Comparative studies of structure, spectroscopic properties and intensity parameters of tetragonal rare earth vanadate nanophosphors doped with Eu(III)

Autorzy

Tomasz Grzyb

Agata Szczeszak

Andrii Shyichuk

Renaldo Tenorio Moura

Albano Neto Carneiro Neto

Nina Andrzejewska

Oscar Loureiro Malta

Stefan Lis

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Streszczenie

Hydrothermal method was applied in order to synthesize nanocrystalline YVO_4, $LaVO_4$ and $GdVO_4$ materials doped with Eu^{3+} ions. The conditions of synthesis were chosen to allow control of the process based on precipitation reaction in an autoclave, at elevated temperature and pressure. The prepared materials crystallized as single phase spherical-like nanocrystals of the tetragonal $I4_1/amd$ structure. The average size of the particles was in the range of 7–10 nm in the YVO_4- and $GdVO_4$-based products and about 32 nm when $LaVO_4$ was the host compound. The excitation spectra of the materials prepared revealed a broad and intense band in the UV region. The band resulted from charge transfer phenomena: excitation of the VO_4^{3+} groups was followed by the energy transfer to Eu^{3+} ions. Intense, red emission of the samples was a result of electronic transitions in Eu^{3+} dopant ions. The theoretical Judd-Ofelt intensity parameters Ω_λ, obtained using the novel approach to the calculation of Eu-O bond stretching force constant and subsequently charge factors, were compared to the experimental Ω_λ. Forced electric dipole part of Ω_λ was calculated from scratch (using Eu^{3+} coordination geometry in $REVO_4$ from DFT calculations), while a single parameter in the dynamic coupling part was fitted to the experimental data. The issues related to the force constant calculation are discussed. Crucial influence of crystal lattice distortions on Ω_λ and Eu^{3+} emission intensities of the materials was shown.

Słowa kluczowe

Rare earth vanadates, Hydrothermal method, Nanomaterials, luminescence, Judd-Ofelt intensity parameters, Crystal distortions