INFLUENCE OF GROWTH TEMPERATURE ON LUMINESCENCE PROPERTIES OF ZnSe:Gd CRYSTALS

Evghenii GONCEARENCO

Zinc selenide (ZnSe) single crystals have wide prospects to use in optoelectronics, spintronics and nonlinear optics. Doping with rare earth impurity gives the "cleaning" effect to the ZnSe samples and also increases edge emission of the crystals [1]. Thus, this paper describes how the growth temperature influence on luminescence properties of the ZnSe doped with Gd impurity.

The easiest doping method is thermal diffusion, but for rare earth impurities it is not compatible. The samples were doped at growth at different temperatures (950°C, 1000°C and 1050°C) using physical transport method. The grown ingots were cut into rectangle peaces, ant then polished and etched. Obtained samples were excited by ultraviolet nitrogen laser ИЛГИ-503 (λ = 337.1 nm) for visible spectral range and by green Nd^{3+}:YAG (λ = 532 nm) for IR spectral range. Photoluminescence (PL) spectra were analized in 400-2500 nm spectral range at 77K.

The edge PL emission characterized by excitonic transition and the most intense emission has the sample grown at 1000°C (Fig. 1(a)). Other samples radiate more then 3 times weaker bands. The shape of the edge bands does not have changes and it has Gaussian form. In the remained visible spectra have been registered a band at 530 nm and a weak one at 635 nm (Fig. 1(b)). While we increase temperature of the growth these bands became weaker and disappear at 1050°C. In the infrared (IR) spectral region have been detected two bands, at 995 nm and a complex one at 2 μm region (Fig. 2). The band at 995 nm has maximum emission when sample was grown at 1000°C and emission efficiency drops while temperature rises or reduces (Fig. 2(a)). The complex band in the 2 μm spectral range changes its shape and intensity (Fig. 2(b)).

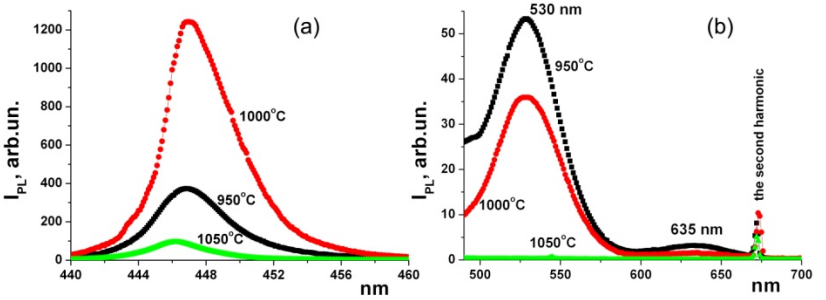


Fig. 1. PL properties of the ZnSe:Gd samples grown at various temperatures in the visible spectral range at 77K

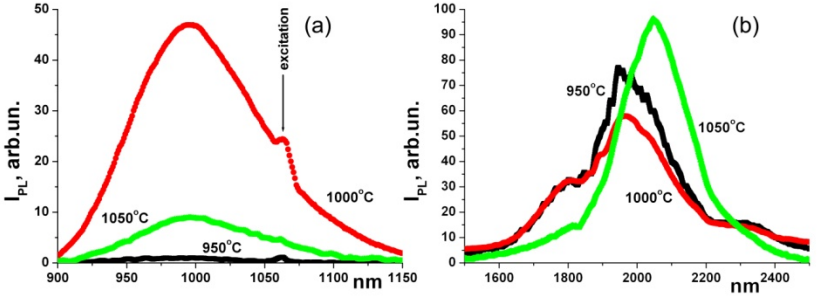


Fig. 2. PL properties of the ZnSe:Gd samples grown at various temperatures in the IR spectral range at 77K

Analyzing the obtained bands in full range there are some interesting results. First of all we may note that the IR bands are referred to intracentered transition of the background impurities. If we will compare obtained band at 1050°C with the band of ZnSe:Cr sample (Fig. 3(a)) we can say that mention band corresponds to the Cr^{2+} ion transition, from the the first excites state ($^5E(D)$) to the ground state [2]. However, the registered band in visible range at 530 and 635 nm correspond to the transition from the conduction band to the shallow acceptor impurity of the Cu. So, the last one is that if we will utilize the method of Alentsev-Fock to decompose our complex band in 2 μm range then we will see that this band consist of four simple one (Fig. 3(b)). The intensity of every component varies while we change the growth temperature (Fig. 2(b)). We can suppose that Gd impurity not only activate the background impurities, but also redistribute the energy between them. Also, there is a possibility that these background impurities are arranged in the crystal with different configuration. Thus, the PL spectra of the ZnSe:Gd sample changes while the temperature is modifying.

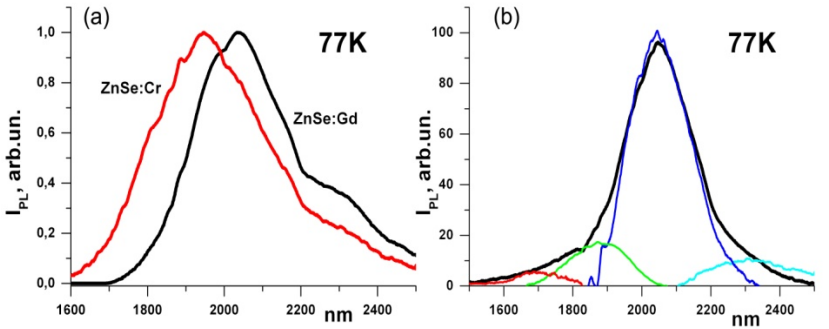


Fig. 3. (a) – PL properties of the ZnSe:Gd and ZnSe:Cr samples;

(b) – decomposition of the PL spectra on the simple bands for ZnSe:Gd grown at 1050°C

In conclusion I would like to mention the following: 1) temperature profile of growth have extreme influence on PL properties of the ZnSe:Gd; 2) using different temperature of growth we can adjust the emission intensity of the needed bands; 3) at the same time, Gd impurity activate radiative centers in the investigated spectral range; 4) there is a possibility that performing annealing in different media or using various impurity concentration will be enough to understand the physical properties of the ZnSe:Gd samples.

References:

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