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HRTEM morphological features on grain boundary diffusion and particulate necking, photoluminescence and thermoluminescence investigations of nano Ce^{3+}:LuAG

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Abstract

Homogeneous and non-agglomerative Ce:LuAG nanoparticles with different Ce^{3+} doping concentrations (*0.05, 0.10 and 0.15 mol%*) were prepared by surfactant free aqueous precipitation synthesis via low temperature refluxer route. The synthesized powders are post calcined at 900 $^{\circ}$C and 1300 $^{\circ}$C for 4 h; and characterized by thermo-gravimetric (TG), differential scanning calorimetry (DSC), X-ray diffraction (XRD), high resolution scanning electron microscopy (HR-SEM), high resolution transmission electron microscopy (HR-TEM), photoluminescence (PL), decay life-time (DLT) and thermoluminescence (TL) techniques. XRD result confirms the formation of cubic phase without the evolution of any intermediate and secondary phases. HR-SEM shows that the nanoparticles synthesized by the surfactant-free approach resulted in non-agglomerated spheroidal morphology. An attempt is also made to calculate grain boundary diffusion (D_{gb}) parameter of Ce:LuAG nanoparticles observed from TEM nano-particulate necking morphology. The nanophosphor exhibit enhanced green luminescence (λ_{em}= 505 nm) under blue light excitation (λ_{ex}= 450 nm). The TL behavior is also investigated under the exposure of γ-ray (^{60}Co) source. TL dosimetric parameters such as order of kinetics (μ_g), activation energy (E) and frequency factor (S) are calculated using Chen's equation. The fast DLT of ~17 ns observed in the Ce:LuAG nanophosphors can be useful for scintillators and fluorescent device applications.

Keywords: Ce:LuAG; Refluxer synthesis; HRTEM, Grain boundary diffusion; Photoluminescence; Thermoluminescence.

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