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$LiY_{0.3}Lu_{0.7}F_4$: Ce^{3+},Pr^{3+} Mixed Crystal as a Perspective Up-Conversionally Pumped UV Active Medium

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Abstract. Investigation results of effective population of states of 5d-configuration of Ce^{3+} ions by energy transfer from Pr^{3+} ions in $LiY_{0.3}Lu_{0.7}F_4$ (LYLF) crystals are discussed. The real concentrations of Pr^{3+} and Ce^{3+} ions in LYLF crystals are determined. Such parameters as excited 4f-5d state photoionization cross-section of Pr^{3+} ions, ground state cross-section of Ce^{3+} ions at 266 nm wavelengths and energy transfer coefficients of energy transfer from Pr^{3+} to Ce^{3+} ions were estimated. The results of pump-probe experiments on 5d-4f transitions of Ce^{3+} ions in LYLF crystals are presented. The optimal parameters for getting maximal gain on 5d-4f transitions of Ce^{3+} ions were determined by mathematical modeling.

Currently tunable solid-state optical quantum generators of UV range are most easily implemented on interconfigurational $4f^{n-1}5d$ - $4f^n$ transitions of rare-earth ions in wide-bandgap dielectric crystals. In this case the pumping of the laser is usually carried out by UV harmonics of visible and infrared radiation generated by of commercially available lasers, or powerful UV radiation of excimer lasers. However, UV pumping radiation induces in solid-state active elements various photodynamic processes (PDP), which cause degradation of the optical properties of active media. One of the ways to avoid or significantly reduce harmful manifestations of PDP is to use up-conversion pumping [1].

Here we investigate an opportunity of effective population of states of 5d-configuration of Ce^{3+} ions in $LiY_{0.3}Lu_{0.7}F_4$ (LYLF) crystals by stepwise $^3H_4$-4f5d up-conversion excitation of states of 4f5d-configuration of Pr^{3+} ions, followed by the transfer of excitation energy from Pr^{3+} to Ce^{3+} ions.

We determine the real concentrations of Pr^{3+} and Ce^{3+} ions in LYLF crystals. Such parameters as excited 4f5d state photoionization cross-section of Pr^{3+} ions, ground state cross-section of Ce^{3+} ions at 266 nm wavelengths and energy transfer coefficients of energy transfer from Pr^{3+} to Ce^{3+} ions were estimated. Obtained results of pump-probe experiments and results of mathematical modeling demonstrate good prospects of using crystal $LiY_{0.3}Lu_{0.7}F_4$:Ce^{3+}, Pr^{3+} as an active medium of solid-state laser with up-conversion pumping. This work was funded by the subsidy of the Russian Government (agreement # 02.A03.21.0002) to support the Program of Competitive Growth of KFU among World's Leading Academic Centers, the subsidy allocated to KFU for the state assignment in the sphere of scientific activities and RFBR grant 15-02-05309

Reference

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