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Synthesis and characterization of Ca3(VO4)2 activated with Sm3+ for luminescent applications

Recently, research on vanadates has generated genuine interest due to their high luminescent efficiency [1], resonant excitation with commercial NUV chips (λex = 350 nm) [2], high thermal stability [3], excellent chemical stability [4], and extraordinary dopant solubility. These qualities make vanadate matrices suitable for the incorporation of lanthanides to modulate their emissions to specific hues. In this regard, this work focuses on the synthesis and characterization of calcium orthovanadate (Ca2(VO4)2) activated with different contents of Sm3+. The compound is obtained through a double substitution synthesis using the solvent evaporation technique. The expected structure for Ca2(VO4)2 presents a trigonal symmetry [5]. The structural relationship was complemented by Raman spectroscopy, revealing that the main modes of symmetric and asymmetric vibrations correspond to [VO4]3- units. Scanning electron microscopy (SEM) micrographs show a loose aggregation morphology of the particles where smaller particles aggregate and form larger particles. By diffuse reflectance spectroscopy and the Kubelka-Munk algorithm, a forbidden band gap energy of 4.43 eV is determined [6]. The excitation spectra of Ca2(VO4)2 with different amounts of Sm was monitored at 646 nm, show the highest peak in the transition band (4G5/2⟶6H9/2) located at a wavelength of 406 nm. The emission spectra are obtained under direct and indirect excitation of the Sm3+ ion at excitation wavelengths of 275 and 406 nm, where characteristic emissions of Sm3+ 4G5/2⟶5H5/2, 6H7/2, 6H9/2, and 6H11/2 + 4G5/2 are observed. Additionally, an increase in local asymmetry is determined through the ratio of electric (ED) and magnetic (MD) dipole intensities.

Keywords

Ca3(VO4)2, Sm3+, Raman, SEM, Kubelka-Munk algorithm,

Reference

[1]https://doi.org/10.1021/jp910884c
[2]https://doi.org/10.1039/C8TC05110K
[3]https://doi.org/10.1021/acs.inorgchem.8b01808
[4]https://doi.org/10.1038/ncomms12012
[5]https://doi.org/10.1021/ic302333e

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Author approval

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