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Spectroscopic Studies of Strong Red Emitting $CaAl_2O_4:Eu^{3+}$ Nano-phosphor for WLED's Applications Using Judd–Ofelt Theory

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Abstract

Eu^{3+} doped Calcium aluminate nanophosphor was fabricated via sonochemical route and characterized with scanning electron microscopy (SEM), X-ray diffraction (PXRD), photoluminescence (PL). PL excitation and emission spectrum were studied to explore the PL properties of $CaAl_2O_4:Eu^{3+}$ nanophosphor. The PL emission spectrum exhibit intense peaks at ~ 577, 588, 615, 654 and 702 nm, which were assigned to transitions of Eu^{3+} ions as $^5D_0 \rightarrow {}^7F_1$, $^5D_0 \rightarrow {}^7F_2$, $^5D_0 \rightarrow {}^7F_3$ and $^5D_0 \rightarrow {}^7F_4$ respectively. The chromaticity coordinates of the synthesised sample was projected to be (0.608, 0.393) and its corresponding correlated color temperature (CCT) was estimated to be ~ 1300 K, which is suitable for warm white light display applications. The Judd–Ofelt (J-O) intensity parameters and radiative charecteristics such as radiative lifetime, transition probabilities, branching ratios and lifetimes for the excited states of Eu^{3+} ions were computed from the emission spectra using Judd–Ofelt (J-O) theory. From aforementioned results, $CaAl_2O_4:Eu^{3+}$ (5 mol %) nanophosphor can be regarded as a promising red phosphor, which is appropriate in solid state lighting and display devices using UV or blue chips.

Keywords: ***Bio-inspired; Sonochemical route; Photoluminescence; LED****.*

1.0 INTRODUCTION

Nanotchnology and Nanoscience together are showing many promising applications mainly in biology, information technogy, nanoelectronics, medicinal field, etc., [1-3]. Therefore for future industrial revolution the blending of these two can be considered [4]. Alkaline earth aluminates with bright photoluminescence at visible region have attracted more interest in recent years [5]. Because of their important electronic, optical and structural properties. [6-8].

Traditional sources like incandescent and fluorescent lamps were having lower luminous efficacy and hence very sensitive to human eyes . Hence regular efforts were made by reserchers to find efficient nanophosphors with unique properties [9 -12].

Calcium aluminate ($CaAl_2O_4$) develops more interest for the researchers due to its promising applications in the field of WLED'S,optical communications,biological labeling agents, low power laser therapy etc.,[13 -15]. Further in developing a new way to find clear image of latent finger prints(LFPs) the nanomaterials have been proposed with which we can identify most useful ridge details[16]. In general, photoluminescence observed in phosphors are assigned to the f to f or f to d transitions of lanthanides ions. Along to this, luminescence intensity depends on the the nature of the host lattice and site symmetry.

According to literature survey, no results are reported on the synthesis of $CaAl_2O_4$ via ultrasound sonication method hence in this work, $CaAl_2O_4:Eu^{3+}$ nanophosphor is synthesized by this method using lemon juice as a surfactant. The method is found to be cheap, fast, simple and safe. The synthesized nanophosphor is well characterized by Powder XRD, DRS, PL studies.

2. EXPERIMENTAL

$CaAl_2O_4$: Eu^{3+} (5 mol %) nanophosphor was prepared by ultrasound assisted sonochemical route . The chemicals like analytical grade Aluminium nitrate [Al $(NO_3)_3.9H_2O$ (purity 99.9%)], Calcium nitrate [$Ca(NO_3)_2.4H_2O$ (99.9%)], Europium oxide (Eu_2O_3) and lemon juice as a surfactant are taken in proper stoichiometric ratios. The metal nitrates