

The nature of the high-temperature thermally stimulated luminescence spectra of KCl:Li, NaCl:Li, KCl:Na and RbCl:Na single crystals

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High-temperature integral peaks of thermally stimulated luminescence (HTSL) are widely used as probes in the dosimetric monitoring of ionizing radiation. In classical dosimeters systems, the principal dosimetric features correspond to HTSL peaks at 473 K (TLD-100) and 490 K (TLD-700H).

However, the mechanisms responsible for the efficient formation of radiation defects, have not yet been systematically investigated in dosimeters based on alkali halide crystals, as well as contribution of cationic impurities on radiation defect formation and, finally, HTSL spectra have not been fully incorporated into interpretations of the recombination nature of luminescence.

In this work, systematic studies [1–3] were conducted on KCl:Li, NaCl:Li, KCl:Na, and RbCl:Na crystals. The investigation included measurements of integral HTSL, HTSL spectra, X-ray luminescence (XRL), tunneling luminescence (TL), TL decay kinetics, and optical absorption associated with radiation defect concentrations, with the aim of identifying a common mechanism responsible for enhanced light yield of dosimetric peaks.

Pronounced HTSL dosimetric peaks were observed with maxima at 530 K for NaCl:Li, 505 K for KCl:Li, 570 K for KCl:Na, and 550 K for RbCl:Na. Their spectral composition exhibit maxima at 3.4 eV (NaCl:Li), 2.8 eV and 3.1 eV (KCl:Li, KCl:Na), and 3.48 eV (RbCl:Na).

It is established that the enhanced formation of radiation defects proceeds via an associative mechanism involving mobile halogen atoms interacting within the field of light cations (Li^+ , Na^+). Upon their thermal dissociation, Li^+ (Na^+) ions facilitate recombination of free electrons with non-relaxed holes, leading to the formation of exciton-like luminescence centers. Thus, the integral HTSL in these materials is governed by exciton-like luminescence in the field of light cations.

Additional confirmation of these assumptions was obtained from the results of an investigation of the luminescence of $\text{Li}^+(\text{Na}^+)$ centers in comparison with other compounds doped with isoelectronic impurities, such as CsI:Na [4] and Sc^{3+} doped (Y, Lu)AG garnets [5].

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