Luminescence and photoconductivity of zinc selenide crystals, doped with transition metal elements

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The interest in research of zinc selenide crystals doped with transition metal elements has increased considerably during the past few years. High quantum yield of emission and small Stokes losses of transition metal ions in zinc selenide allow to use these crystals as active media and passive gates for IR-lasers. The practical application of such lasers includes spectroscopy, biology, medicine, optical communications and navigation systems.

Further practical application of these crystals is limited by lack of simple and reliable technology doping by transition elements with controlled optical and photoelectric parameters, as well as the lack of information about their optical properties in the visible and near-infrared spectral region.

In this study, ZnSe: Ti, V, Cr, Fe, Co, Ni crystals obtained by diffusion doping are investigated. In the photoluminescence spectra of these crystals revealed a new series of emission lines in the visible and near-infrared spectral range. It is established that the relative luminescence intensity of the investigated crystals heavily depends on the photon energy of excitation light. As the excitation photon energy is lowered, the contribution of low energy bands to the luminescence spectrum increases. At the same time, under changes in the excitation photon energy, the position of emission peaks remains unchanged. This effect is typical of intracenter luminescence. A comparison of the photoluminescence spectra with previously studied the absorption spectra allowed to establish one correspondence between the absorption and photoluminescence lines in these crystals and determine the value of the Stokes shift.

Temperature shift of the first two high-energy photoconductivity lines correlated with a shift of the fundamental absorption edge position of the crystals. Accordingly, the depth of the ground state level of transition metal ions in ZnSe crystals is determined.

In these crystals first discovered a series of high-temperature photoconductivity lines in the visible region. These lines were observed at temperatures above 300K. The spectral position of the photoconductivity lines remains unchanged with increasing temperature and matches with the position of the previously studied lines intracenter absorption. The mechanism of high-temperature photoconductivity is proposed. It is assumed that in this case a two-step process. At first, electrons execute intracenter optical transitions from the ground state to higher excited states. Then thermally activated transitions of electrons from the levels of excited states to the conduction band occur.