



Effect of Ca^{2+} and Sr^{2+} alkaline earth ions on luminescence properties of $\text{BaAl}_{12}\text{O}_{19}:\text{Eu}$ nanophosphor

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ABSTRACT

Nanosized barium aluminate materials was doped by divalent cations (Ca^{2+} , Sr^{2+}) and Eu^{2+} having nominal compositions $\text{Ba}_{1-x}\text{MxAl}_{12}\text{O}_{19}:\text{Eu}$ ($\text{M} = \text{Ca}$ and Sr) ($x = 0.1\text{--}0.5$), were synthesized by the combustion method. These phosphors were characterized by XRD, scanning electron microscopy–energy-dispersive spectrometry (SEM–EDS) and photoluminescence measurement. The photoluminescence characterization showed the presence of Eu ion in divalent form which gave emission bands peaking at 444 nm for the 320 nm excitation (solid-state lighting excitation), while for 254 nm it gave the same emission wavelength of low intensity (1.5 times) compared to 320 nm excitation. It was also observed that alkaline earth metal (Ca^{2+} and Sr^{2+}) dopants increase the intensity of Eu^{2+} ion in $\text{BaAl}_{12}\text{O}_{19}$ lattice, thus this phosphor may be useful for solid-state lighting.

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1. Introduction

The growth of high-brightness light emitter applications and their related markets (HB LEDs and some lasers) would continue to lead the semiconductor arena, with newer product strength. Specifically, only HB LEDs and non-telecom laser diodes have shown significant growth since 1999. The past average annual growth rates for almost a decade have 50% and with the product demands annual growth rates around 20% are anticipated for at least the next 5 years. The application areas of such materials includes not only the largest direct LED application area of cell phone but also hand held liquid crystal display (LCD) back-lighting units along with outdoor and indoor signs and auto lighting, but the smaller market segments such as architectural, marine and aviation lighting, road and rail signals and flash units for digital cameras.

Since, visible LEDs were first reported in 1960s [1] and thus they have been widely utilized for backlight of the liquid crystal display, traffic signals, and especially for solid-state lighting [2]. In

comparison with the incandescent and fluorescent lamps, Ga(In)N-based white LEDs have a number of advantages such as high efficiency, good reliability and long lifetime, etc. [3]. The most common method to generate the white LED for solid-state lighting is to combine a blue LED with a yellow phosphor ($\text{Y}_{1-a}\text{Gd}_a)_3(\text{Al}_{1-b}\text{Ga}_b)_5\text{O}_{12}:\text{Ce}^{3+}$ and (YAG:Ce) [2–5] and in this YAG:Ce-based white LED has low color-rendering index and high color temperature. Recently, white LEDs fabricated by red/green/blue tricolor phosphors with near (n)-UV Ga(In)N chips have been considered as the most efficient method because (n)-UV lights almost have little effect on the color quality [6,7]. In the past decade, $\text{A}_{1-x}\text{Eu}_x\text{Al}_{12}\text{O}_{19}$ ($\text{A} = \text{Ca}$, Sr , Ba), compounds were investigated as the host materials of long lasting phosphors by co-doping with trivalent rare-earth ions [8]. But, the effect of alkaline earth ions such as Ca and Sr in the above system and its effect on the luminescence behaviour of the materials was not focused by the researchers and hence material is considered as the main attempt in the present investigation.

2. Experimental

All the phosphor have been prepared by combustion technique. For the production of phosphor in the investigation

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the following starting AR grade materials (99.99% purity) were used such as barium nitrate ($\text{Ba}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$), calcium nitrate ($\text{Ca}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$), strontium nitrate ($\text{Sr}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$), aluminium

nitrate ($\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$), europium oxide (Eu_2O_3) were used in developing these materials along with urea (NH_2CONH_2) fuel for combustion.

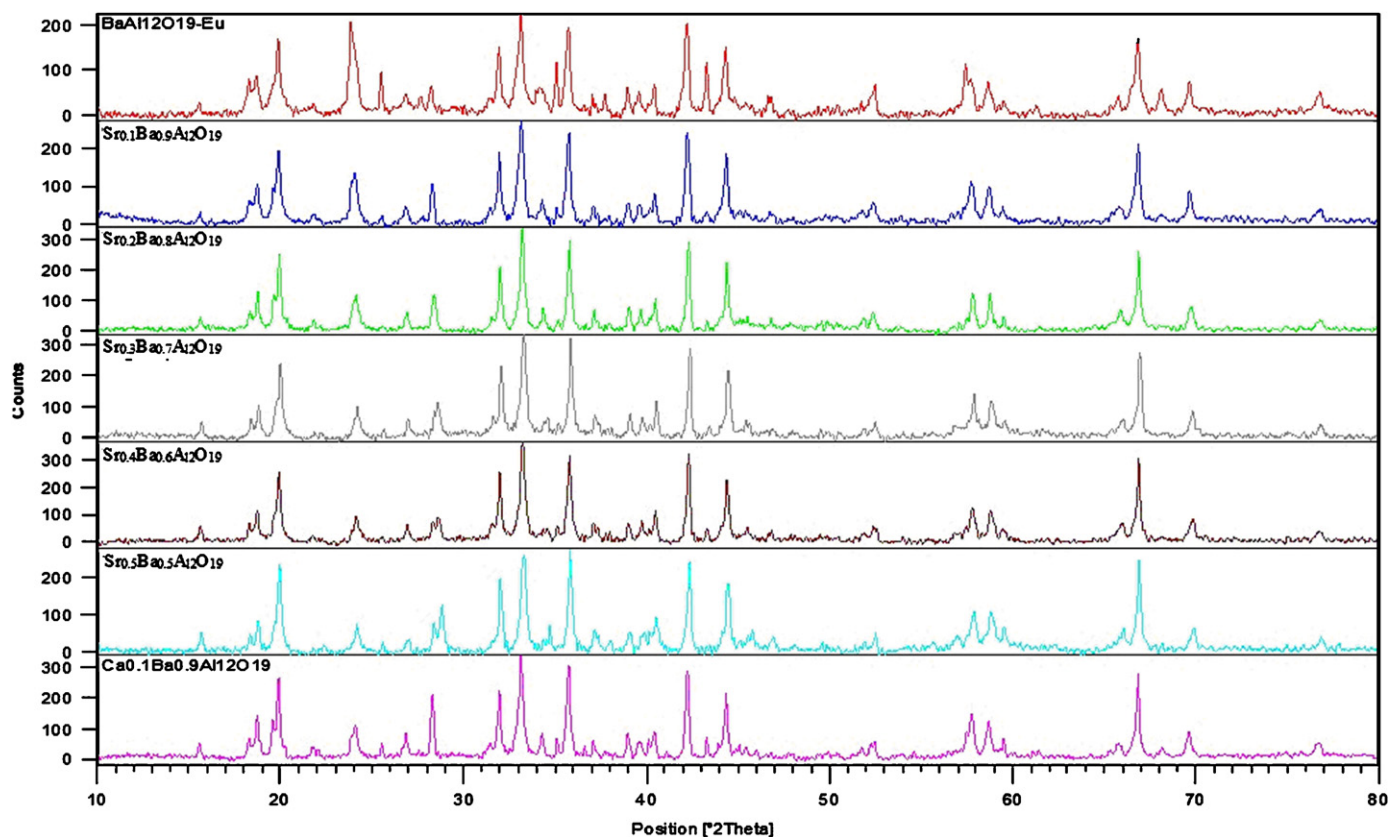


Fig. 1. XRD pattern.

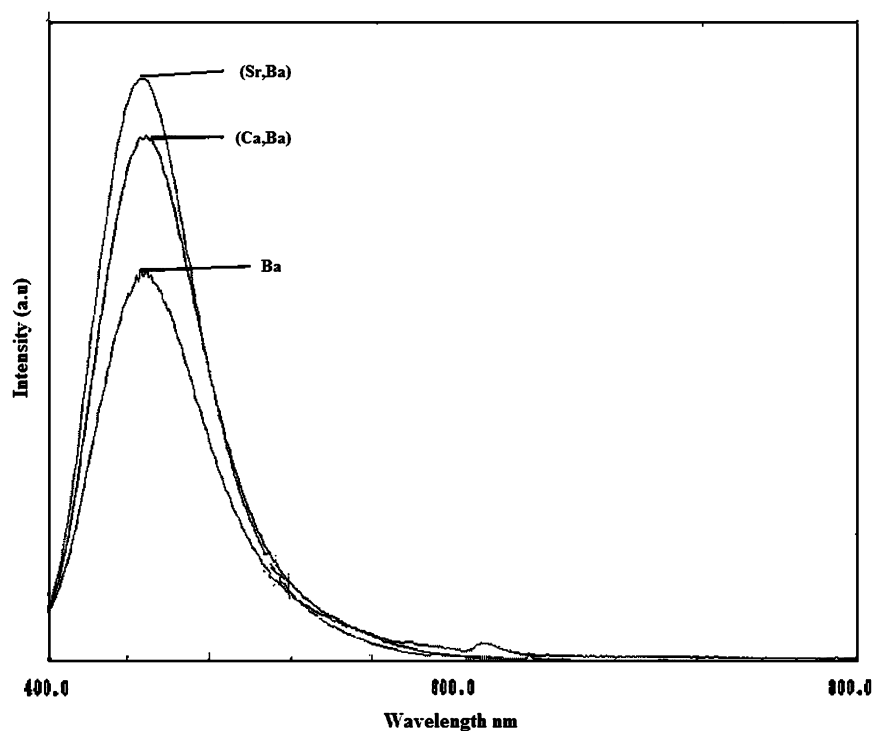


Fig. 2. Photoluminescence spectra for 3 mol% Eu doped in $\text{BaAl}_{12}\text{O}_{19}$ and substitution of Ca and Sr ion (exci. wavelength 320 nm).

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