



Solvothermal synthesis and luminescent properties of hierarchical flowerlike $\text{ZnAl}_2\text{O}_4:\text{Ho}^{3+}$ microstructures

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ABSTRACT

Hierarchical microstructures of $\text{ZnAl}_2\text{O}_4:\text{Ho}^{3+}$ (0.25–5 mol %) nanophosphors (NPs) were synthesized via solvothermal route using *Epigallocatechin gallate* (EGCG) as a bio-surfactant. The effect of EGCG concentration on the morphology was studied in detail. The Powder X-ray diffraction (PXRD) studies confirm the cubic phase of the samples. The photoluminescence (PL) emission spectra exhibit peaks at ~ 540, 553 and 666 nm were due to transitions $^5\text{F}_4 \rightarrow ^5\text{I}_8$, $^5\text{S}_2 \rightarrow ^5\text{I}_8$ and $^5\text{F}_5 \rightarrow ^5\text{I}_8$ of Ho^{3+} ions, respectively. Thermoluminescence (TL) properties of $\text{ZnAl}_2\text{O}_4:\text{Ho}^{3+}$ (0.25–5 mol %) NPs were studied after exposure of ^{60}Co γ -rays at a warming rate of 6°Cs^{-1} . The TL intensity was found to increase with γ -dose. The kinetic parameters have been determined using Chen's method from the deconvoluted glow curve. The CIE Chromaticity co-ordinates of all the prepared phosphors were located in the blue region. The above results clearly evident that the optimized Ho^{3+} activated ZnAl_2O_4 NPs was a promising single phased phosphor for WLED's and dosimetry applications.

1. Introduction

In the recent years, increased worldwide interest in both green synthesis and nanotechnologies [1], more sustainable manufacturing routes to crystalline nanometric inorganic materials. The vast majority of published literature on the syntheses of nanoparticles (NPs) relates to materials prepared under static or batch processes [2] or using multi-step processes. More recently, there is an increasing number of publications which demonstrated the potential of rapid and continuous methods for controlled manufacture of inorganic nanomaterials [3–5].

The rare earth doped NPs have been paid much attention owing to their high thermal stability, superior catalytic, electrical and optical properties [6]. In contradiction to the analogous bulk samples, nanoscopic phosphors present the following advantages: (i) high packing density, (ii) low light-scattering effects, (iii) shorter preparation time, (iv) lower sintering temperatures (when necessary), and (v) they are easily suspendable in liquid media. Reducing crystal size, physical phenomena which are not noticeable in macro/microdimensions, e.g., quantum mechanical effects, can be highlighted, influencing the optical properties of nanostructured semiconductors [7].

Over the past few decades, many researchers have been focused on

the fabrication of efficient luminescent nanophosphors due to its wide range of applications on display, solar cells, catalysts, sensors, etc. [8]. Among them, nano zinc aluminate (ZnAl_2O_4) has been found to be an efficient host material with a wide optical band gap (~ 3.8 eV), high thermal and chemical stability, high mechanical resistance, low acidity, hydrophobicity and the possibility of generating broadband emission. Due to its transparency and electro conductive properties, it can be used for ultraviolet (UV) photo electronic devices [9]. Commonly, the ZnAl_2O_4 was fabricated by various routes, namely, solid-state reaction, co-precipitation, hydrothermal, microwave, solvothermal, combustion, and sol-gel methods. Among these routes, the green approach and most promising can be considered is the solvothermal synthesis processes due to its improvement of producing pure and ultrafine powders [10].

In the present work, a simple solvothermal method has been followed for the preparation of the Ho^{3+} ions doped ZnAl_2O_3 using EGCG as a bio-surfactant. The obtained samples were well characterized by means of PXRD, SEM, TEM, DRS, PL and TL. The effect of EGCG surfactant concentration on morphology of the sample was studied in detail. The kinetic parameters, namely activation energy (E), order of kinetics (b) and frequency factor (s) were estimated by TL glow curves

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