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Luminescence properties of isovalently doped ZnSe crystals

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The results of investigation of Te and O impurity influence on photoluminescence spectra (PL) of ZnSe crystals and the ascertainment of the nature of radiative centres are presented. The short-wavelength band in the PL spectra of the ZnSe:Te and ZnSe:O:Te crystals has the exciton nature. The band with λ_{max} = 486 nm is observed only in the PL spectrum of the ZnSe:O:Te crystal annealed in Zn vapour. In this region of the PL spectra of the ZnSe:Te crystals, we observe only the long-wavelength fall of the band at λ_{max} = 466 nm. We suppose that the band with λ_{max} = 486 nm is associated with radiative recombination of donor-acceptor pairs. The Zn_i defects may be as the donors, the O_{Se} or (O_{Se}–D) centres as the acceptor levels. The band with the maximum at 636 nm is associated with radiative transitions of the electrons from the conduction band to the associative acceptor.

Представлены результаты исследований влияния легирования Te и O на спектры фотолюминесценции (ФЛ) кристаллов ZnSe, а также обсуждается природа их излучательных центров. Показано, что коротковолновая полоса в спектрах ФЛ кристаллов ZnSe:Te и ZnSe:O:Te имеет экситонную природу. Полоса с λ_{max} = 486 нм наблюдается только в спектрах ФЛ кристаллов ZnSe:O:Te, оттоженных в парах Zn. Для кристаллов ZnSe:Te в этой области спектра существует лишь длинноволновый спад полосы с λ_{max} = 466 нм. Предполагается, что полоса с λ_{max} = 486 нм связана с рекомбинацией донорно-акцепторных пар. В качестве донорных уровней выступают дефекты Zn_i, а в качестве акцепторных центров могут быть O_{Se} или (O_{Se}–D). Полоса с максимумом при 636 нм связана с переходами электронов с зоны проводимости на ассоциативный акцептор.

Scintillators based on zinc selenide are, in fact, ZnSe crystals doped with an isovalent dopant — Te and/or O. They are grown by the Bridgman method and are subsequently subjected to the thermal treatment (annealing) in zinc vapor (1300 K, 24–8 h). The post-growth thermal treatment is a very important stage of the technological process of scintillator production. At this stage, formation of luminescence centers is completed, and possible channels of non-radiative recombination are suppressed, as well as the levels responsible for the afterglow. Annealing of ZnSe(Te) crystals in Zn gives rise to the crystal lattice defects related to the interstitial zinc. Two types of ZnSe-based scintillators are known, the peculiar features of which are related to the growth and after-growth treatment procedures. The first type scintillators (ZnSe(Te)) have high light output (up to 140 % with respect to CsI(Tl)), their lumi-