Study of optical and luminescent properties of nanocrystals $NaYF_4:Tm^{3+}$, Yb^{3+} in the UV range in the application of integrated optics

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Abstract. Studied the photoluminescence properties of synthesized nanocrystals doped with rare-earth ions NaYF4:Tm^{3+}, Yb^{3+}, measured luminescence spectra and absorption in the visible and near infrared regions of 300-1000 nm. Were measured the energy of phonons these nanocrystals, the average phonon energy was 332cm^{-1}. Made optical waveguide impregnated with nanoparticles $NaYF_4$: Yb^{3+}, Tm^{3+} as the prospect of a compact source of radiation in the visible and UV range.

Recently, luminescent properties of materials doped with rare earth (RE) ions are attracted great attention due to their special characteristics: rich structure of the energy levels, low phonon energy, narrow lines of photoluminescence (PL) and a prolonged lifetime of the excited states. Such materials are nanoparticles, which are crystalline matrix of β-$NaYF_4$ a hexagonal structure, doped with rare-earth ions Tm^{3+}, Yb^{3+}. Yb^{3+} are used as donors transmit the absorbed energy-acceptor ions (Er^{3+}, Tm^{3+}) to increase efficiency upconversion. Ytterbium ion has broad absorption band in the range 970-980 nm [1].

Synthesized monodisperse upconversion nanoparticles with a core-shell structure with a size of 70 to 80 nm by the method described in [2]. The core - $NaYF_4$ simultaneously doped Yb^{3+}, Tm^{3+}, shell - $NaYF_4$.

To study the optical and photoluminescence properties of stable colloid was prepared using 2.966 g trihlometana and adding 0.1% by weight of upconversion nanoparticles. To nanoparticles were uniformly distributed over the volume of the solvent mixture by ultrasonic bath for 20 minutes.

Nanocrystals PL spectrum measurements were carried out using a spectrofluorometer Fluorolog3 manufactured by Horiba Jobin Yvon. The luminescence spectrum, taken at room temperature, is shown in Fig. 1a. It is evident that nanocrystals exhibit intense photoluminescence lines in the visible and near-IR spectral range.

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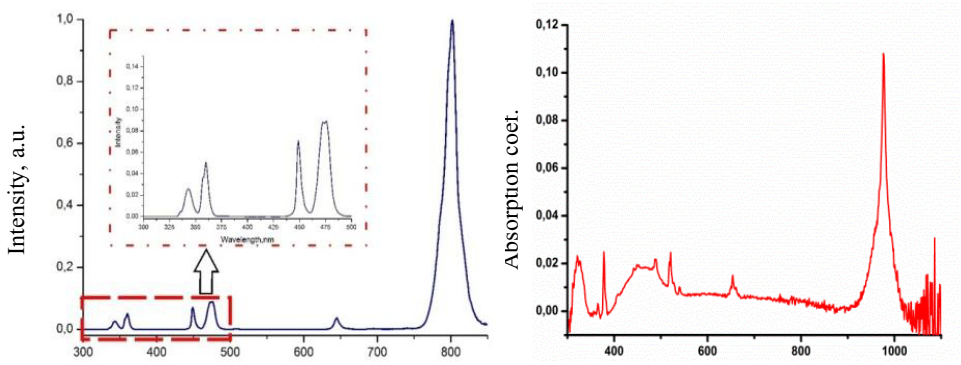

Fig. 1. The photoluminescence spectra of (a) and absorption (b) nanoparticles $NaYF_4$: Yb^{3+}, Tm^{3+} @ $NaYF_4$

To determine the phonon spectrum used Raman spectrometer LABRam HR800 Horiba JY, a test signal is a light He-Ne laser with a wavelength of 632.8 nm, because this wavelength does not fall in the absorption band of the material (1b). In this crystalline matrix, there are several phonon frequencies from 291 cm^{-1} up to 413 cm^{-1}.

For the manufacture of the waveguide used photocurable polymeric material SU-8 production MicroChem, in which nanoparticles are impregnated, by adding 0.1% by weight of the nanocrystals followed ultrasonic mixture. Light-guiding core formed by contact UV photolithography on a silicon substrate. waveguide length was 3 cm from the light-guiding core size 8x8 mm. The results obtained in the current work demonstrates the possibility of using nanoscale crystals synthesized in integrated optics to create the compact sources of radiation in the ultraviolet and visible regions of the spectrum.

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References

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