

Synthesis and Properties of the $\text{La}_{1-x-y}\text{Eu}_y\text{Ca}_x\text{VO}_4$ ($0 \leq x, y \leq 0.2$) Compounds

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Abstract

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The $\text{La}_{1-x}\text{Ca}_x\text{VO}_4$ and $\text{La}_{1-x-y}\text{Eu}_y\text{Ca}_x\text{VO}_4$ ($0 \leq x, y \leq 0.2$) micro/nanosized powders were prepared by aqueous nitrate-citrate sol-gel synthesis. Phase composition of the sample depends on the x and y values. The $\text{La}_{0.9}\text{Ca}_{0.1}\text{VO}_4$ is crystallized in monoclinic structure up to the $x = 0.1$. The $\text{La}_{0.9}\text{Eu}_{0.05}\text{Ca}_{0.05}\text{VO}_4$ sample was also attributed to the monoclinic structure. Increasing concentration of europium and calcium ions in $\text{La}_{1-x-y}\text{Eu}_y\text{Ca}_x\text{VO}_4$ 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 the $\text{La}_{1-x}\text{Ca}_x\text{VO}_4$ samples is weak and consists of wide bands in the 450–800 nm spectral range. The observed bands at 570 and 630 were ascribed to electron transitions in the distorted VO_4^{3-} vanadate groups. Emission of the $\text{La}_{1-x-y}\text{Eu}_y\text{Ca}_x\text{VO}_4$ samples consists of narrow spectral lines in the 550–730 nm spectral range. The lines are caused by the $^5\text{D}_0 \rightarrow ^7\text{F}_1$ electron transitions in the Eu^{3+} ions. The Ca^{2+} ions incorporation increases the intensity of the Eu^{3+} ions luminescence. 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 $\text{La}_{1-x-y}\text{Eu}_y\text{Ca}_x\text{VO}_4$ 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.

Keywords: Vanadate, Sol-gel, Eu^{3+} , Luminescence