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# Thermoluminescence of doped $Li_2B_4O_7$ single crystals

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Thermoluminescence (TL) properties of Cu, K, Ag and Ga doped $Li_2B_4O_7$ single crystals were investigated in the temperature range 20–300°C. It was found that K and Ga impurities only strengthen the separate TL peaks which exist also in the intentionally undoped single crystals, while the Cu and Ga impurities form the new efficient TL centers. The possible models of these centers are discussed.

Исследованы термолюминесцентные (ТСЛ) свойства монокристаллов $Li_2B_4O_7$, легированных Cu, K, Ag и Ga, в температурном интервале 20–300°C. Выяснено, что примеси K и Ga только усиливают отдельные пики ТСЛ, которые существуют и в специально нелегированных монокристаллах, тогда как примеси Cu и Ag создают новые эффективные центры ТСЛ. Обсуждены возможные модели этих центров.

Lithium tetraborate $Li_2B_4O_7$ (TBL) is a perspective material for radiation dosimetry using thermoluminescence (TL) due to the fact that its effective atomic number (7,3) is almost the same as that of human body (7,4). That is why some companies just produce industrial variants of polycrystalline TBL tablets with different dopes for TL dosimeters. Such tablets, however, have certain drawbacks as compared to single crystals: hygroscopicity, lower quantum yield and low reproducibility of TL parameters. Therefore, despite of the higher cost of TBL single crystals as compared to polycrystalline samples, rather intense works to improve the TL parameters of the single crystals are in progress. In particular, similar to polycrystalline TBL, attempts are made for improving TL parameters of the single crystals by doping with different impurities. For example, in [1, 2] the growth and TL investigations of Ce, Eu, Tm rare-earth elements doped TBL single crystals were described and models of the centers responsible for TL in these crystals were proposed. From the TL-dosimetry point of view, however, the best results up to date have been obtained for copper-doped TBL single crystals [3]. Models of the TL centers in TBL:Cu are not developed neither for the single crystals nor for polycrystals. The lack of a unique TL center model in TBL:Cu single crystals does not allow to optimize the dosimetry parameters of these crystals. This work is aimed at the growth and TL investigations of Cu, K, Ag, and Ga doped TBL single crystals and analysis of the nature of TL centers therein.

The TBL single crystals were grown using the standard Czochralsky technique from the stoichiometric melt. The doping was performed at the stage of the $Li_2CO_3$–$H_3BO_3$ blend synthesis by adding the necessary amount of CuO, $K_2CO_3$, $AgNO_3$, or $Ga_2O_3$. For the investigations, the samples of the $\varnothing 5 \times 1$ mm$^3$ size standard for TL-dosimeters were prepared. The TL was measured in the temperature range 20–300°C using a special thermostat allowing to irradiate the samples under investigation by X-quanta beam