INFLUENCE OF CRYSTAL STRUCTURE ON ENERGY TRANSFER TO Tb^{3+} IN $K_5Tb(MoO_4)_4$ AND $KTb(MoO_4)_2$ CRYSTALS

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The present work shows a comparative study of Tb^{3+} luminescence in compounds possessing the same elemental composition but distinctly different crystal structures. The experimental results reveal the effect of crystal structure type on luminescence properties and energy transfer processes in $K_5Tb(MoO_4)_4$ and $KTb(MoO_4)_2$ representing the monoclinic and orthorhombic crystal structure, respectively [1,2]. Emission spectra revealed several bands of different intensities in the 380-640 nm range, corresponding to the intra-configurational 4f-4f transitions of Tb^{3+} ions in both materials. The emission bands of dissimilar structures in the green spectral range 480-640 nm allowed the estimation of site symmetries of Tb^{3+} ions in both materials. The relative intensity of the bands that appear due to the $^5D_3$–^7F_J transitions in the blue 380-440 nm region is shown to be dependent on the average distance between Tb^{3+} ions in the crystals. The excitation spectra measured in the VUV-Vis range showed similar band positions for the 4f-4f transitions for both structure types; however, a prominent difference of ~0.2 eV in the onset of the fundamental absorption edge was observed, indicative of different energy band gap values of the crystals studied. The decay kinetics study shows that the $KTb(MoO_4)_2$ crystal has a shorter luminescence decay time of green emission (~0.5 ms) as compared to that in $K_5Tb(MoO_4)_4$ (~1.7 ms), which is in line with the previous observation of the dependence of the decay time of the green emission on impurity concentration in Tb^{3+} doped oxides [3]. The shortening of luminescence decay time supports the idea of concentration quenching of Tb^{3+} in the crystal. Temperature-dependent investigations yielded insights into the luminescence quenching mechanism determining luminescence thermal stability in both materials. Based on the results, the processes of energy transfer to the Tb^{3+} luminescence center and the symmetry of these centers, which are dependent on the identified crystal structure, are analyzed in detail.

References:

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