Investigation of the influence of various factors on the efficiency of upconversion processes in BaY$_2$F$_8$:Yb$^{3+}$,Pr$^{3+}$,Ce$^{3+}$ with diode-pumped

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Abstract — This report presents an analysis of the parameters affecting the efficiency of up-conversion UV luminescence excitation in a single crystal BaY$_2$F$_8$: (Yb$^{3+}$,Pr$^{3+}$,Ce$^{3+}$) with a diode-pumped.

Keywords—up-conversion; BaY$_2$F$_8$; UV luminescence.

This report presents an analysis of the parameters affecting the efficiency of up-conversion UV luminescence excitation in a single crystal BaY$_2$F$_8$: (Yb$^{3+}$,Pr$^{3+}$,Ce$^{3+}$) with a diode-pumped.

The UV luminescence excitation scheme Pr$^{3+}$ and Ce$^{3+}$ in this crystal under continuous excitation laser diodes with emission of 960, 840 - 800 and 405 nm: $^2$F$_{7/2}$ → $^2$F$_{5/2}$ (Yb$^{3+}$, 960 nm) → $^1$G$_{4}$ (Pr$^{3+}$, 960 and/or 840/808 nm) → $^1$I$_{e}$, $^1$P$_{1}$, $^1$P$_{0}$ (Pr$^{3+}$, 808/800 nm or 405 nm) →5d (Pr$^{3+}$) → $^5$d (Ce$^{3+}$) have been developed previously.

The UV luminescence from 5d states of ions Pr$^{3+}$ and Ce$^{3+}$ using one of the developed up-conversion schemes excitation was detected experimentally [1].

When this has been registered in the associated spectrum of a visible range (from 400 to 600 nm), that allowed to estimate unproductive losses of energy as a result of up-conversion transmission of energy between ions in a crystal.

To reduce these losses and improve the efficiency of the pumping of the active medium were analyzed sequentially all the major stages of transport energy in developed up-conversion schemes.

**Ion-pair interactions Yb$^{3+}$ → Pr$^{3+}$ and Pr$^{3+}$ → Ce$^{3+}$**

Probability of excitation transfer between the active centers of the ions determined by such experimental values as the distance between the interacting ions, the oscillator strength of the absorption coefficient, the luminescence decay time, the degree of overlap of the absorption bands of the sensitizer and activator.

For successful inter-ion energy transfer is necessary that it occurred before the relaxation process occurs sensitizer, because it leads to energy losses. This condition imposes restrictions on the distance between the sensitizer and activator.

If ions occupy two nearest sites in the crystal lattice, then the excitation transfer will be of the order $10^{-19}$ - $10^{-21}$ sec. Rate of interionic transmission of energy of Yb$^{3+}$ → Pr$^{3+}$ is four orders less than the lifetime of the excited $^2$F$_{7/2}$ state of Yb$^{3+}$ ion.

This creates the conditions for a highly efficient inter-ion energy transfer in the transition $^2$F$_{7/2}$ (Yb$^{3+}$) → $^1$G$_{4}$ (Pr$^{3+}$). We also considered extent of overlapping of strips of absorption and emission in ion-pair Yb$^{3+}$ → Pr$^{3+}$ and Pr$^{3+}$ → Ce$^{3+}$ and a technique of doped of the activators, providing an arrangement of ions of Yb$^{3+}$, Pr$^{3+}$ and Ce$^{3+}$ within one elementary cell.

**Balance beam energy multi-wave excitation**

Known that the absorption coefficients at f-f transitions rare-earth ions are low, therefore for a complete absorption of the exciting radiation with direct pumping need to use bulk crystals.

In the case of multi-wave up-conversion excitation is possible to significantly reduce the size of the active medium by controlling the speed of population and deactivation of intermediate levels balanced beam power.

The report will be presented experimental data on the dynamics of deactivation $^1$P$_{1}$ levels of ions Pr$^{3+}$ luminescence when excited by different combinations of beams 960 nm, 808 nm and 840 nm laser diodes.

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REFERENCES