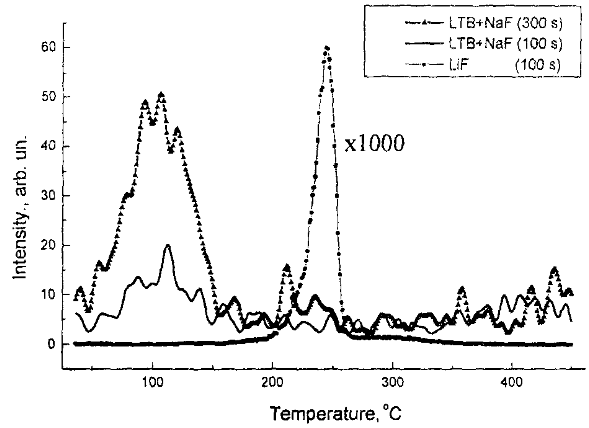

Fig. 1.TSL curve of $Li_2B_4O_7$ with NaF dopant ($1 \cdot 10^{-5}$ mol)

To produce the doped LTB samples one has to comply with the following technological regimes: vacuum not worse than $5 \cdot 10^{-5} \div 1 \cdot 10^{-6}$ Torr, container temperature – 850-900°C, synthesis duration - 20 min. A series of experimental samples have been produced, with based on the XPA data, are in the amorphous state, the ZnS dopant concentration being from $5 \cdot 10^{-4}$ to $1 \cdot 10^{-5}$ mol. The reduction of the ZnS dopant concentration results in the XL in the TSL spectra studies, the introduction of NaF into the

LTB matrix results in the main TSL maximum shift towards the lower temperatures, as compared to the LiF standard samples.

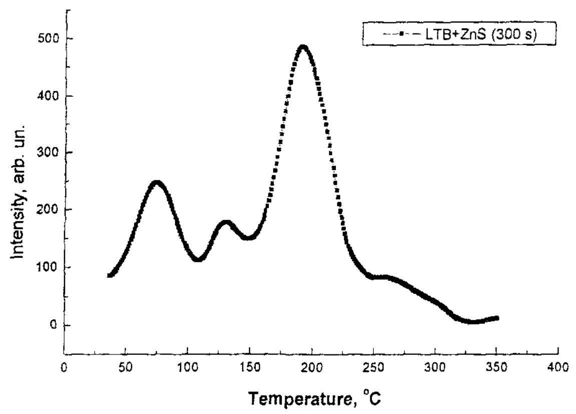

Fig. 2. TSL curve of $Li_2B_4O_7$ with ZnS dopant ($1 \cdot 10^{-5}$ mol)

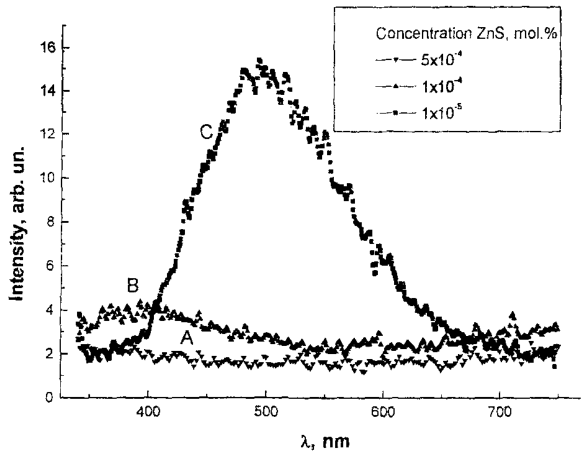

Fig. 3. XL spectrum of ZnS-doped $Li_2B_4O_7$.

For the standard LiF samples the TSL maximum is observed at 518 K, while for the NaF-doped $Li_2B_4O_7$ – at 383 K (Fig. 1). In the TSL curve of ZnS-doped LTB melts three maxima at 460, 405 and 350 K are revealed (Fig. 2). The most intense maximum is shifted against LiF towards the lower temperatures. It should be noted that the high-temperature maximum intensity as compared to that in LiF indicates the promising character of doped alloy use in TSL. The TSL and XL intensities depend significantly on the dopant concentration. At the $5 \cdot 10^{-4}$ mol concentrations the XL intensity is low (Fig. 3, curve A). The reduction of the ZnS concentration to $1 \cdot 10^{-4}$ mol results in the XL intensity increase with the maximum close to 400 nm (Fig. 3, curve B). At the $1 \cdot 10^{-5}$ mol concentration the XL intensity increases, and maximum is shifted towards the long-wave region (500 nm, Fig. 3, curve C).

The experimental data agree well with earlier TSL results and band structure model data. The introduction of ZnS and NaF dopants results in the perturbation of additional trapping levels LTB, that, in turn, increases the XL and TSL intensity.

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ОДЕРЖАННЯ ТА ДОСЛІДЖЕННЯ ВЛАСТИВОСТЕЙ ТЕТРАБОРАТУ ЛІТІЮ, ЛЕГОВАНОГО СУЛЬФІДОМ ЦИНКУ ТА ФТОРИДОМ НАТРІЮ

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Методом вакуумного синтезу одержано сплави тетраборату літію $Li_2B_4O_7$ з різним процентним вмістом легуючих компонент. Встановлено оптимальні режими синтезу та процентний вміст домішок, який знаходиться в інтервалі 0.005-0.1 моль. Введення легуючих компонент NaF та ZnS в матрицю $Li_2B_4O_7$ приводить до утворення додаткових рівнів прилипання, що зумовлюють підвищення інтенсивності рентгено- та термостимульованої люмінесценції.