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Emission spectra of YAG:Er^{3+} under pulse laser-thermal excitation

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Abstract. Spectra and kinetics of emission of YAG:0.5% Er^{3+} monocrystal in visible and NIR ranges were investigated under laser-thermal excitation by the pulses of CO_2 laser of 100 ns duration at wavelength λ = 10,6 μm. Kinetics of integral emission was interpreted.

Spectra of YAG:0.5% Er^{3+} monocrystal under laser-thermal excitation by pulses of CO_2 laser were recorded by spectrometer AvaSpec 2048 with sensitivity calibrated using etalon tungsten lamp. Recording time of monocrystal emission was 1 s. Integral emission of monocrystal was transmitted by optical fiber on photodiode LFD-2A with sensitivity region of 400-1700 nm and recorded by oscilloscope Tektronix TDS 220.

Laser-thermal spectra of monocrystal are superpositions of continuous spectrum and selective emission (SE) peaks. Intensities of spectra grow with increase of laser pulse energy densities $W_1<W_2<W_3$ (Fig.1). Positions of SE peaks (1, 2, 3) in region of λ=544÷999 nm correspond to Er^{3+} transitions $^4I_{9/2}$, $^4I_{11/2} \rightarrow {}^4I_{15/2}$ observed in luminescence spectrum of the monocrystal (Fig.2) also. Separate spectral peaks (2, 3) in region of λ=397÷660 nm on Fig.1 correspond to wavelengths of plasma radiation peaks of air laser-induced breakdown spectra [3, 4].

For interpretation of kinetics of YAG:Er^{3+} monocrystal emission we used model of unsteady transport of energy by both heat conduction and self-emission in plane layer with the monocrystal parameters [1, 2]. According to calculations input layer of 100 μm thickness is heated by the laser pulse with W=0.5 ÷ 2.0 J/cm^2 and λ=10.6 μm up to T= 500 ÷ 1100K and population of Er^{3+} electronic-vibrational levels increases. Calculated space-time distribution of temperature T(z, t) was used in kinetics equations of population of $^4I_{15/2}$ и $^4I_{13/2}$ levels in the input layer (z=0). Temporal dependence $T(0, t)/T_0$ (T_0=293K) is presented on Fig. 3 (2). Solution of kinetics equations gave SE intensity I(t) of the selected transition of Er^{3+} (presented on Fig. 3 (3)) which corresponds to oscillogram of monocrystal integral emission (4) on Fig. 3. This fact is result of thermal equilibrium population of Er^{3+} levels in the layer.

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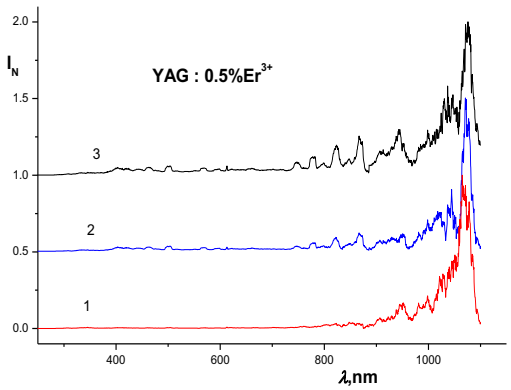

Fig. 1. Normalized emission spectra (1, 2, 3) of monocrystal YAG: 0.5%Er^{3+} under $W_1<W_2<W_3$ energy densities of pulse laser-thermal excitation at λ_{ex} = 10.6 μm.

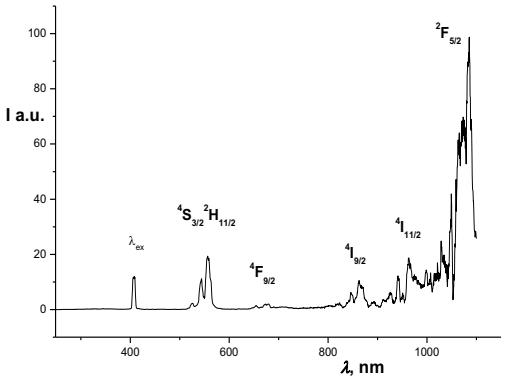

Fig. 2. Luminescence spectrum of YAG: 0.5%Er^{3+} monocrystal under laser diode excitation at λ_{ex} = 405 nm.

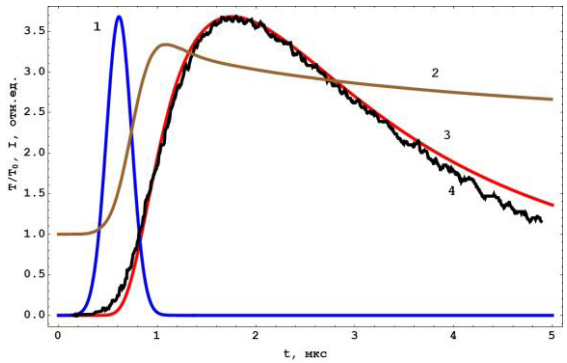

Fig. 3. Calculated temporal dependences of temperature T/T_0 (2) and SE intensity (3) of YAG: Er^{3+} monocrystal under laser pulse (1) excitation. Oscillogram of integral emission (4).

References

1. V.M. Marchenko, Y.A. Shakir, *International Conference "Laser Optics – 2014"* (St. Petersburg, 2014)
2. V.M. Marchenko, Y.A. Shakir. Advances in Applied Physics **2**, 335 (2014)
3. R.J. Nordstrom, Appl. Spectroscopy **49**, 1490 (1995)
4. L.J. Radziemski, D.A. Cremers, M. Bostian, R.C. Chinni, C. Navarro-Northrup, Appl. Spectroscopy **61**, 1141 (2007)