

STUDY OF SPATIALLY SEPARATED LUMINESCENCE CENTERS OF POLYCRYSTALLINE CVD ZnSe WITH EXCESS OF SELENIUM AND OXYGEN USING DIFFERENT FLUORESCENCE SPECTROMETERS

I.I. ABBASOV¹, M.A. MUSAYEV¹, J.I. HUSEYNOV², D.J. ASKEROV¹,
R.Sh. RAHIMOV³, S.Q. NURIYEVA³, A.J. MAMMADOVA⁴

¹ Azerbaijan State Oil and Industry University

² Azerbaijan State Pedagogical University,

³ Baku State University, Nanotechnology Center

⁴ Institute of Biophysics, National Academy of Sciences of Azerbaijan,

Spatially separated luminescence centers of polycrystalline CVD (chemical vapour deposition) ZnSe with an excess of selenium and oxygen were investigated using two different fluorescence spectrometers (Fluo Time 300 Easy Tau, Cary Eclipse) with a xenon lamp with a power of 300 and 75 W, respectively, as an excitation source.

The homogeneity region of CVD-zinc selenide has a two-sided character and, unlike other zinc chalcogenides, it is characterized by a wide range of compositions with an excess of oxygen and selenium - ZnSe(O)Se.

Samples of polycrystalline ZnSe 3 mm thick were obtained by chemical vapor deposition (CVD) at the Institute of Chemistry of High-Purity Substances, Russian Academy of Sciences (Nizhny Novgorod). Growth samples specially not doped. The concentration of background impurities for the studied sample of polycrystalline CVD ZnSe was determined by two methods: atomic emission spectroscopy and laser mass spectrometry. Total impurity content $<10^{16}-10^{17} \text{ cm}^{-3}$ (Cu $\sim 10^{16} \text{ cm}^{-3}$). The oxygen concentration is controlled by chemical gas chromatographic analysis: O $\sim 10^{18}-10^{20} \text{ cm}^{-3}$ [2,3].

Photoluminescence spectra were obtained using a universal fluorescence spectrometer (Fluo Time 300 Easy Tau, Cary Eclipse). A xenon lamp with a power of 300 and 75 W was used as an excitation source in the spectrometers, respectively, and all measurements were carried out at T=300K.

At the beginning, PL was studied (Fluo Time 300 Easy Tau) with a stepwise change in the

excitation energy in the region of the fundamental absorption edge (including the “additional absorption” edge associated with an increased oxygen content): starting from 420 nm to 455 nm with an interval of 5 nm, close to the energy LO-phonon ($\sim 37-31 \text{ meV}$) in ZnSe, from 455 to 475 nm the change was carried out with an interval of 10 nm (0.11 eV), and from 475 nm to 515 nm by 20 nm (0.1 eV). For excitation wavelengths from 420 nm to 455 nm with an energy range close in energy to the ZnSe LO phonon 35–38 meV, the PL spectra were observed in the wavelength range 451–497 nm, i.e. multiphonon exciton spectra associated with the oxygen center were observed, and upon excitation from 455 nm to 515 nm with an interval of 10 nm and 20 nm, green and yellow-green spectra were mainly observed in the wavelength range 507–547 nm.

An analysis of the spectra showed that the long-wavelength shift of the photoluminescence spectra with decreasing excitation energy corresponds to a shift along the energy scale of the band model with a corresponding change in the type of radiative transitions [4].

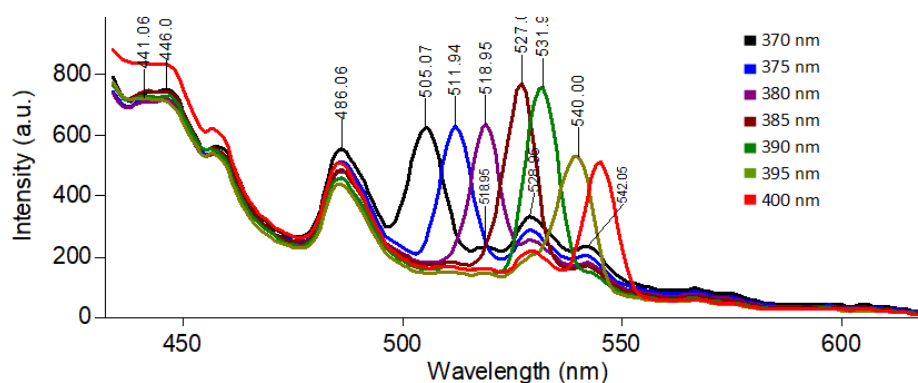


Fig. 1. Photoluminescence spectra of polycrystalline CVD ZnSe upon excitation with wavelengths varying with a 5nm interval in the range 370-400 nm.

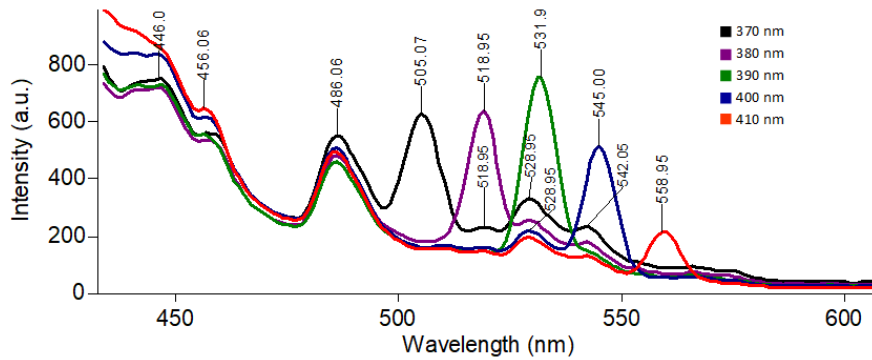


Fig. 2. Photoluminescence spectra of polycrystalline CVD ZnSe upon excitation with wavelengths varying with a 10nm interval in the range 370-410 nm.

On another spectrofluorimeter, Cary Eclipse, the PL spectra were taken as follows: first, the excitation of the sample was carried out by light with a wavelength of $\lambda_{ex}=370$ nm, and the excitation spectrum was simultaneously recorded for all maxima ($\lambda_{max} = 505, 529, 542,$ and 565 nm) that were observed in the spectrum in this measurement. The maxima in the excitation spectra cover the wavelength range of 370–414 nm. In this case, the obtained PL spectra with a stepwise change in the excitation energy from 370 nm to 414 nm, first 5 nm (~45–40 meV), then 10 nm (~90–80 meV) are shown in Figs. 1, 2, and the measurement result showed that only the maximum at the wavelength $\lambda = 505$ nm undergoes changes.

The band, where it has a maximum at $\lambda = 505$ nm (Fig. 1,2) represent the zero-phonon component of the ZnSe SAL edge radiation. It is known that the observation at room temperature of the long-wavelength "anomalous" edge glow of ZnSe is associated not only with an excess of oxygen and

selenium, but also with the presence of copper [4,5,6]. With a stepwise change of ~45-40 meV (Fig. 1.) and ~90-80 meV (Fig. 2.) of the excitation energy in the region of the fundamental absorption edge, the PL spectra of isoelectronic oxygen centers are observed, which are unevenly distributed in the bulk of the crystals, due to their predominant segregation by packing defects.

Based on the analysis of the PL spectra observed on two spectrofluorimeters of different power, it will be possible to describe in more detail the presence and inhomogeneous distribution of spatially separated luminescence centers in ZnSe(O)Se crystals. The study of the PL spectra associated with the inhomogeneous distribution of oxygen and background impurities over the surface and volume in the test sample with a step change in the energy of the exciting light, allows new opportunities for the method of optical diagnostics of single-crystal systems with defects.

- | | |
|--|--|
| <p>[1] G.G. Devyatykh, E.M. Gavrishchuk and others. High-purity substances. 1990. No. 2. C.174.</p> <p>[2] V.I. Oleshko, S.S. Vilchinskaya, N.K. Morozov. FTP. 2021. №5. S. 403.</p> <p>[3] N.K. Morozova, I.N. Miroshnikova. Semiconductors. 2021. №1. P.102.</p> | <p>[4] N.K. Morozova, I.I. Abbasov, E.M. Gavrishchuk and others. FTP. 2022. №1. P.80.</p> <p>[5] N.K. Morozova, I.I. Abbasov. FTP. 2022. №5. P.484.</p> <p>[6] G.B. Stringfellow and R.H. Bube. 1968. Photoelectronic properties of ZnSe crystals. Phys. Rev. 171, p. 903.</p> |
|--|--|