COMPARATIVE INVESTIGATION OF DOPING CONCENTRATION EFFECTS ON STRUCTURAL AND PHOTOLUMINESCENT PROPERTIES OF CAGDALO$_4$ AND CAYALO$_4$ PHOSPHORS

Domantas Černius[1,2], Monika Skruodienė[2,3], Milda Petrulevičienė[2,3], Meldra Kemere[3], Ramūnas Skaudžius[1,2]

[1]Vilnius University, Department of Inorganic Chemistry, Lithuania
[2]Center for Physical Sciences and Technology, Department of Chemical Engineering and Technology, Lithuania
[3]University of Latvia, Institute of Solid-State Physics, LV-1063, Riga, Latvia
domantas.cernius@chgf.stud.vu.lt

$CaGdAlO_4$ (CALGO) and $CaYAlO_4$ (CALYO) have attracted significant attention as host matrices for rare-earth (RE^{3+}) ions due to their favorable combination of thermal and structural properties. Crystallizing in the tetragonal *I4/mmm* space group, these materials exhibit a "disordered" crystal structure where Ca^{2+} and RE^{3+} ions share the same lattice sites. This disorder leads to a broadening of absorption and emission bands, a key requirement for high-efficiency laser crystals [1, 2]. Furthermore, CALGO and CALYO possess high thermal conductivity and excellent mechanical stability, allowing them to withstand the thermal loading typical of high-power optical applications [3]. Moreover, Yb-doped crystals are promising candidates for ultrashort-pulsed laser generation, where high thermal-conductivity is essential and both matrices exceed the minimum thermal requirements for such applications [2].

This study focuses on determining the optimal concentrations of Holmium (Ho^{3+}) and Ytterbium (Yb^{3+}) dopants, incorporated separately, to maximize optical performance while maintaining host crystallinity. X-ray Diffraction (XRD) is employed to monitor increasing dopant concentrations compromise phase purity. Previous studies show that in Yb^{3+}-doped CALYO, replacing the main ions with dopants causes a small but measurable changes in the volume of the elementary cell [2], whereas in Yb^{3+}-doped CALGO crystals, crystal structure remains well-preserved [4]. Scanning Electron Microscopy (SEM) is used to observe the surface morphology and determine the particle size. Luminescence measurements provide direct insight into the optical behavior of the dopant ions within the host lattice. By analyzing the emission spectra, it is possible to quantify the emission intensity of Ho^{3+} and Yb^{3+} ions and evaluate how it evolves with dopant concentration. These measurements reveal the efficiency of radiative transitions, identify characteristic emission bands, and allow detection of concentration-dependent effects such as energy transfer and quenching [1]. By correlating the structural information from XRD and SEM with the photoluminescence analysis, this study defines the optimal doping concentrations for CALGO and CALYO confirming their potential as high-performance optical materials.

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