Highly nonstoichiometric $Tb_2Y_{0.1-1}Al_5O_{12}$:Ce single crystals with modified microstructure, defect concentration, luminescence, and scintillation properties

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The Ce^{3+} doped $Y_3Al_5O_{12}$ (YAG:Ce) single crystal is a member of the family of high-performance complex oxide scintillators. Ce^{3+} centers exhibit high quantum efficiency and fast response with a decay time of approximately 50 ns in the 520 nm emission band [1]. However, the YAG host lattice contains electron traps associated with antisite defects and oxygen vacancies, which considerably reduces the yield of scintillation light and decelerate the kinetics of scintillation decay. Increasing the concentration of Ce^{3+} ions to improve the capture of electron-hole pairs is not feasible because energy transfer between Ce^{3+} ions can reduce the light output. The improvement of scintillation parameters can be achieved by enhancing energy transfer from the host lattice to the activator. Introducing Tb atoms to the host lattice can efficiently transfer excitation energy towards Ce^{3+} ions [2]. Previous reports have revealed that an excess of RE_2O_3 increases the concentration of RE_{Al} antisite defects (ADs). Therefore, in order to reduce the concentration of RE_{Al} ADs, strong non-stoichiometry was introduced to Ce^{3+}-doped $Tb_2Y_1Al_5O_{12}$ single crystals. This research investigates the crystal growth of both stoichiometric $Tb_2Y_1Al_5O_{12}$:Ce and non-stoichiometric Ce^{3+}-doped $Tb_2Y_{0.1}Al_5O_{12}$ single crystals using the μ-PD method. The study aims to explore the influence of non-stoichiometry on various aspects, including crystal growth, microstructure distortion, defect concentration as well as luminescence and scintillation properties. To analyze these effects, XRD, SEM-EDS, thermally stimulated luminescence, photoluminescence, and scintillation properties are utilized.

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