Spectroscopic Characterization of Eu$^{3+}$:KY(WO$_4$)$_2$ Laser Crystal

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Abstract—Monoclinic Eu:KY(WO$_4$)$_2$ laser crystals are grown by TSSG method; polarization-resolved absorption and stimulated-emission cross-section spectra are determined for this crystal. Spectroscopic properties are modeled within ASCI theory. Under UV excitation, Eu:KY(WO$_4$)$_2$ provides intense red emission with CIE coordinates $x = 0.670$, $y = 0.329$.

Keywords—trivalent europium; double tungstates; red emission

I. INTRODUCTION

Trivalent europium ions Eu$^{3+}$ attract attention due to intense visible emissions associated with $^{5}D_0 \rightarrow ^{7}F_J$ transitions. Different crystalline materials have been studied as potential hosts for Eu-doping, mainly for production of red phosphors. Recently, it was also shown that Eu:double tungstates can be laser-active yielding red output at 702 nm [1]. In the present paper, we aimed to study novel laser crystal, Eu:KY(WO$_4$)$_2$.

II. ABSORPTION

Monoclinic 2at.%Eu:KY(WO$_4$)$_2$ crystal was grown from the flux by TSSG method, Fig. 1. This figure represents also its absorption spectrum in the visible, as well as polarization-resolved structure of band related with $^{7}F_1 \rightarrow ^{5}D_1$ transition (that is suitable for laser-pumping). Excited-state absorption was estimated by means of modified Judd-Olfet method. It was determined that ESA from upper laser level, $^{7}D_0$, can suppress laser oscillations in $^{5}D_0 \rightarrow ^{7}F_2$ channel.

![Fig. 1. Absorption of 2at.%Eu:KY(WO$_4$)$_2$ crystal in the visible (left graph), anisotropy of absorption band related with $^{7}F_1 \rightarrow ^{5}D_1$ transition (right graph), inset represents image of as-grown crystal boule.]

III. LUMINESCENCE

Photoluminescence spectrum of Eu:KY(WO$_4$)$_2$ crystal under 532 nm excitation (for $E \parallel N_m$), as well as PL decay curve, are shown in Fig. 2. The lifetime of $^{5}D_0$ state is 430 μs. Stimulated-emission cross-sections for $^{5}D_0 \rightarrow ^{7}F_4$ transition are shown in Fig. 2. Light polarization along $N_m$ optical indicatrix axis is most preferable from the point of access to higher $\sigma_{\text{abs}}$. Under UV excitation, Eu:KY(WO$_4$)$_2$ crystal provides intense red emission (CIE coordinates $x = 0.670$, $y = 0.329$). Dominant wavelength in the PL spectrum is 613 nm with 98% purity.

![Fig. 2. PL spectrum and decay curve of Eu:KY(WO$_4$)$_2$ crystal (left graph), stimulated-emission cross-sections for $^{5}D_0 \rightarrow ^{7}F_4$ transition (right graph).]

IV. CONCLUSIONS

Polarization-resolved study of absorption and luminescence of novel laser crystal, Eu:KY(WO$_4$)$_2$, is performed for the first time, to our knowledge. Eu:KY(WO$_4$)$_2$ looks promising for CW visible (702.8 nm) lasers, as well as red phosphors.

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REFERENCES