Synthesis of $M(WO_4)$:Eu (M : Group 1 or 2) for LED and its Luminescent Properties

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Abstract

$M(WO_4)$:Eu phosphor as a red emitting phosphor for LED was prepared by solid state method. Tungstate phosphors were exited at long wavelength ultra violet region. In special, the emission of Eu-doped $M(WO_4)$:Eu phosphor under the excitation of 410nm appeared at 613nm. $M(WO_4)$:Eu phosphors with M : Group 1 had a higher excitation intensity than those of the phosphors with M : Group 2 at long-wavelength UV.

1. Introduction

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

The excitation wavelength range of LED is from 380nm to 410nm. That reason originate to the semiconductor which excites energy. According to current tendencies for energy-saving, new research and development for more efficient LED is being implemented. It is necessary to develop fluorescent materials with excitation wavelength range of 400nm and over.

$M(WO_4)$ phosphor is known as a blue emitting phosphor. $M(WO_4)$ show high luminescence intensities to excitation in the range from 250nm to 310nm but low luminescence intensities to excitation in the range from 320nm to 410nm. The excitation wavelength of Eu doped $M(WO_4)$ was shifted long-wavelength.

In this work, we synthesized $M(WO_4)$:Eu red phosphor particles by the solid-state method and investigated their luminescent properties.

2. Experimental Section

Eu-doped $M(WO_4)$ phosphor powders were synthesized by the conventional solid-state

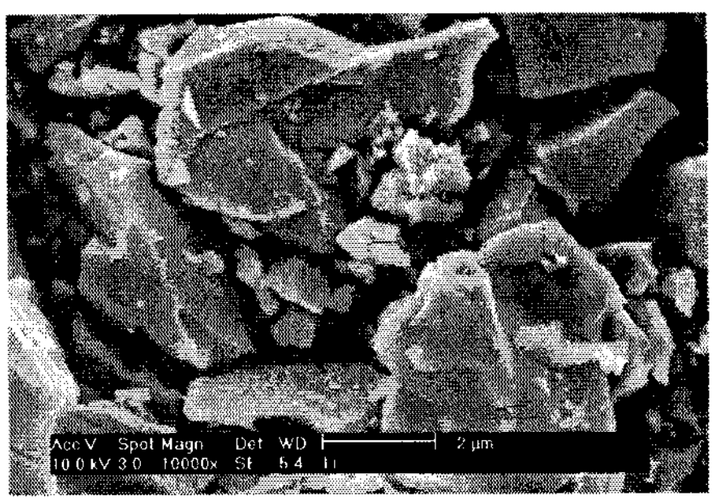
reaction of WO_3, Eu_2O_3 and Group 1 or 2 metal carbonate powders (99.99% pure, High purity Chemicals Inc.). The mixed powder was heated in the temperature range of 850~950°C for 3 h under oxygen atmosphere. The effects of leaching treatment have been investigated for the sake of LED application. The crystalline phase was characterized by powder X-ray diffraction (XRD). The morphology of the phosphor particles was observed by field emission scanning electron microscopy (FE-SEM). Photoluminescence characteristic of samples were measured by photo-luminescence spectroscopy (PL).

3. Results and Discussion

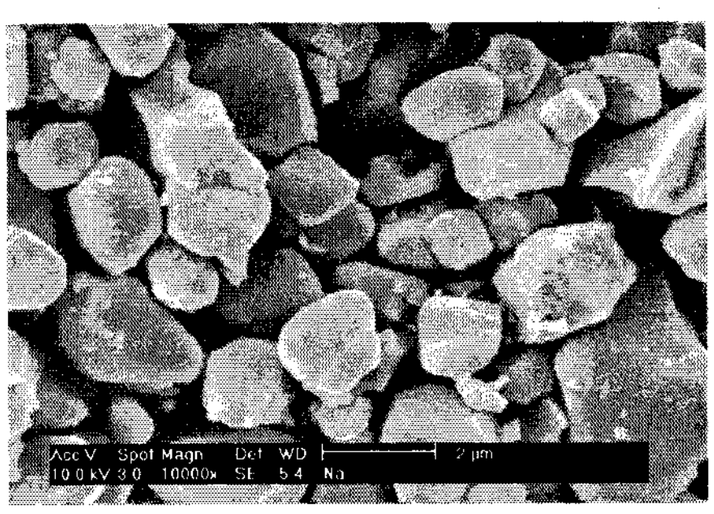
$M(WO_4)$:Eu phosphor particles were prepared by the solid-state reaction. The SEM images of the M^1 (WO4):Eu (M^1 : Group1) phosphor particles are illustrated in Fig 1. As shown in Fig 1, the phosphor particles have a particle size in the range of 2μm to 10μm. Emission of $M(WO_4)$:Eu phosphor under the excitation of 410nm appeared with the peaks at 613nm. Figure 2. shows the emission spectra of $M^1(WO_4)$:Eu phosphor by UV excitation. (M^1 : Group 1) Figure 3. shows the excitation spectra of M^1(WO4):Eu phosphor by UV excitation. (M^1 : Group 1) The emission intensity of PL spectra was increased in the order of $Li^{+1} > K^{+1} > Na^{+1}$.

Figure 4. shows a SEM image of $M^2(WO_4)$:Eu (M^2 : Group2) phosphors. The $M^2(WO_4)$:Eu (M^2 : Group2) phosphors and $M^1(WO_4)$:Eu (M^1 : Group1) phosphors size are similar. Figure 5. and Figure 6. show emission and excitation spectra of $M^2(WO_4)$:Eu (M^2 : Group2). The emission intensity of PL spectra was increased in the order of $Mg^{+2} > Ca^{+2} > Sr^{+2}$.

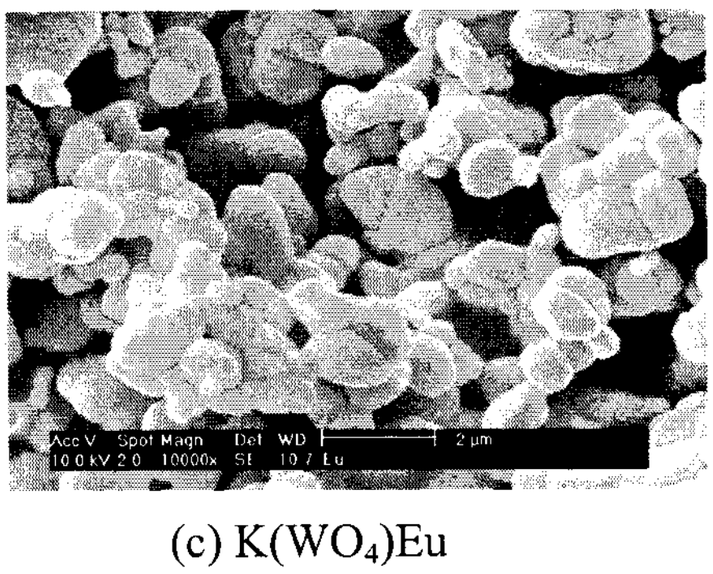
$M^1(WO_4)$:Eu phosphors with M^1 : Group 1 have higher excitation intensity than those of the phosphors with M^2 : Group 2 under long-wavelength UV.



(a) $Li(WO_4)Eu$



(b) $Na(WO_4)Eu$



(c) $K(WO_4)Eu$

Figure 1. SEM images of $M^1(WO_4)Eu$ powders (M^1 : Group 1)

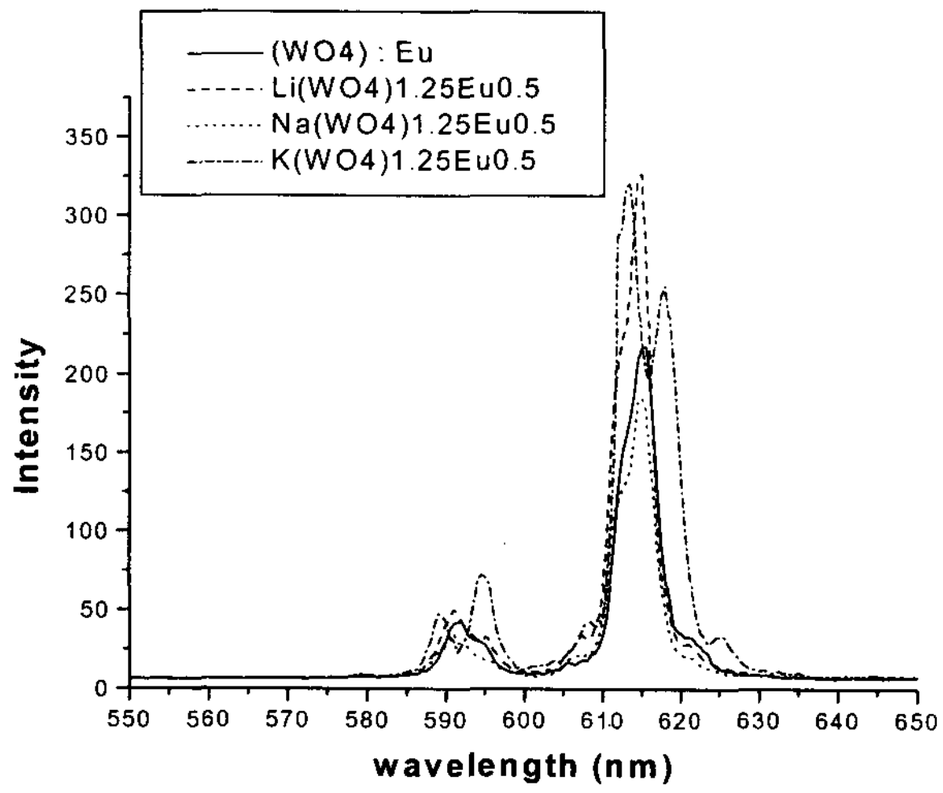
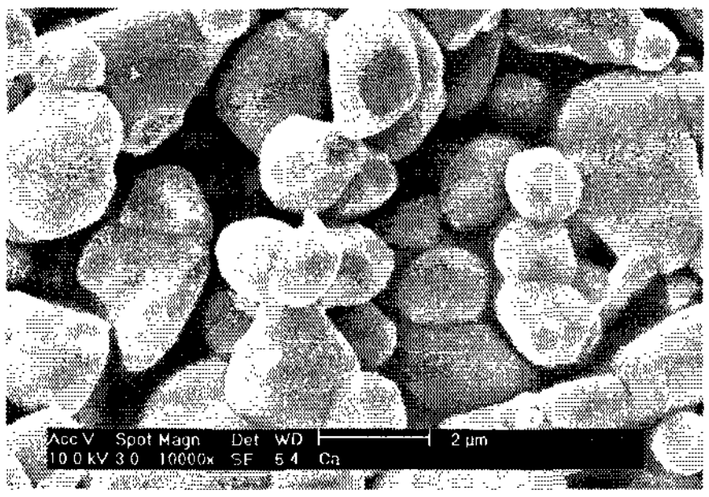
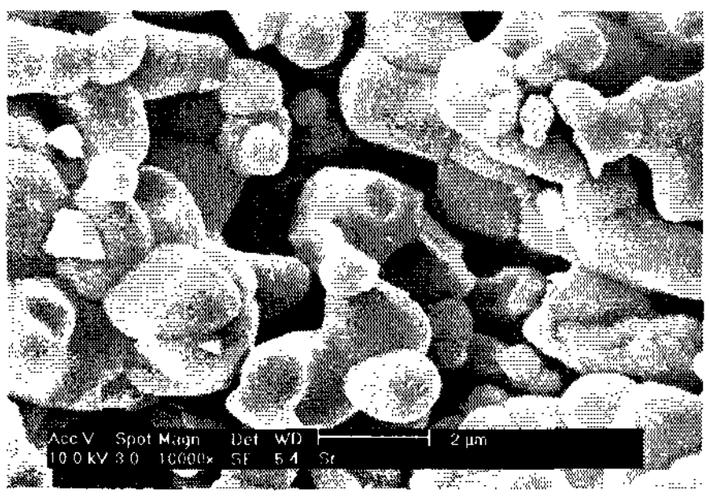


Figure 2. Emission spectra of $M^1(WO_4)$:Eu phosphor (M^1 : Group 1)



(b) $Ca(WO_4)Eu$



(c) $Sr(WO_4)Eu$

Figure 4. SEM images of $M^2(WO_4)$:Eu powders (M^2 : Group 2)

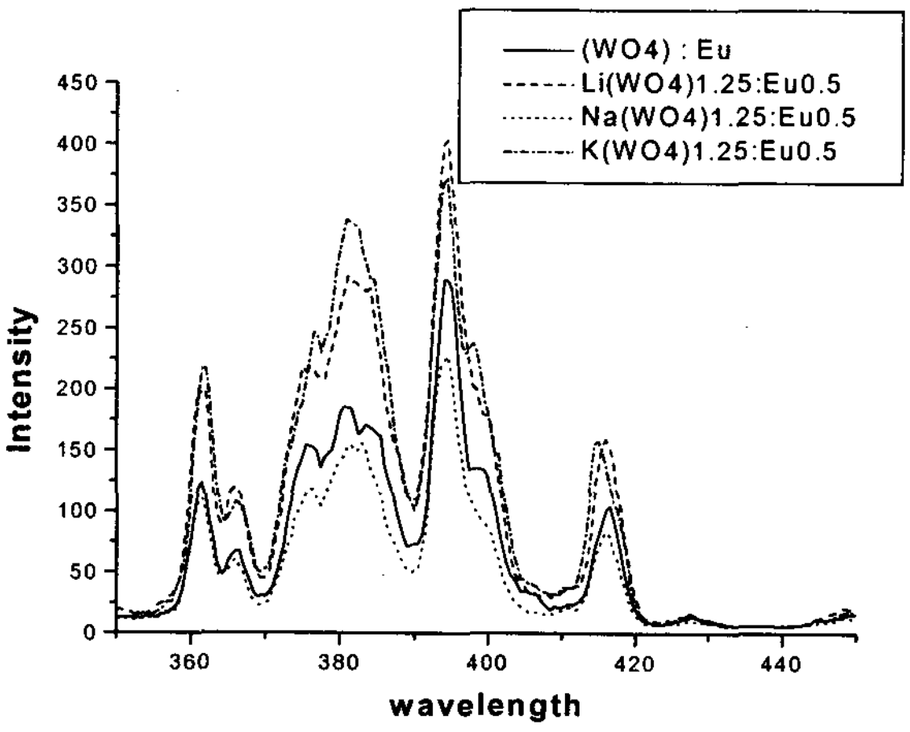
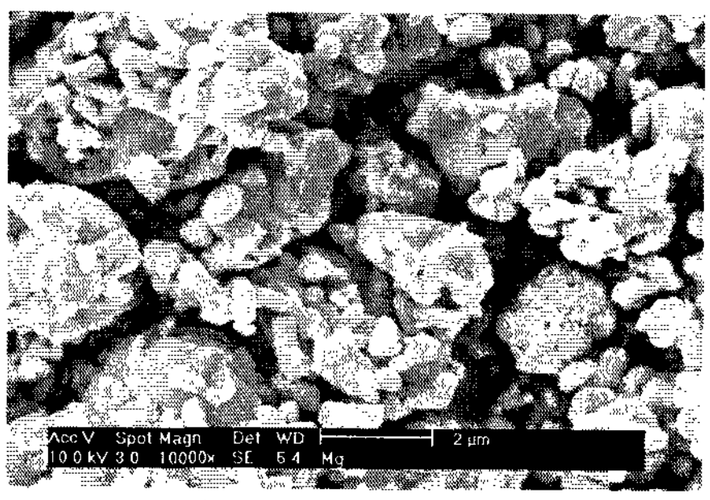


Figure 3. Excitation spectra of $M^1(WO_4)$:Eu phosphor (M^1 : Group 1)



(a) $Mg(WO_4)Eu$

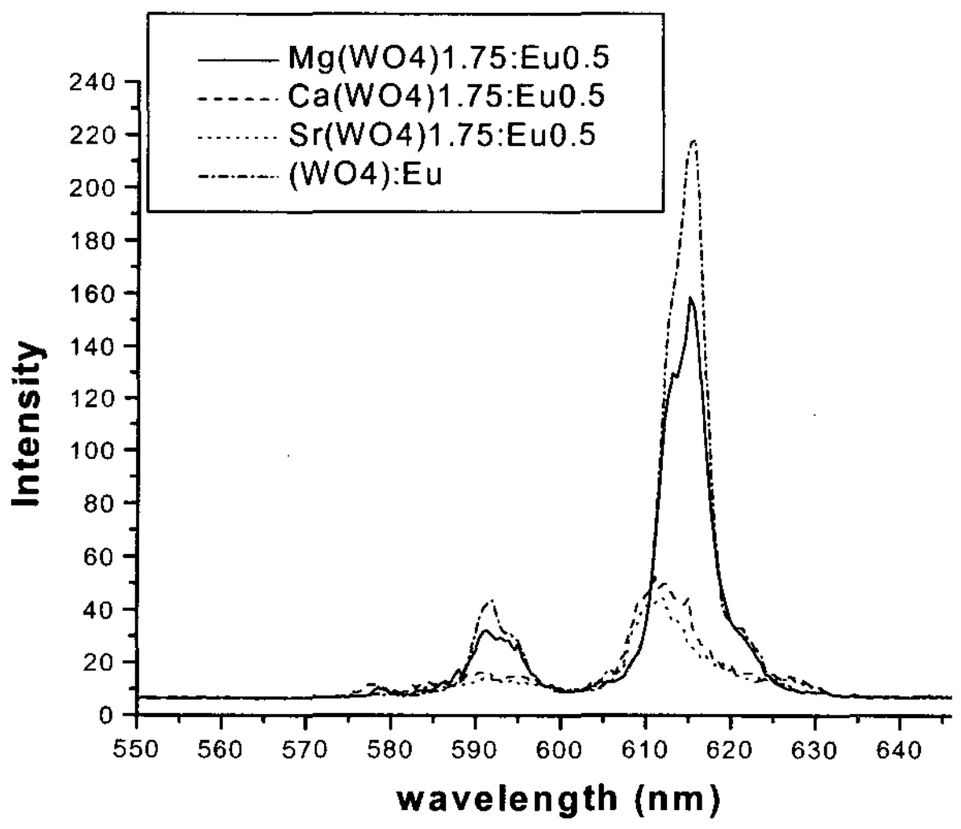


Figure 5. Emission spectra of $M^2(WO_4)$:Eu phosphor (M^2 : Group 2)

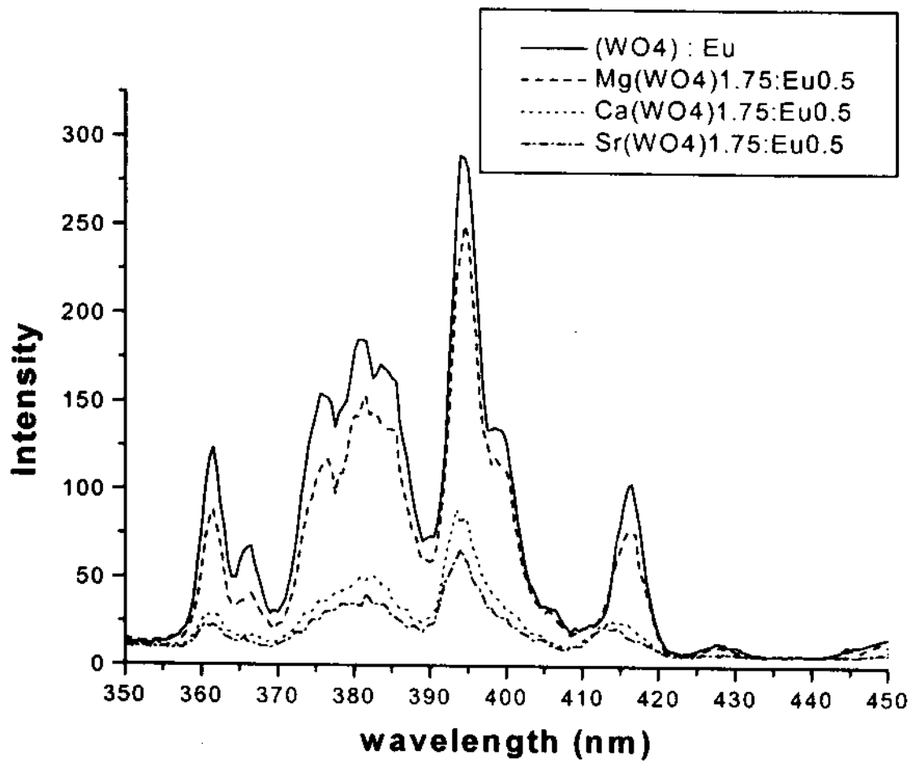


Figure 6. Excitation spectra of $M^2(WO_4)$:Eu phosphor (M^2 : Group 2)

4. Conclusions

$M(WO_4)$:Eu (M : Group 1 or 2) phosphor LED (Light Emitting Diode) as a red emitting phosphor was prepared by the solid state method. The emission intensity of PL spectra was increased in the order of $Li^{+1} > K^{+1} > Na^{+1} > Mg^{+2} > Ca^{+2} > Sr^{+2}$.

Reference

[1] Dawson, W; Nakanishi-Ueda, T; Armstrong, D; Reitze, D; Samuelson, D; Hope, M; Fukuda, S; Matsuishi, M; Ozawa, T; Ueda et alExperimental Eye Research, Volume 73, Issue 1, July 2001, Pages 137-147

[2] Alberto Colasanti, Annamaria Kisslinger, Dirk Kusch, Raffaele Liuzzi, Michele Mastrocinque, Franz-Peter Montforts, Maria Quarto, Partizia Riccio, Giuseppe Roberti and Fulvia Villani. Journal of Photochemistry and Photobiology B: Biology, Volume 38,