Structural and Spectroscopic properties of Eu^{3+} doped Y_3TaO_7

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Rare-earth (RE) luminescence is widely studied due to its many technological applications, as waveguides, LEDs, solar cells and biomarkers.[1] RE^{3+} ions doped materials with a low energy phonon can present emission bands at visible spectral region and NIR. Usually, Eu^{3+} ions are used as structural probes allowing the investigation of the local structure in which the lanthanides are due to their specific well known and assigned electronic transitions.[2] In the present work, we report the synthesis, structural and spectroscopic characterization of Eu^{3+} doped Y_3TaO_7 (yttrium tantalate) prepared by a new method. Eu^{3+} doped Y_3TaO_7 was prepared by dripping an ethanolic solution containing ethoxyethanol, tantalum ethoxyde and $Y(NO_3)_3$ at suitable proportion in a basic and ethanolic solution and stirring for 1 hour. The solid was separated by centrifugation and afterwards anealed at 900°C and 1100°C for 2 hours. The X-ray diffraction analysis shows the crystallization of Y_3TaO_7 orthorhombic phase with space group *C2221*. The infrared spectroscopy (FTIR) revealed the presence of Ta-O and Y-O vibrational modes and the absence of OH groups. The emission spectra were obtained under excitation at 394 nm (corresponding to the Eu^{3+} $^7F_0 \rightarrow {}^5L_6$ transition). Relaxation processes led to the population of the excited state $^5D_0$ from the $^5L_6$ excited state and then the electronic transitions $^5D_0 \rightarrow {}^7F_J$ (J = 0, 1, 2, 3 and 4) were observed. These spectra presented a broad band, indicating the Eu^{3+} ions located in different symmetry sites in the host. The intensity ratio of the $^5D_0 \rightarrow {}^7F_2$ and $^5D_0 \rightarrow {}^7F_1$ transitions provide important structural information about the local symmetry sites occupied by Eu^{3+} ions, and a ratio close to 2.0 was observed suggesting that Eu^{3+} ions are occupying relative high symmetry sites. The excited state $^5D_0$ lifetimes for samples containing different concentrations of Eu^{3+} ions showed a single exponential profile, with absent or very low energy losses by non-radiative processes. No concentration quenching was found for the samples containing up to 5.0 mol% Eu^{3+}, which strongly indicates the introduction of high Eu^{3+} concentration into the Y_3TaO_7 host without RE cluster formation. Additionally to the structural probe application, the high quantum efficiency values combined with enhanced emission intensity make Eu^{3+} doped Y_3TaO_7 suitable host to be employed as red luminophor.

References

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