MUTUAL INFLUENCE OF Cr AND Yb IMPURITIES ON PHOTOLUMINESCENCE PROPERTIES OF ZnSe CRYSTALS

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Infrared (IR) spectral region in 1.5-2.5 μm range are recently intense investigated. It is analyzed because of the absence or minimal number of the air absorption bands. Therefore, zinc senelide (ZnSe) doped with chromium (Cr) has wide prospect for production of light source radiating in noted spectral range [1]. ZnSe doping with ytterbium (Yb) results to a partly "cleaning" effect of the crystal from background impurities. In this paper investigation results of mutual influence of Cr and Yb impurities on photoluminescence (PL) properties of ZnSe crystals are discussed.

On the first stage, the big ZnSe ingot was cut into plates. After, these plates were doped using heat-treatment method in Bi + 0.02 at.% Cr; Bi + 0.025 at.% Yb and (Bi + 0.02 at.% Cr + 0.025 at.% Yb) melts at 1150K. Finally, obtained samples were separated from Bi and was performed polishing with following etching. PL properties were analyzed in 400-2500 nm spectral range at room and at boiling liquid nitrogen temperatures. Samples were excited by ultraviolet nitrogen laser ИЛГИ-503 (337.1 nm) for visible spectral range and by green Nd^{3+}:YAG (532 nm) for IR spectral range.

Initial ZnSe sample are characterized by intense emission in edge spectral range with 448 nm maximum at 77K and 462 nm at 300K (Fig.1). Doped ZnSe:Cr samples in Bi melt lead to the reducing effect of edge emission and shifts band maximum to the 449.5 nm, also, appear "tail" in the long wavelength spectral range. Obtained changes could be explained by appearance of the

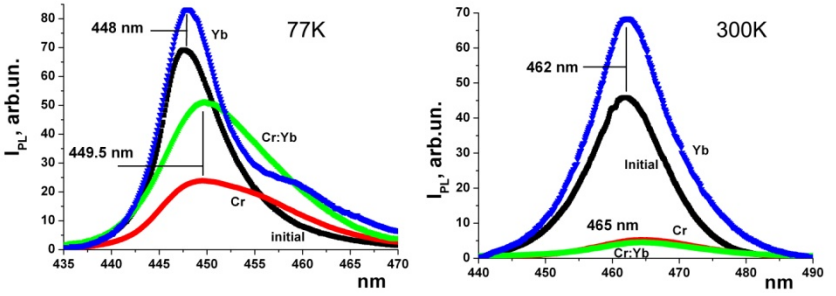


Fig. 1. PL spectra of initial and doped ZnSe samples in Bi + 0.02 at.% Cr; Bi + 0.025 at.% Yb and (Bi + 0.02 at.% Cr + 0.025 at.% Yb) melts in the edge spectral range

shallow acceptor levels in the band-gap, which are more favorable [2]. Doping ZnSe samples with Yb impurity increases edge emission and also purify from the nonradiative recombination and activate shallow acceptor levels (bend at 460 nm). Mutual doping with Cr and Yb impurities permit us to adjust intensity of the edge emission in range between maximum emissions of ZnSe:Cr and initial ZnSe samples. At the same time, the emission form remains. In the remained visible spectral range have not been registered changes, in other words misses emission bands.

PL properties in the IR spectral range of the investigated samples are characterized by two emission bands with maximum at 960 and 2070 nm, which do not change their position with temperature modification (Fig.2). However, band at 2 μm spectral range has complex form. Thus, we could conclude that registered band relates to the intracentered transition and compare with literature data [2], maximum at 2070 nm corresponds to the transition from the first excites state (^{5}E(D)) to the ground state ($^5T_2$(D)) of Cr^{2+} ion.

Studying more detailed luminescence properties of the analyzed set of samples, we can establish that initial ZnSe sample do not have emission in the IR spectral range. Doping with the Cr impurity give us mentioned bands in the IR range (Fig. 2) where they can be easily registered. Doping ZnSe samples with Yb impurity activate shallow Cr impurity and "purifies" from the nonradiative recombination in comparison with initial ZnSe sample. At the same time, mutual doping with Cr and Yb impurity permit to amplify intensity of the emission band at 2070 nm, but reduces band at 960 nm (Fig. 2). We can suppose that energy in the samples is redistributing from 1 μm to the 2 μm spectral range.

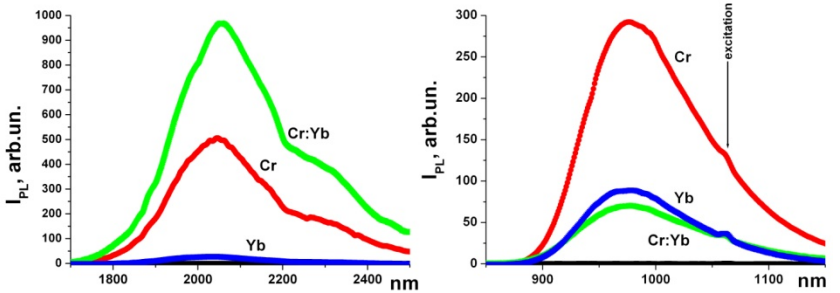


Fig. 2. PL spectra of initial and doped ZnSe samples in Bi + 0.02 at.% Cr; Bi + 0.025 at.% Yb and (Bi + 0.02 at.% Cr + 0.025 at.% Yb) melts in the IR spectral range at 77K

Summarizing our research we can conclude: 1) ZnSe samples doped by Cr impurity allow to extend prospects; 2) Yb impurity "purifies" initial and doped ZnSe samples from the nonradiative transitions; 3) at the same time,

Yb impurity activate radiative centers in the investigated spectral range; 4) mutual doping of ZnSe samples by Cr and Yb impurities allows to adjust intensity of both edge emission band and in the 2 μm spectral range emission band.

References:

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