Structure, Morphology, and Spectroscopy Studies of $La_{1-x}RE_xVO_4$ Nanoparticles Synthesized by Various Methods

O. V. Chukova ✉, S. Nedilko, S. G. Nedilko, A. A. Slepets, T. A. Voitenko, M. Androulidaki, A. Papadopoulos & E. I. Stratakis

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Abstract

The $La_{1-x}Eu_xVO_4$ ($0 \le x, y \le 0.3$) and $La_{1-x-y}Eu_yCa_xVO_4$ ($0 \le x, y \le 0.2$) nanoparticles were synthesized by various methods and investigated. Phase composition of the sample depends on the x, y values. The $La_{1-x}Eu_xVO_4$ can be crystallized in monoclinic structure up to $x = 0.1$ or $x = 0.05$ depending on the method of synthesis. The $La_{0.9}Eu_{0.05}Ca_{0.05}VO_4$ sample was also attributed to the monoclinic structure. Increasing concentration of europium and calcium ions in $La_{1-x-y}Eu_yCa_xVO_4$ solid solutions leads to the change of the crystal structure and subsequently stabilization of the tetragonal phase takes place. The obtained samples were characterized by XRD analysis, SEM microscopy, and IR spectroscopy. Luminescence properties of the synthesized powders were studied. Emission of all the $La_{1-x}Eu_xVO_4$ and $La_{1-x-y}Eu_yCa_xVO_4$ samples consists of narrow spectral lines in the 550 – 730 nm spectral range. The lines are caused by the $^5D_0 \rightarrow {}^7F_J$ electron transitions in the Eu^{3+} ions. The Ca^{2+} ions incorporation increases intensity of the Eu^{3+} ions luminescence. The structure of the spectra depends on Ca^{2+} concentration and excitation wave length. The carried out analysis has revealed that Eu^{3+} ions form at least two different types of emission centers in the $La_{1-x-y}Eu_yCa_xVO_4$ samples. The assumption is made that type I centers are formed by the Eu^{3+} ions in their regular positions in the crystal lattice, while the type II centers have complex structure and consist of Eu^{3+} ions, Ca^{2+} cations, and oxygen vacancies. It is established that Ca-induced defects are also responsible for additional excitation band near 400 nm.