Synthesis, characterization and luminescence investigation of Pr^{3+} doped and Pr^{3+}/Yb^{3+} co-doped Y_2O_3 spherical particles for photonic applications

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Owing to the fast growing demand of electric energy, the development of solar energy technologies has been attracting considerable attention by the academic society. To overcome the low energy conversion efficiencies of well commercially established single junction solar cells, rare earth doped materials exhibiting energy conversion processes, upconversion and downconversion, can be incorporated in such solar cell systems.[1] In the present work, we report on the synthesis and characterization of Pr^{3+} doped and Pr^{3+}/ Yb^{3+} co-doped Y_2O_3 spherical particles by using homogeneous precipitation synthetic method. Samples were synthesized with doping concentration ranging from 0.5% to 4.0% (mol%) and annealed at 900 °C. The scanning electron microscopy (SEM) analyses revealed a narrow size dispersion for all the synthesis with average diameter values at about 150 nm. Employing the Fourier Transform Infrared (FTIR) technique, it was possible to evaluate the structural evolution in function of the annealing temperature. In addition, XRD analyses confirmed Y_2O_3 cubic structure formation after annealing treatment at 900 °C. Photoluminescence study has been carried out in order to verify the emission profiles in function of Pr^{3+} doping content and Pr^{3+}: Yb^{3+} co-doping ratios as well as the energy transfer processes between the activator and sensitizer ions. The emission spectra of the co-doped samples showed emission bands at 978 nm due to the $^2F_{5/2}\rightarrow{}^2F_{7/2}$ transition of Yb^{3+} ions and about 1050 nm related to the $^1D_2\rightarrow{}^3F_{3,4}$ of the Pr^{3+} ions. Considering the well defined Stark components of the aforementioned (Pr^{3+}:$^1D_2\rightarrow{}^3F_{3,4}$ and Yb^{3+}:$^2F_{5/2}\rightarrow{}^2F_{7/2}$) transitions, it is possible to infer the yttrium site substitution by the doping ions. The nanoparticles could be well dispersed in different solvents and will be incorporated into organic and inorganic systems such as polymeric films (PMMA) and silicates matrices in order to verify their functionalities and potential photonic applications. In conclusion, Pr^{3+} doped and Pr^{3+}/ Yb^{3+} co-doped Y_2O_3 spherical particle are potential candidates for many photonic application such as light gathering and energy conversion in solar devices.

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