Combinatorial Synthesis and Screening of the Eu^{2+}-activated Phosphors for LED in the System $CaO-Al_2O_3-SiO_2$

Seung Hyok Park*, Ho Shin Yoon, Chang Hae Kim and Ho Gyeom Jang

Advanced Materials Division, Korea Research Institute of Chemical Technology

**Department of Chemistry, Korea University, Seoul, Korea*

P.O. Box 107, Yusong, Daejeon 305-600, Korea, 042-860-7375, hyok@krict.re.kr

Abstract

We have synthesized phosphor in the system $CaO-Al_2O_3-SiO_2$ by combinatorial polymerized-complex method. The application of combinatorial synthesis and characterization of luminescent materials has been enlarged to identification and optimization in interesting new phosphor. In this study, we investigated luminescent properties of above-mentioned materials by excitation and emission spectra. In Eu^{2+} activated $Ca_1Al_2Si_2O_8$ phosphor emit the blue light.

1. Introduction

Light emitting Diode's (LED) are special diodes that emit light when connected in a circuit. LED have changed quickly in the past few years.[1] New high-efficiency LED boast brightness that makes them usable in daylight and provide colors that include long-sought blue and even white. The virtues of LED, compared with incandescent sources, are clear long life plus power efficiency.[2] Phosphor for LED is the most important element that influence to the properties of LED.

The polymerized-complex combinatorial chemistry method makes it possible to the same that is adopted for the conventional powder sample.

In this work, we were synthesized Eu^{2+} activated phosphors in the system $CaO-Al_2O_3-SiO_2$ by Pechni-type polymerizable complex technique based on polyesterification between citric acid and ethylene glycohol, screened the higher luminescent composition at UV excitation and characterized the phosphors.

2. Experimental Section

The phosphor samples were prepared by a polymerized-complex method as can be seen in Fig. 1. The each solutions including Ca^{2+}, Al^{3+} and Eu^{3+} metal ion, citric acid and ethylene glycohol solution were injected into test tubes according to the composition of samples to be prepared. The mixed solution was heated at 135℃ for hydrolysis and polymerization, and then transparent solution-complex polymeric precursor was obtained. The burning-out step contains the

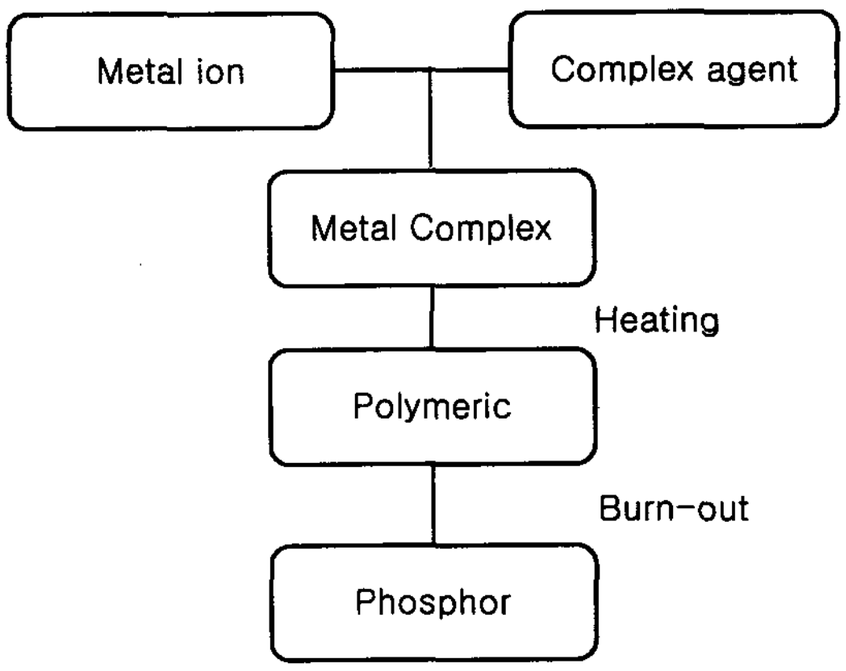

Figure 1. Flow diagram of complex-polymeric combinatorial chemistry method.

removal of organic materials at 600~700℃ for 3-5hr in the furnace and heating at 1000~1500℃ for 3hr in reducing atmosphere(5% H_2/N_2).

3. Results and Discussion

Figure. 2. is the number of samples in the ternary combinatorial library. The concentration of Eu^{2+} was fixed at 0.01mol in the ternary system. The concentration of Ca^{2+} comes to be high as go to the upside and subtracts the concentration of Eu^{2+} from the concentration of Ca^{2+} to be substituted. The concentration of Al^{3+} comes to be high as the under left and the concentration of Si^{4+} comes to be high as the under right.

As well known, the emission of Eu^{2+} ion generally shows a broad band character with a $4f^65d \rightarrow 4f^7$ transition nature (except the f-f line emission at about 360nm in some special compounds). The wavelength position of the emission bands depends very much on hosts, changing from the near UV to red. This dependence is interpreted as due to the crystal field splitting of the 5d level. With increasing crystal field strength, the emission bands shift to longer wavelength. Such viewpoint, this work offers library to see luminescence property of Eu^{2+} in many host which can be prepared in ternary system at a time.

Figure 3. show the luminescence libraries for the Eu^{2+} ion in the ternary $CaO\text{-}Al_2O_3\text{-}SiO_2$ system at the 365nm excitation. According to the Figure 3, overall radiation tendency is blue. Overall luminescence intensity increased as the temperature came to be high but decreased in 1500° C by phase transition or the change of particle shape.

4. Conlclusion

We investigated luminescent properties of $CaAl_2Si_2O_8$:Eu compound by excitation and emission spectra. In result, $CaAl_2Si_2O_8$:Eu phosphor emit blue light.

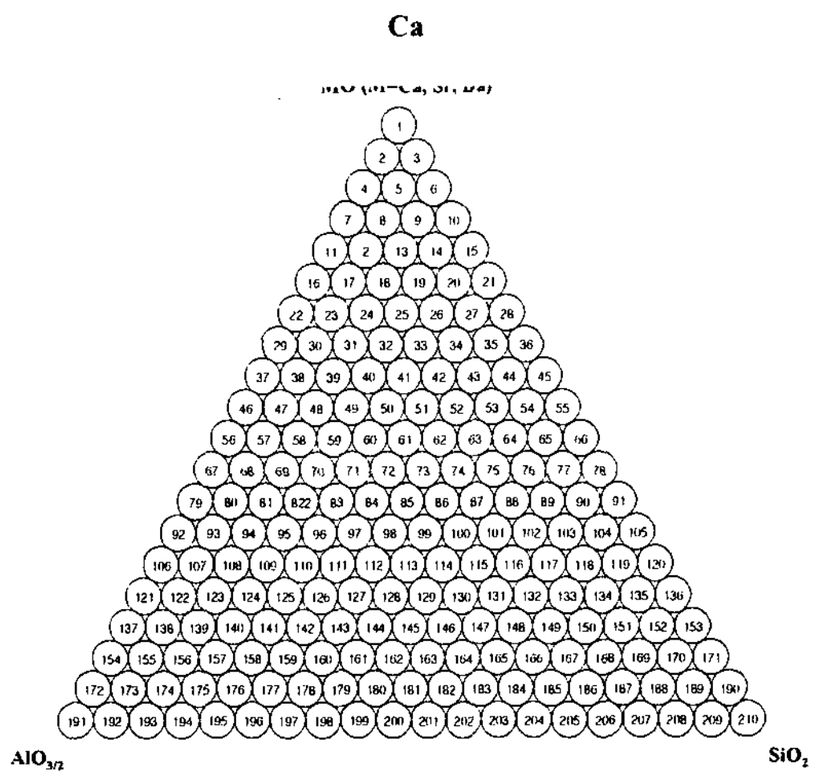

Figure 2. The number of samples of library

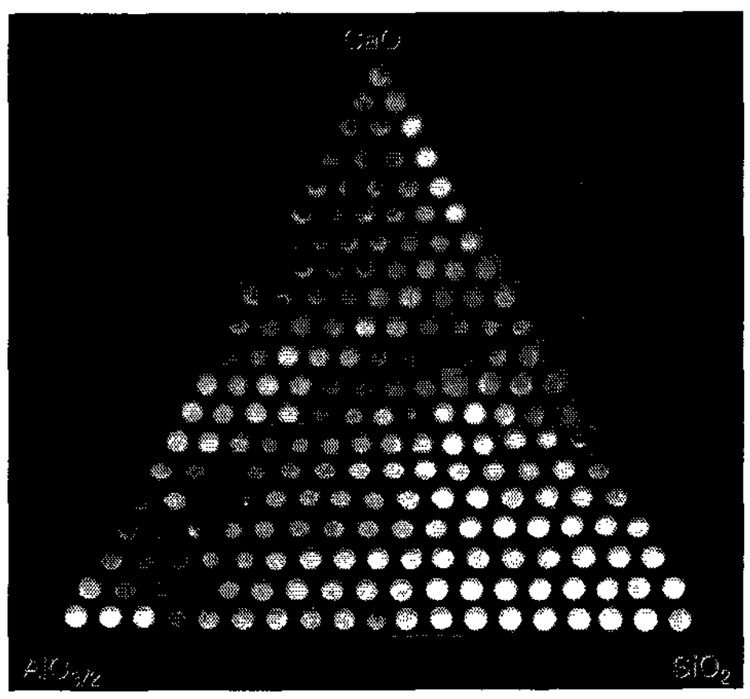

Figure 3. Library for Eu^{2+} ion in the ternary $CaO\text{-}Al_2O_3\text{-}SiO_2$ system under 365nm excitation.

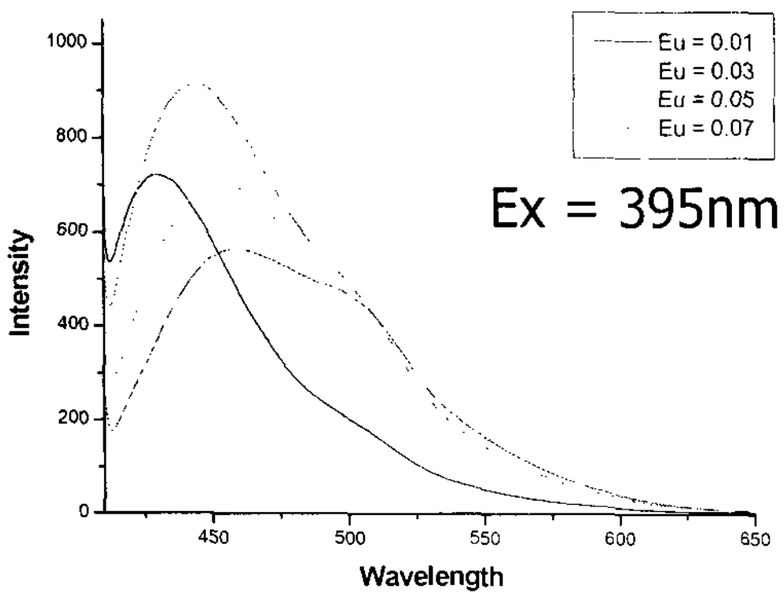

Figure 4. Emission spectra of $Ca_{1-x}Al_2Si_2O_8:Eu_x$ in the various Eu^{2+} concentration.

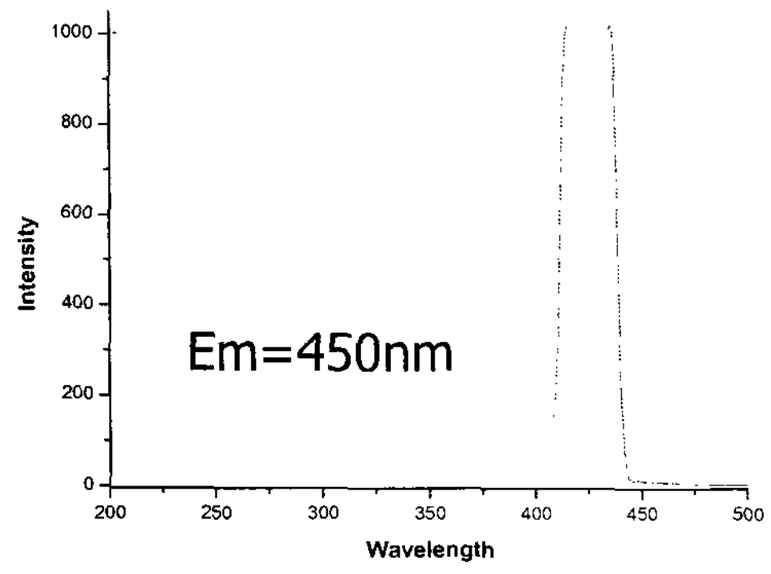

Figure 5. Excitation spectra of $Ca_{1-x}Al_2Si_2O_8:Eu_x$ in the various Eu^{2+} concentration.

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