STUDY OF THE DEPENDENCE OF THE RADIATION INTENSITY IN THE NEAR INFRARED RANGE OF ZnSe:Fe ON THE POWER OF THE EXCITING SOURCE

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In this work, the luminescence of impurity-defect centers for two ZnSe:Fe+ crystals with different concentrations of iron atoms in the near infrared range was investigated. In particular, the dependence of the intensity of the maxima in the spectra on the power of the excitation source is considered.

Keywords: polycrystalline CVD (chemical vapor deposition) ZnSe, impurity-defect luminescence , iron in zinc selenide, high isostatic pressure(HIP).
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INTRODUCTION

Polycrystalline samples of CVD ZnSe doped with Fe^{2+} are promising for optics, optoelectronics, laser technology, etc. Numerous studies are actively investigating the generation of radiation by such crystals in the mid-IR range, and lasers with the ability to tune the wavelength in the range of 3.7-5 μm have already been created [1-6]. The radiative processes are mainly intracenter d-d transitions described by crystal field theory [1-3].

These studies mainly investigated the mid-infrared (IR) range, at low temperatures.
In this paper, we investigate the photoluminescence spectra in the wavelength range of 0.8–1.1μm observed upon excitation by semiconductor lasers (λ_{ex} = 532 nm) in two CVD ZnSe samples doped with different iron concentrations at room temperature (T = 300 K). In particular, the dependence of the intensity of the maxima in the photoluminescence spectra on the excitation source power is considered.

METHODS AND EXPERIMENTS

Fe film was deposited on both sides of CVD ZnSe samples by electron beam evaporation, followed by diffusion doping by HIP (high isostatic pressure) processing

Diffusion doping in the first ZnSe: Fe11 sample was carried out at 1000 atm, 1423 K for 66.5 h and in the second ZnSe: Fe12 sample at 1000 atm, 1523 K for 26 h.

The maximum iron impurity concentration determined from the absorption edge shift in the ZnSe:Fe samples is $9.83 \cdot 10^{18}$ cm^{-3} (ZnSe: Fe11) and $7.27 \cdot 10^{18}$ cm^{-3} (ZnSe: Fe12), respectively. The forbidden band widths are respectively 2.6 eV and 2.62 eV.

The luminescence studies were carried out on a Nanofinder 30 Confocal micro-Raman spectrometer (Tokyo Instr., Japan). The second harmonic of the Nd:YAG laser with the radiation wavelength λex = 532 nm and the maximal power 10 mW was used as an excitation source. The spectral resolution was not worse than ~ 0.014 nm. A cooled CCD camera with the resolution 1024×128 pixels operating in photon-counting mode served as a radiation detector the luminescence spectra were recorded in the region λ = 440÷1500 nm.

RESULTS AND DISCUSSION

The samples were excited by light with wavelength λex = 532 (at a power of 1 mW) and the luminescence spectrum of both samples shows maxima at 930 nm, but they differ in intensity and half-width.

The dependence of the intensity of the maximum in the spectrum on the excitation power was also investigated, with the excitation power varying from 1 mW to 10 mW. (Fig.1,2). As can be seen from the figures, the behavior of the intensity of the maxima on the excitation power is quite different .

In the ZnSe:Fe11 sample with a concentration higher than that of ZnSe:Fe12, starting from an excitation power of 5 mW, changes are observed in the spectrum at a wavelength of 800 nm, and with an increase in excitation power to 10 mW, this change turns into a stepwise inflection(Fig.1).

However, in the ZnSe:Fe12 sample, changes in the spectrum at a wavelength of 800 nm occur from the very beginning of excitation, and with an increase in excitation power to 10 mW, a wide doublet structure with maxima at 800 nm and 930 nm appears in the spectrum(Fig.2). The appearance of a doublet structure with maxima at 800 nm and 930 nm in the ZnSe:Fe12 sample with increasing excitation power indicates the complex nature of impurity-defect centers where radiative recombination occurs. when exposed to a crystal field, the singlet level 5D of the Fe^{2+} ion splits into a doublet 5E and a triplet 5T2, where 5E is the ground state and 5T2 is the first excited state. The triplet excited states 5T2 split as a result of spin-orbit interaction [7] and from the lower first split level 3T1, possible transitions to 5E result in radiation in the wavelength range of 0.8-1.2 μm.

It can be said that the mechanism of radiative recombination, which forms emission lines in the spectral range of 0.83-0.93 μm, is associated with intracenter radiative transitions of iron atoms included in the complex defect in the form of Fe^{2+}, i.e. it is associated with the radiative transition $^3T_1$ (^3H)–^5E(^5D) [6-8].

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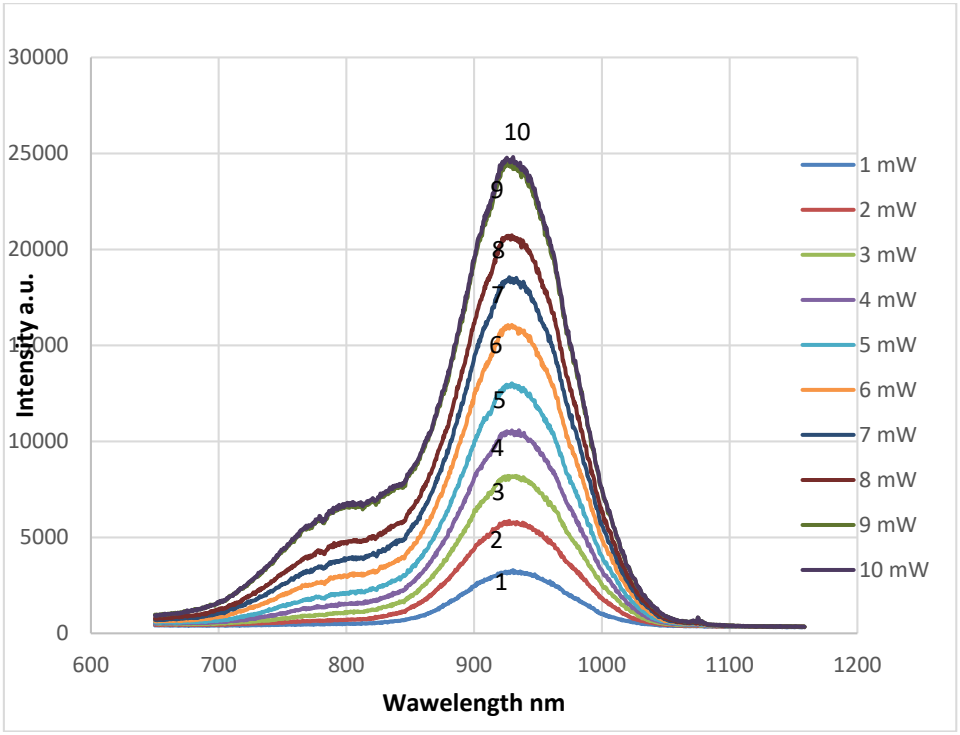

Fig.1. Dependence of radiation intensity corresponding to λ_{max} = 930 nm on the power of excitation source (laser at λex = 532 nm, sample ZnSe:Fe11).

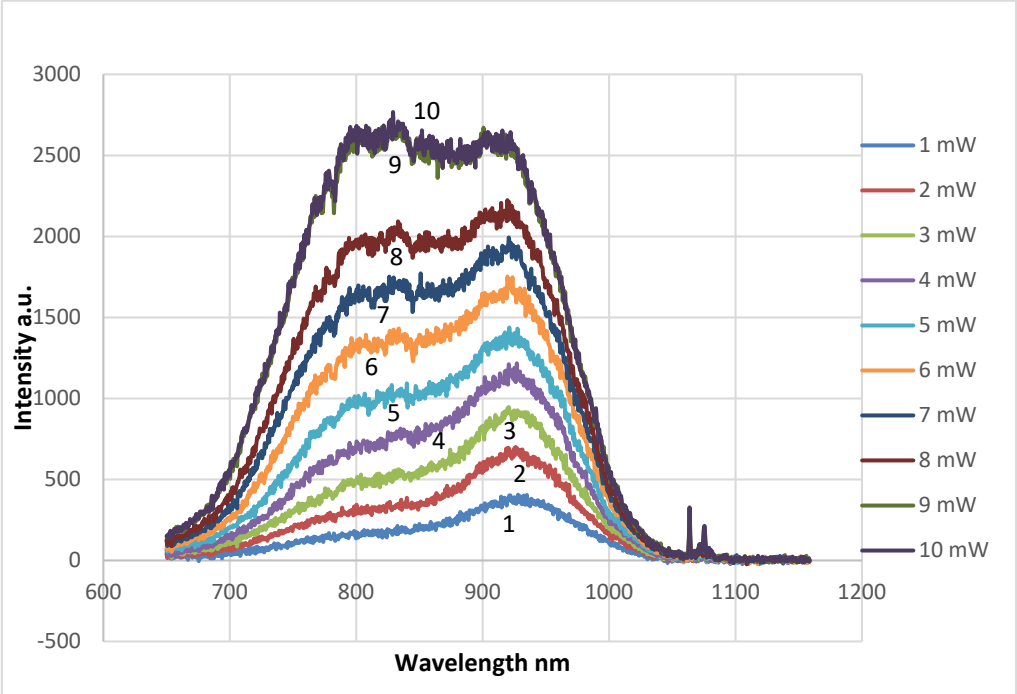

Fig.2. Dependence of radiation intensity corresponding to λ_{max} = 930 nm on the power of excitation source (laser at λex = 532 nm, sample ZnSe:Fe12).

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