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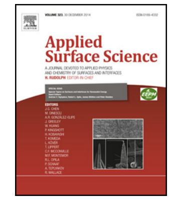

A near-UV-converted $LiMgBO_3:Dy^{3+}$ nanophosphor: Surface and spectral investigations

A.K. Bedyal [a], Vinay Kumar [a,b,*], Ram Prakash [a], O.M. Ntwaeaborwa [b], H.C. Swart [b]

[a] School of Physics, Shri Mata Vaishno Devi University, Katra 182320, India
[b] Department of Physics, University of the Free State, P.O. Box 339, Bloemfontein ZA9300, South Africa

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ABSTRACT

A near-ultra violet (UV) converted $LiMgBO_3:Dy^{3+}$ nanophosphors have been synthesized by the combustion method. The structural, spectral and optical properties were examined by powder X-ray diffraction, fluorescent spectrophotometry and UV–vis spectroscopy. The excitation spectra of the phosphors contain sharp peaks at 294, 323, 348 and 385 nm due to the 4f–4f transition of the Dy^{3+} ion. The phosphor is efficiently excited by near-UV chips. Upon near-UV excitation the phosphor emits intense blue and yellow with a weak red band centered at 484, 573 and 669 nm respectively, ascribed to the transition of Dy^{3+} ion from ${}^4F_{9/2} \rightarrow {}^6H_{15/2}$, ${}^6H_{13/2}$, ${}^6H_{11/2}$. The diffuse reflectance spectra of the phosphors were consistent with the excitation spectra and were used to calculate the band gap of the material, approximated to be 5.4 eV. The calculated CIE coordinates (0.45, 0.46) under 348 nm excitation were found to be in the white spectrum region. For surface investigation, X-ray photoelectron spectroscopy was used which confirms the presence of all the elements on the surface of the material.

1. Introduction

Recently, the studies on spectral properties of alkali–alkaline based oxide materials ($MNBO_3$, A = alkali, B = alkaline) have generated interest in research community, because of their good thermal and chemical properties [1–2]. These materials have high melting points, capability to accommodate defects, high thermal expansion coefficient, low thermal conductivity and strong absorption in the near-ultraviolet region, makes them a strong candidate for the solid state lighting, display devices, optoelectronic devices and light-emitting diodes (LEDs) [3–7]. Today, the investigation of oxide based light emitting materials for white light-emitting diodes (w-LEDs) applications have generated interest due to the advantages such as long lifetime, low energy consumption, high luminescence efficiency and environmental friendliness [8]. WLEDs produced by downconverting the blue light from InGaN using suitable color converters, such as YAG:Ce (cerium-doped yttrium aluminum garnet) has certain demerits, such as halo effect, low color rendering index (CRI) and re-absorption of the blue emission which limits its applicability [9–11]. Therefore, in order to overcome these limitations, another approach has been suggested in which tricolor (red/green/blue) phosphors have been excited by a near-ultraviolet light to produce white light with high color tolerance and high conversion efficiency with excellent optical and thermal stability [12,13]. Hence, the potential application of near-UV converted phosphors for white WLED is expected to increase considerably. Therefore, the phosphors excited by near-UV light are highly desirable and could be explored for their potential applications in lighting.

Among the rare earth ions, Dy^{3+} is of much interest because of the existence of two characteristic emission bands in the blue (∼480 nm) and yellow (∼570 nm) regions, which correspond to the magnetic dipole transition (${}^4F_{9/2} \rightarrow {}^6H_{15/2}$) and the hypersensitive electric dipole transition (${}^4F_{9/2} \rightarrow {}^6H_{13/2}$) of Dy^{3+} [14,15]. In addition, the intensity of the yellow emission is strongly affected by the crystal field environment of the host lattice and the radial integral of *4f* and *5d* electrons [16]. Hence, the white light could be produced by tailoring the yellow to blue (Y/B) intensity ratio. Research on alkali–alkaline based oxide phosphors has been carried out extensively and the materials are explored for their potential applications in the lighting industry [17–20]. However, there are only few reports available on rare earth doped $LiMgBO_3$ phosphors [21–23]. Moreover, there is lack of reports on the surface

* Corresponding author at: School of Physics, Shri Mata Vaishno Devi University, Katra 182320, India Tel.: +91 1991 285699; fax: +91 1991 285694.
E-mail addresses: vinaykdhiman@yahoo.com, vinaykumar@smvdu.ac.in (V. Kumar).

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