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The role of intrinsic defects in formation of low-energy emission band of ZnSe<Te> and ZnSe<Cd> crystals

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Defect formation mechanisms in ZnSe<Te> and ZnSe<Cd> crystals have been considered in comparison with those in undoped zinc selenide crystals. The red emission band formation in ZnSe<Te> and ZnSe<Cd> crystals is established to be due to Zn_i interstitials and $(V'_{Zn}Zn_i^{\bullet})$, respectively.

Проведен анализ механизмов дефектообразования в кристаллах ZnSe<Te> и ZnSe<Cd> в сравнении с нелегированными образцами селенида цинка. Установлено, что за формирование красной полосы кристаллов ZnSe<Te> и ZnSe<Cd> отвечают соответственно междоузельные атомы цинка Zn_i и комплексы $(V'_{Zn}Zn_i^{\bullet})$.

The use of wide-band II–IV compounds in physics and technology of ionizing radiation detectors is due to the need for improvement of their performance parameters, in particular, of thermal and radiation resistance of those parameters. It has been shown [1, 2] that this object can be gained, in particular, via doping the crystals by isovalent impurities (IVI). In most cases, those do not form local levels within the band gap of the semiconductor but favor generation of the intrinsic point defects (IPD) of the lattice defining the material physical properties. The ensemble composition, concentration, and energy structure of defects depend, in turn, on the basic material parameters, the IVI type, and the doping technology. In this work, the IPD generation mechanisms are considered in the case of zinc selenide crystals doped with Te and Cd impurities as well as their role in the formation of the semiconductor luminescence characteristics. The main attention will be given to the red emission band that is of most importance when zinc selenide is used as an effective scintillation material [2].

Single-crystal 4×4×1 mm^3 plates of intentionally undoped ZnSe were used as the initial substrates. The crystals were grown from melt under inert atmosphere and showed a low electron conductivity at room temperature ($\sigma_n \approx 10^{-10}\ \Omega^{-1}cm^{-1}$). The ZnSe<Cd> layers were produced by annealing of the substrates in saturated Cd vapor at $T_a \approx 800$ K. The T_a value was selected because the solid solution $Cd_{1-x}Zn_xSe$ is not formed still at such temperatures [3] while the red band intensity attaining its maximum [4]. The ZnSe<Te> crystals were doped with tellurium impurity in the course of growing up to 0.1 % (mol.) and then annealed in saturated zinc vapor at 1300 K [2, 5]. This technology provides a rather high radioluminescence efficiency of the samples in red spectral region attaining 15 to 20 % at 300 K. Note that the radioluminescence spectra are similar to optically excited ones [5]. This feature makes it possible to study the nature of centers responsible for the red emission using