R1-O-051801

OPTICAL SPECTROSCOPY OF NONLINEAR $YAl_3(BO_3)_4$: Mn CRYSTAL*

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Complex orthoborates of rare earth (RE) elements and trivalent cations are described by the general formula $RM_3(BO_3)_4$, where R = Y, La – Lu, M = Al, Ga, Cr, Mn, Fe, and crystallize into the structure of the huntite mineral $CaMg_3(CO_3)_4$. Crystals are of considerable interest as nonlinear optical, magnetoelectric, luminescent, and laser materials.

Among them, yttrium-aluminum borates $YAl_3(BO_3)_4$ are known phosphors in the case of partial replacement of Y^{3+} ions by rare earth ions. $YAl_3(BO_3)4:Eu^{3+}$ under UV excitation exhibits red luminescence, close in chromaticity coordinates to the parameters of the ideal commercial $Y_2O_3:Eu^{3+}$ phosphor. $YAl_3(BO_3)4:Eu^{3+}/Tb^{3+}$ is an environmentally friendly material for a white LED, which is advantageous in terms of its intensity, luminescence power, and cost [1]. Under UV excitation in $YAl_3(BO_3)_4:Sm^{3+}$ and $YAl_3(BO_3)_4:Tm^{3+}$, reddish-orange and blue radiation was obtained, respectively [2, 3].

In [4], the authors obtained the luminescence spectra of $YAl_3(BO_3)_4$ doped with manganese. The obtained spectra (in particular, three narrow lines in the region of 680 nm) are characteristic of Mn^{4+}, but further analysis is required to better understand the manganese valence in this compound and its optical spectra.

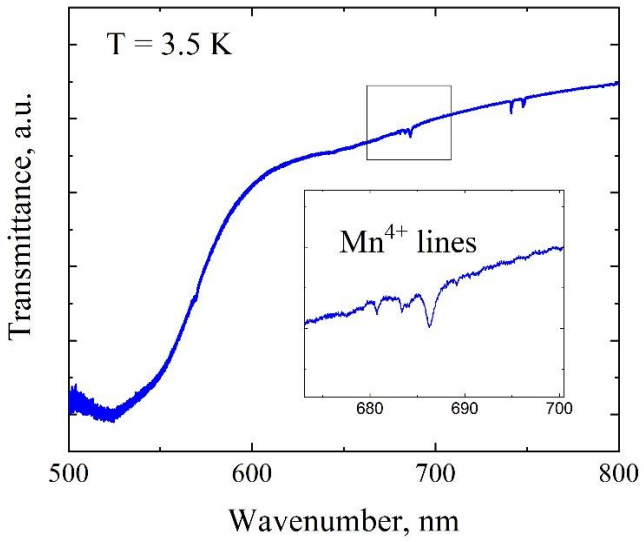

Fig.1. Transmission spectrum of $YAl_3(BO_3)_4$: Mn at T = 3.5 K.

In the present work, the luminescence spectra were recorded in a wide temperature range and at different pump wavelengths. Additionally, high-resolution low-temperature transmission spectra (up to 0.1 cm^{-1}) were measured in which three Mn^{4+} lines were also observed at frequencies around 680 nm (Fig. 1). An analysis of the obtained spectroscopic data made it possible to make an assumption about the energy structure of the electron shells of the Mn^{4+} and Mn^{2+} ions in $YAl_3(BO_3)_4$:Mn manganese.

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* The work was supported by Russian Science Foundation, Grant № 21-72-00134