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Optical spectroscopy and crystal field calculation of Tb^{3+} doped in $\text{YAl}_3(\text{BO}_3)_4$ single crystal

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Abstract

Single crystals of $\text{YAl}_3(\text{BO}_3)_4$ doped with 2.8% Tb^{3+} were grown by spontaneous nucleation from $\text{K}_2\text{Mo}_3\text{O}_{10}$ and B_2O_3 flux. The electronic structure of Tb^{3+} ions doped in $\text{YAl}_3(\text{BO}_3)_4$ crystals are investigated using photoluminescence (PL) and photoluminescence excitation (PLE) spectroscopies. Emission spectra at room and low temperature were measured and were identified from the excited $^5\text{D}_4$ to the ground state multiplets $^7\text{F}_{0,1,2,3,4,5,6}$. The main emission detected around 540 nm corresponds to the $^5\text{D}_4$ - $^7\text{F}_5$ transition. Calorimetric parameters of the Tb^{3+} ions green emission in YAB are calculated ($x = 0.30$, $y = 0.67$). The corresponding decay time around 2.74 ms is fitted with a simple exponential curve. The observed transitions are assigned and analyzed on the basis of group theory assuming that Tb^{3+} ion occupies a D_3 symmetry site. The experimental Stark energy levels of the Tb^{3+} manifolds are established. The crystal field parameters were determined. A best fit between theoretical and experimental energy levels is obtained. The general trend of the crystal field parameters of rare earth ions in YAB host is confirmed. The calculated N_v crystal field strength parameters present a linear variation with 4f electrons number over the rare earth series.

Key words: Optical spectroscopy, Crystal field, Rare earth ions, YAB: Tb^{3+} .

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