CPPP 56 P RADIATIVE RECOMBINATION PROCESSES IN β-ZnP_2 SINGLE CRYSTALS

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The exciton states in monoclinic β-ZnP_2 crystals was the subject of many research papers over a long period of time and have been extensively examined [1-3]. In this work is reported that besides the excitonic luminescence in these crystals there is a broad band emission caused by the recombination via an intrinsic defect. This emission acts as a competitive channel for the excitonic radiative recombination.

The β-ZnP_2 crystals with typical dimensions of several mm^3 were grown by chemical vapour method. The steady-state photoluminescence (PL) was investigated using the 2nd harmonic of CW YAG:Nd^{3+} laser (λ_L=532nm) for excitation in the temperature range T=10÷120K. Results of the X-ray energy dispersion (EDX) analysis of β-ZnP_2 crystals do not show the presence of impurities and an important deviation from stoichiometric composition.

PL spectra of the β-ZnP_2 crystals contain two characteristic parts: the short-wavelength part (λ=0.7÷0.81μm) with several sharp excitonic lines followed by phonon replicas and the broad spectral band located in the near infrared region (λ=0.81÷1.03μm), with the temperature dependent half-width band $\Delta\nu \approx 0.15 \div 0.20$eV.

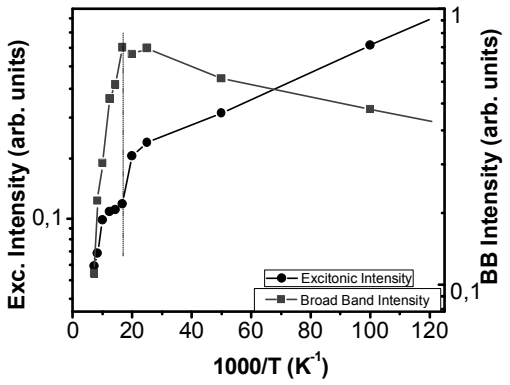

Fig. 1 PL integral intensity for the excitonic (circles) and broad band (squares) emissions as function of temperature

As the temperature is increased the PL intensity is redistributed from the excitonic region to the long wavelength broad band. At higher temperatures T>50÷60K a fast exponential thermal quenching occurs with an activation energy E_T≈0.03eV (Fig. 1). The behaviour of the excitonic luminescence temperature dependence is more complicated – the quenching process is characterized by a step, placed at the same temperature as the beginning of the broad band quenching. It is shown, that the broad band emission with spectral maximum located at 1.3eV (i.e. at about 0.3eV below the conduction band) is caused by a radiative deep centre, associated with an intrinsic defect of the crystalline lattice.

Taking into account the temperature behaviour of the broad band integral intensity as well as the spectral half-width of the band, the single configuration-coordinate diagram of this deep centre is constructed. The kinetic equations describing the recombination processes in β-ZnP_2 are proposed. It is shown, that the temperature behaviour of the excitonic emission integral intensity is governed by the radiative and nonradiative transitions involving the deep centre that acts as an efficient recombination shunt channel for the photo-excited carriers. The origin of the intrinsic defect responsible for the broad band emission of the β-ZnP_2 crystals is discussed.

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References

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