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APPLICATION OF PHOTOLUMINESCENT ANALYSIS TO CONTROL NANOPOWDERS SINC SELENIDE AND ZINC OXIDE

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Abstract. *A method for diagnostics of powdered substances is presented using the example of nanopowders of zinc selenide and zinc oxide. The method is based on the fiber-optic recording of photoluminescence spectra under laser ultraviolet (266 nm) excitation. The developed method can be used to control the quality of a large class of dielectric and semiconductor structures luminescing under the action of ultraviolet radiation.*

Keywords: *photoluminescence, secondary radiation, spectrum, nanopowder, cuvette, zinc selenide, zinc oxide.*

ПРИМЕНЕНИЕ ФОТОЛЮМИНЕСЦЕНТНОГО АНАЛИЗА ДЛЯ КОНТРОЛЯ НАНОПОРОШКОВ СЕЛЕНИДА ЦИНКА И ОКСИДА ЦИНКА

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Аннотация. *Представлен метод диагностики порошкообразных веществ на примере нанопорошков селенида цинка и оксида цинка. Метод основан на волоконно-оптической регистрации спектров фотолюминесценции при лазерном ультрафиолетовом (266 нм) возбуждении. Разработанный метод может быть использован для контроля качества большого класса диэлектрических и полупроводниковых структур, люминесцирующих под действием ультрафиолетового излучения.*

Ключевые слова: *фотолюминесценция, вторичное излучение, спектр, нанопорошок, кювета, селенид цинка, оксид цинка.*

1. Introduction

At present, optical processes in nanocrystalline structures are most intensively studied, which is connected with the rapid development of the industry in the production of such structures. It is established that various external influences on nanocrystalline objects can cause in them rather complex processes that do not appear in large crystals of the same substances [1-5]. The use of methods of optical spectroscopy, including laser spectroscopy [6-7], for a more complete study of these phenomena and processes in combination with modern methods of interpreting the results is very relevant.

In this paper, we present an original method for studying powdered substances, based on recording secondary radiation [8-9].

The results of the investigation of the photoluminescence (PL) spectra of nanopowders of zinc selenide (ZnSe) and zinc oxide (ZnO) by laser spectroscopy are presented. Experimental studies were conducted at room temperature.

2. Materials and methods

To excite and record the photoluminescence spectra, a fiber optic technique was used [3-4]. In this case, the fourth harmonic (266 nm) of an aluminum-yttrium garnet laser generating pulse-periodic radiation with a wavelength of 1064 nm was used as a source of exciting ultraviolet radiation (Figure 1). The average power of the exciting ultraviolet radiation on the surface of the analyzed sample was 10 mW, which made it possible to analyze the object without destructing it. Analyzed substance with a mass of about 10 mg (with an average particle size of 60 nm) in the form of a powder was placed in a mini-resonator cuvette.

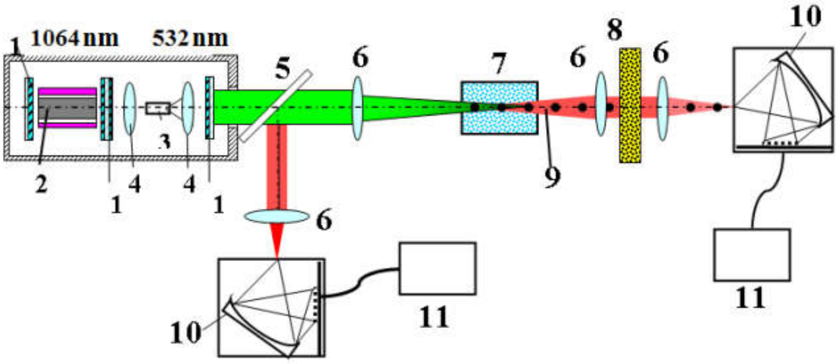

Figure 1: schematic diagram of an experimental setup for the study of powders.1 – laser mirrors, 2 – active medium – YAG:Nd^{3+}, 3 – nonlinear crystal, 4,6 – lenses, 5 – quartz plate, 7 – cuvette, 8 – photonic crystal, 9 – secondary radiation, 10 – minispectrometr, 11 – computer.

3. Results and discussion

In Figure 2 shows the spectrum ZnSe of PL nanopowders obtained by us at room temperature (curve 1). In addition, in the same figure, the PL spectrum of micron powders of zinc selenide (curve 2), obtained by us earlier in [10], is given for comparison.

As can be seen from the figure, the spectra of these samples differ from one another in intensity. The spectral intensity of the PL spectra of the nanopowder ZnSe is greater than the intensity of the micropowder by approximately 12 times. The maximum (λ_{max} = 475 nm) of the PL spectra of ZnSe nanopowders corresponds to the position of the 3L0 band from the series of multiphonon annihilation of A-excitons.

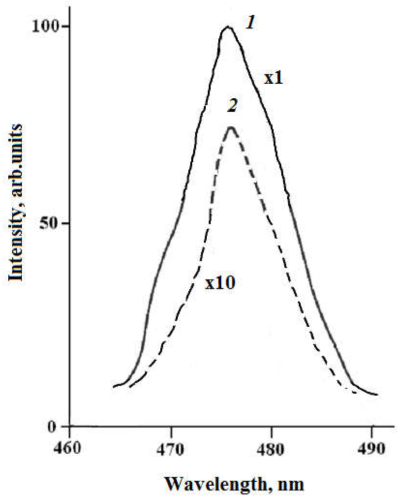

Figure 2: the PL spectra of nanopowders (1) and micropowders ZnSe, obtained at room temperature.

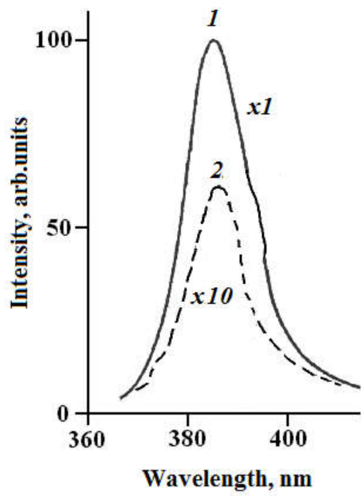

Figure 3: the PL spectra of nanopowders (1) and micropowders ZnO, obtained at room temperature.

In figure 3 shows the ZnO nanopowder PL spectrum obtained at room temperature (curve 1). Here, for comparison, the PL spectrum of micropowders ZnO (curve 2), which we obtained earlier in [5], is given. As can be seen from the figure, the spectra of these samples differ from one another in intensity. The spectral intensity of the PL spectra of the nanopowder ZnO is greater than the intensity of the micropowder by about 16 times. The maximum (λ_{max} = 390 nm) of the PL spectrum of ZnO nanopowders corresponds to the position of the 3L0 band from the series of multiphonon annihilation of A-excitons.

As it was shown earlier that under certain conditions in dispersed media the phenomenon of inelastic opalescence is observed, which consists in a sharp increase in the relative intensity of Raman scattering of light in comparison with the intensity of the exciting line at the exit from the resonator cuvette.

It was also found that in the study of powders in mini- resonator cuvettes, a decrease in the particles of ultradispersed media gave a sharp increase in the intensity of secondary radiation (in particular, the luminescence intensity). In addition, the use of mini-resonator cuvettes has made it possible to realize a "soft" mode of excitation of samples by laser radiation, to ensure that multiple measurements of samples are carried out without destructing them.

3. Conclusion

Thus, in this paper we use the example of structures close in structure nanopowders (ZnSe and ZnO) it is shown that for quantitative non-destructive testing of disperse media, the photoluminescence analysis method can be used effectively.

The developed technique provides obtaining information using small samples of the analyzed substance.

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