Combinatorial Synthesis and Screening of the Eu-activated Phosphors in the System MO-Al_2O_3-SiO_2 (M=Sr, Ba)

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Abstract

We have synthesized some phosphors in the system MO-Al_2O_3–SiO_2 (M=Sr, Ba) by combinatorial polymerized-complex method. Composition and synthetic temperature of phosphors in the liblary was screened from the emission intensities of individual samples under 365nm excitation. As we were screened the higher luminescent candidate composition (or candidate host lattice) at 365nm excitation, investigated whether good radiation was possible at the 405 or 465nm excitation by give the host lattice to be discovered more various change. From libraries about 2 systems, the compound to be expected in long wavelength among the compound to be screened are $Sr_4Al_{14}O_{25}$, $Sr_3Al_2O_6$, $SrAl_2Si_2O_8$, and $BaAl_2Si_2O_8$.

1. Introduction

Recently, a new type of LEDs based on Gallium Nitride (GaN) that emits blue light (at 450–480 nm) efficiently has been developed. It provides significantly brighter light output than the traditional ones. Because blue LEDs emit light with a shorter wavelength than those of green and red LEDs, it is possible to obtain yellow secondary light from a suitable phosphor that can complement the blue emission to yield white light. Also, around 400nm of the UV ray combined with Blue, Green, and Red phosphor can create white LED. It is just same as Red, Green, and Blue combination. This UV LED + Blue, Green, Red phosphor shows better performance in Red emission characteristics than Blue + YAG phosphor based white LED. It is required to increase the power of UV LED and the performance of phosphor. For such reason, in the work, we are investigated to search for phosphors which are possible in a long wavelength area, 405nm and 460nm in particular, by combinatorial chemistry method.

In this work, we were synthesized Eu^{2+}-activated phosphors in the system MO-Al_2O_3-SiO_2 (M=Sr, Ba) by Pechni-Type polymerizable complex technique based on polyesterification between citric acid (CA) and ethylene glycohol (EG), screened the higher luminescent composition at ultraviolet (UV) excitation and characterized the phosphors of a optimized composition.

2. Experimental

To synthesize phosphors, which are exciting at UV, a combinatorial table composed of 210 different compositions was prepared. In accordance with the table, each material sample could be tested with compositions of M(M=Sr, Ba), Al and Si components that is in the range from 0 to 1 in 0.05 increments respectively.

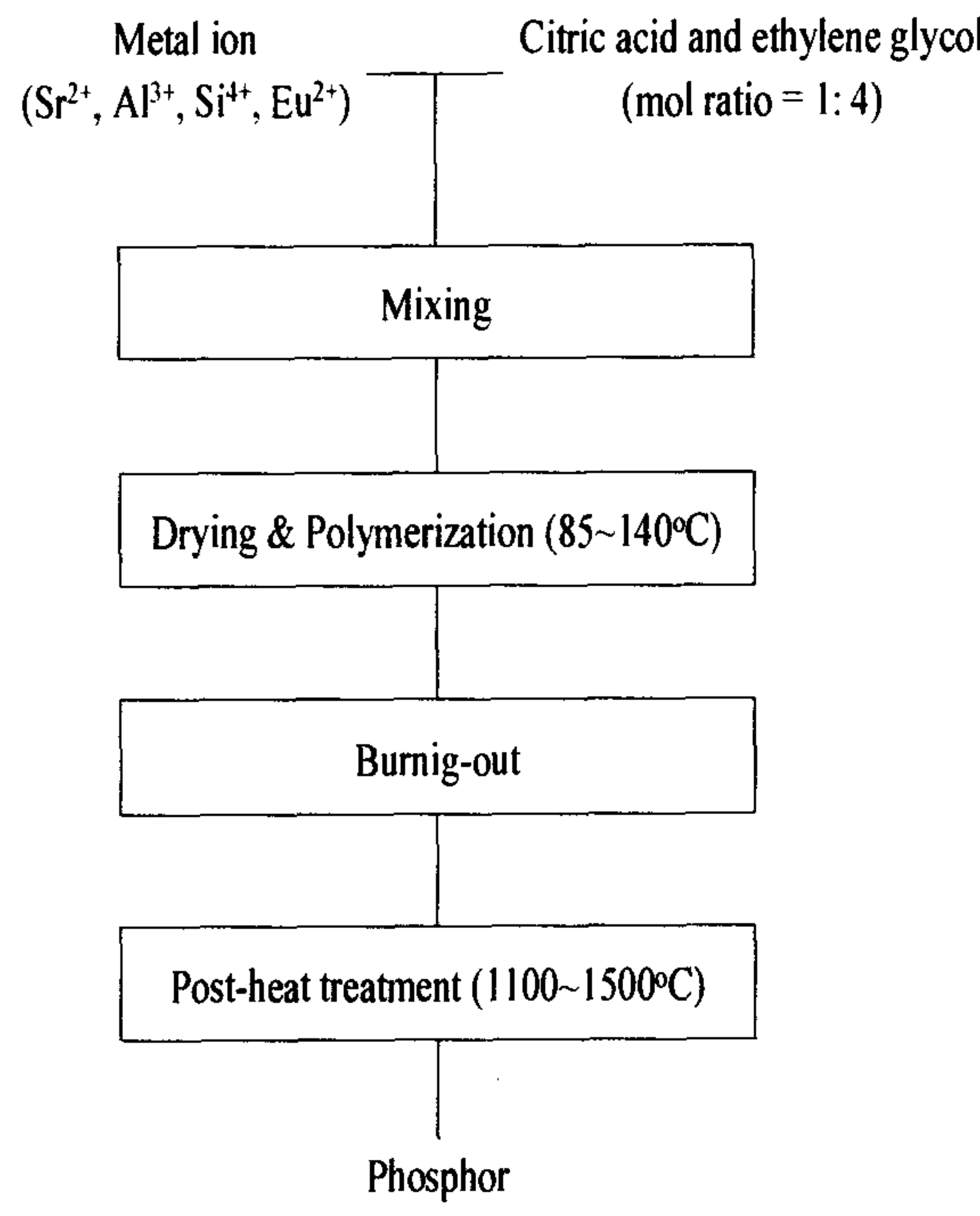

Fig. 1. Flow diagram of complex-polymeric combinatorial chemistry method.

Each ionic solution was injected to 6ml test tube by using micropippetes according to each composition of the combinatorial table. Then, citric acid and ethylene glycohol were added as 2.5 ~ 3.0 times and 5 times to the equivalence of total metal ions at each test tube. After the removal of water, the polymerization of excess citric acid containing metal-citrate complex and ethylene glycohol occur the complex-polymeric precursors. The burning-out step contains the removal of organic materials at 600 ~ 700℃ for 3-5h in furnace.

The post-heat treatment be sequently conducted at 1100 ~ 1500℃ for 3h in an oxidizing or reducing atmosphere. The final weight of the samples is in the range of 0.1g to 0.2g.

3. Result and Discussion

Fig.1, 2 show the luminescence libraries for the Eu^{2+} ion in the ternary $MO-Al_2O_3-SiO_2$ (M=Sr, Ba) system under the 254nm excitation and 365nm excitation. The library of ternary system to be originally the purpose at the 465nm excitation could not make because of so low intensity. But, as we were screened the higher luminescent candidate composition (or candidate host lattice) at 365nm excitation, investigated whether good radiation was possible at the 405 or 465nm excitation by give the host lattice to be discovered more various change. From libraries about 2 systems, the compound to be expected in long wavelength among the compound to be screened are $Sr_4Al_{14}O_{25}$, $SrAl_2Si_2O_8$, and $BaAl_2Si_2O_8$.

(a)

(b)

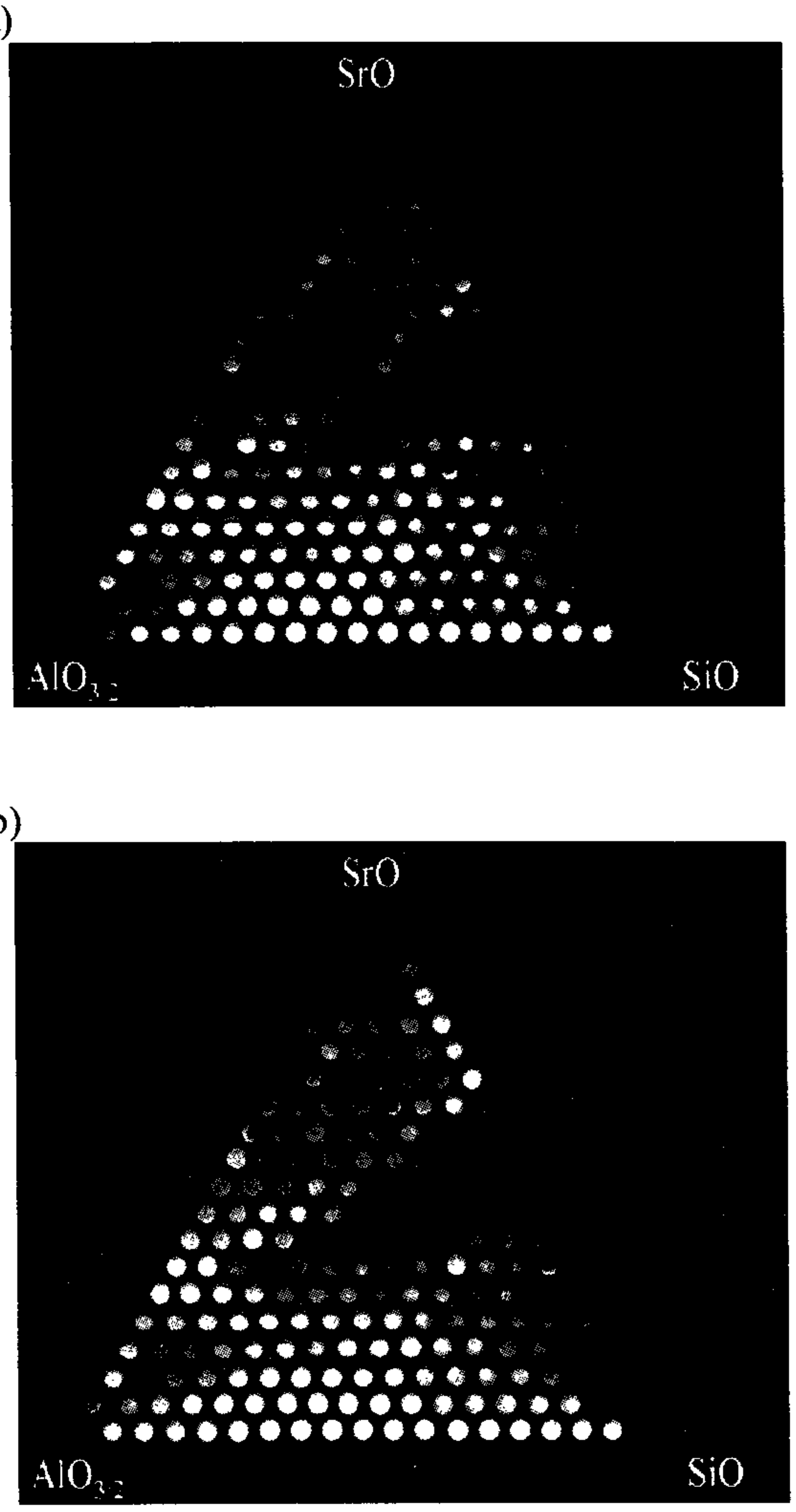

Fig. 2. Library for Eu^{2+} ion in the ternary $SrO-Al_2O_3-SiO_2$ system under (a) 254nm excitation (b) 365nm excitation.

3. Reference

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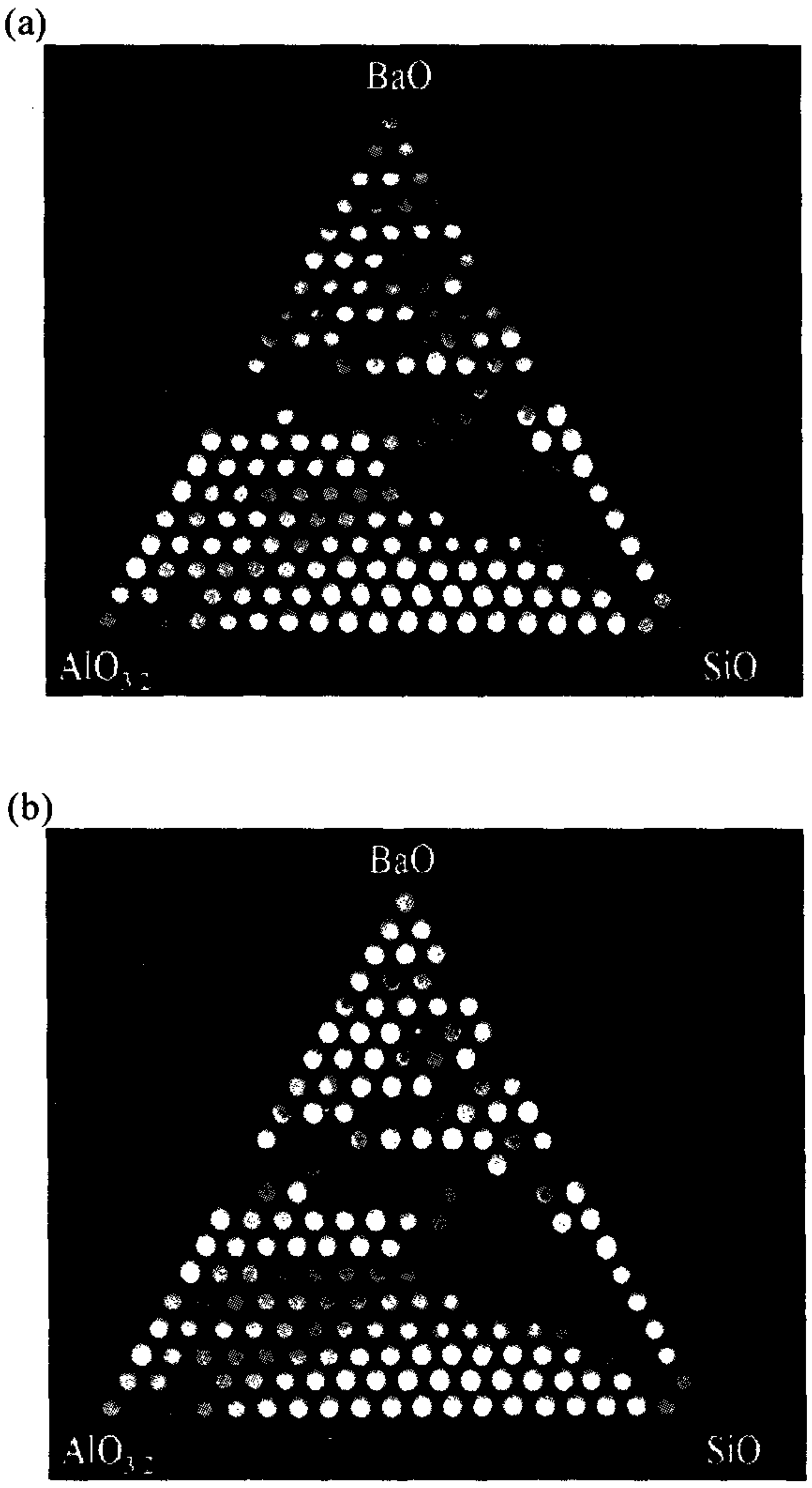

Fig. 3. Library for Eu^{2+} ion in the ternary BaO-Al_2O_3-SiO_2 system under (a) 254nm excitation (b) 365nm excitation.

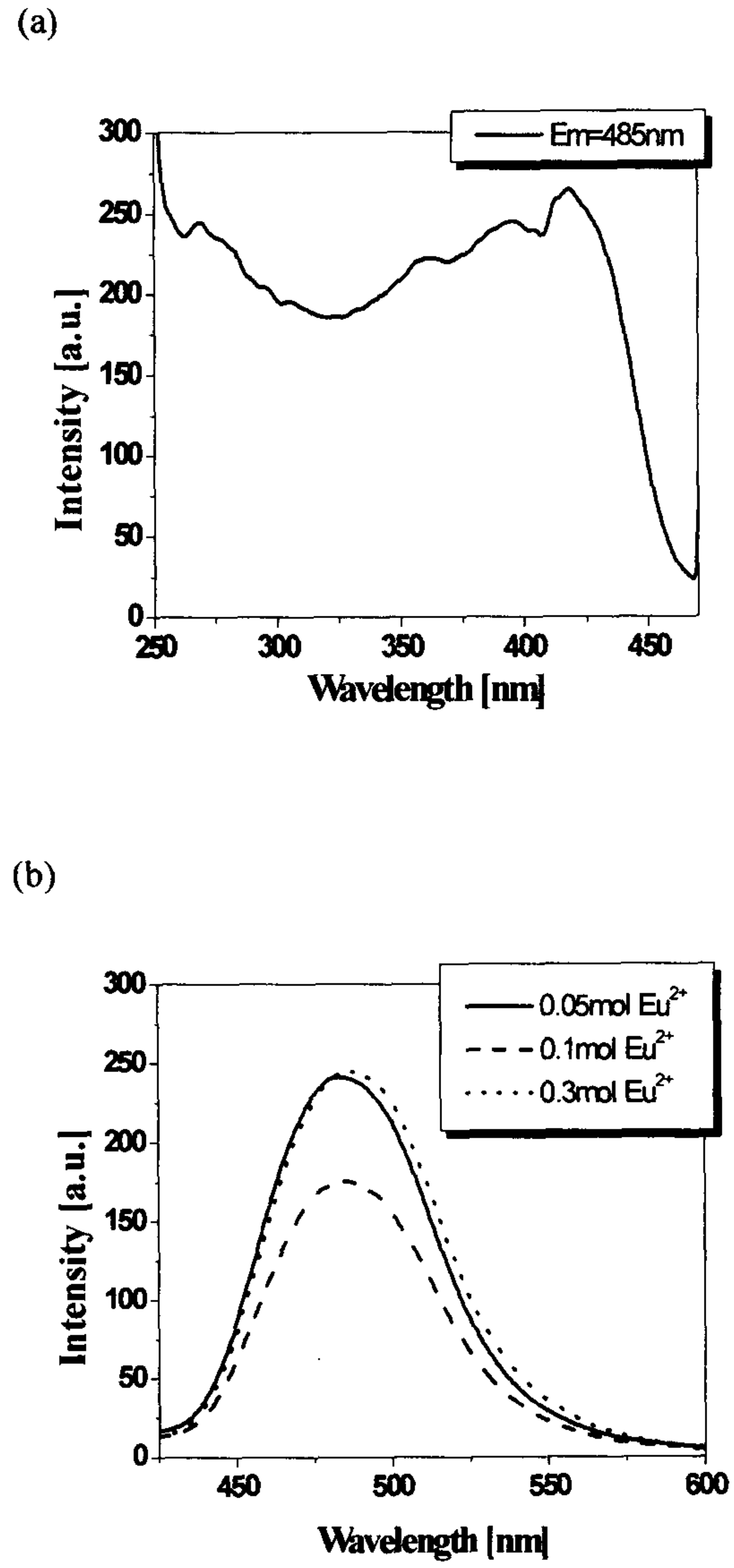

Fig. 4. PL properties of $Sr_4Al_{14}O_{25}$:Eu.
(a) excitation spectra of $Sr_{3.7}Al_{14}O_{25}$: $Eu_{0.3}$ which were prepared for 3h at the temperature of 1200°C in a reducing atmosphere, (b) emission spectra of $Sr_{4-x}Al_{14}O_{25}$:Eu_x in the various Eu^{2+} concentration.

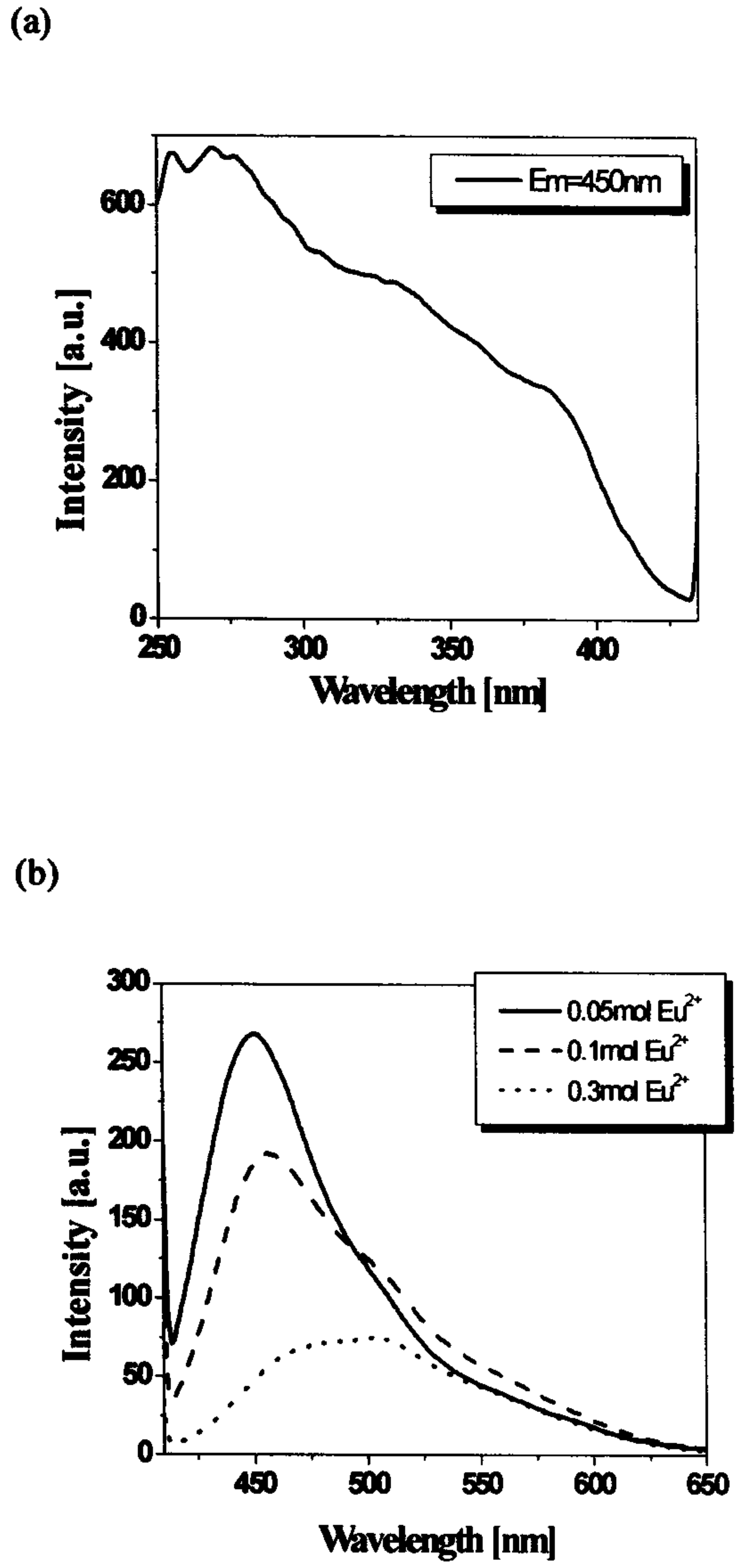

Fig. 5. PL properties of $SrAl_2Si_2O_8$:Eu.
(a) excitation spectra of $Sr_{0.95}Al_2Si_2O_8:Eu_{0.05}$ which were prepared for 3h at the temperature of 1400°C in a reducing atmosphere, (b) emission spectra of $Sr_{1-x}Al_2Si_2O_8:Eu_x$ in the various Eu^{2+} concentration.

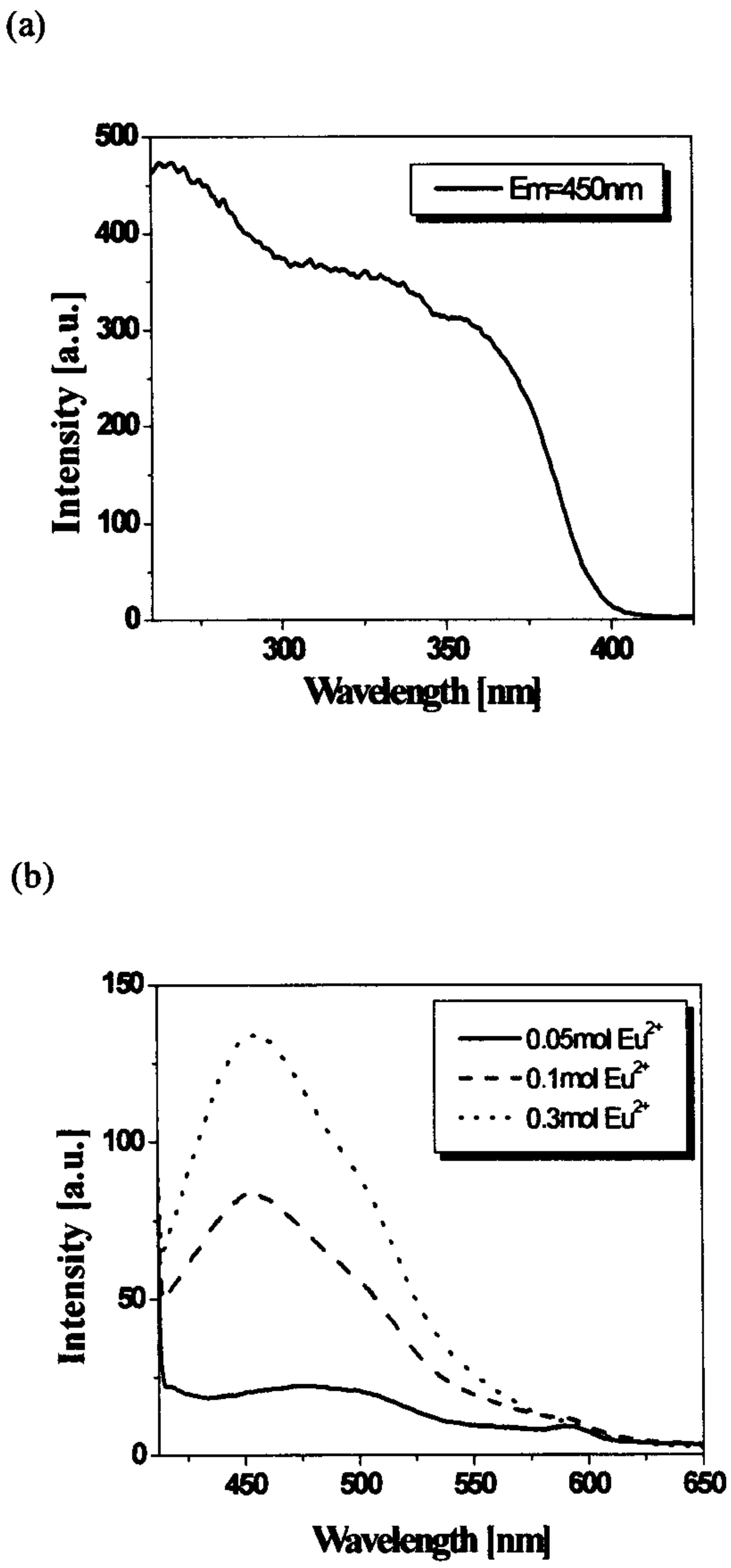

Fig. 6. PL properties of $BaAl_2Si_2O_8$:Eu.
(a) excitation spectra of $Ba_{0.95}Al_2Si_2O_8:Eu_{0.05}$ which were prepared for 3h at the temperature of 1500°C in a reducing atmosphere, (b) emission spectra of $Ba_{1-x}Al_2Si_2O_8:Eu_x$ in the various Eu^{2+} concentration.