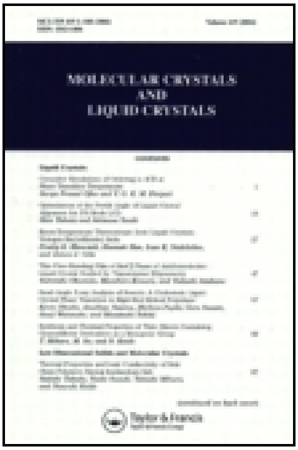

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Optical Characteristics of $BaMgAl_{10}O_{17}:Eu^{2+}$ Phosphors Coated with SiO_2 Nano Film by Using a Radio Frequency Sputtering Method

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In this experiment, $BaMgAl_{10}O_{17}$:Eu^{2+} (BAM) phosphors were coated with thin SiO_2 film by using a radio frequency (RF) sputtering method and investigated their electro-optical properties. It was revealed that the phothluminance properties of BAM phosphors coated with 2 nm SiO_2 film were improved, when compared with non-coated ones and more thickly coated ones. The improvement may be due to the increase of an effective excitation transmitted into the BAM phosphors and the increased vacuum ultraviolet (VUV) absorption of the phosphors via SiO_2. And the decrease in luminance seen in the thickly coated phosphors may be due to the interruption of the thick SiO_2 film in the penetration of VUV. From the results of the experiment, we find that a proper coating of BAM phosphors with thin SiO_2 film is a good way for improving the luminance.

Keywords: flat fluorescent lamp; phosphor; radio frequency sputtering

INTRODUCTION

Flat fluorescent lamp (FFL) uses VUV. This VUV occurs from a gas discharge which excites the phosphors and creates a visible light. In

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this gas discharge process, the energy conversion is not sufficient enough to provide a high efficiency. This is why some of the display devices consume excessive amounts of power and generate redundant heat. Thus, developing phosphors for high luminance efficiency is a main concern for the display industry [1,2].

In particular, there have been numerous efforts in order to enhance the luminance of BAM phosphors. Phosphors coated with MgO for avoiding degradation of phosphors also have been studied [3]. Moreover, several researches with the surface treatment of phosphors coated with SiO_2 have been introduced [4–6].

Thus, coating the surface of phosphors has been known to be a significant role in the display devices. In this experiment, we studied the effects of SiO_2 coating on electro-optical properties of BAM phosphors according to its thickness.

EXPERIMENTAL

We made a vehicle which consisted of ethyl cellulose, ethyl acetate, and a diethylene glycol monobuthylether and mixed it with BAM phosphors. The screen printed thick BAM phosphor film were dried 350°C for 10 min and fired 450°C for 30 min to remove organic solvents from the BAM phosphors.

We coated SiO_2 nano film on the prepared BAM phosphor thick films by using a RF sputtering method (RF power 60 W, Ar partial pressure 60 (Torr). X-ray reflectivity (XRR, Phylps, X'Pert PRO-MRD) was used to measure the thickness of SiO_2 film. The measured results are shown in Table 1.

The existence of SiO_2 nano film was investigated by energy dispersive micro analysis system (EDS, Shimadzu EPMA1600) and secondary ion mass spectrometer (SIMS, MillBROOK, Min Sims). Figure 1 shows SiO_2 films when using EDS analysis. Although we could not confirm 2 nm SiO_2 film when using EDS, we verified the existence of SiO_2 film by SIMS as shown in Figure 2.

RESULTS AND DISCUSSION

The emission spectrum and luminance were measured according to the thickness of SiO_2 film, input gas types, and driving voltages.

TABLE 1 Thickness of SiO_2 Films According to Time

Time	1 min 30 sec	4 min	8 min 30 sec	13 min	17 min
Thickness	2 nm	5 nm	10 nm	15 nm	20 nm

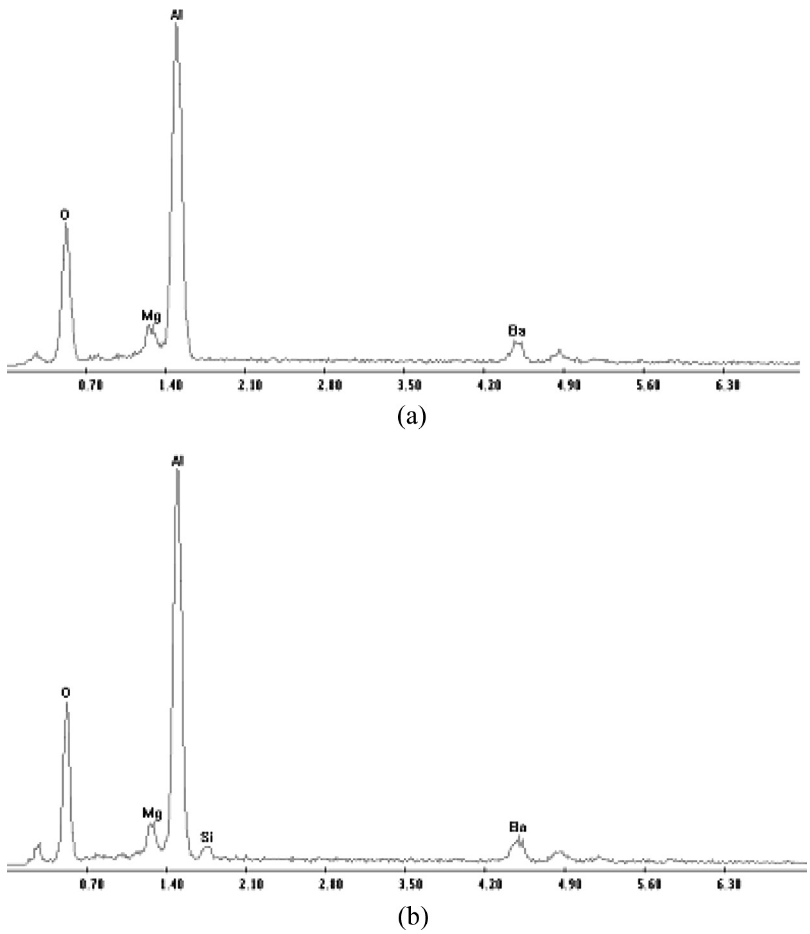


FIGURE 1 (a) EDS analysis of pure BAM phosphors; (b) ESD analysis of 20 nm SiO_2 film on BAM phosphors.

Although the input gas types and driving voltages did not effect on the emission spectrum and luminance, we found that the thickness of SiO_2 film play an important role in the emission spectrum and luminance as seen in Figures 3 and 4. The test panels with the 2 nm SiO_2 film yield highest emissive intensity and luminance.

The reason for this results may be in the difference of refractive index (n) of air (n = 1), SiO_2(n = 1.5), and BAM phosphors (n = 1.7) around 254 nm, resulting in the lower reflectivity on the phosphor surfaces and thence leading to an effective excitation of phosphors.

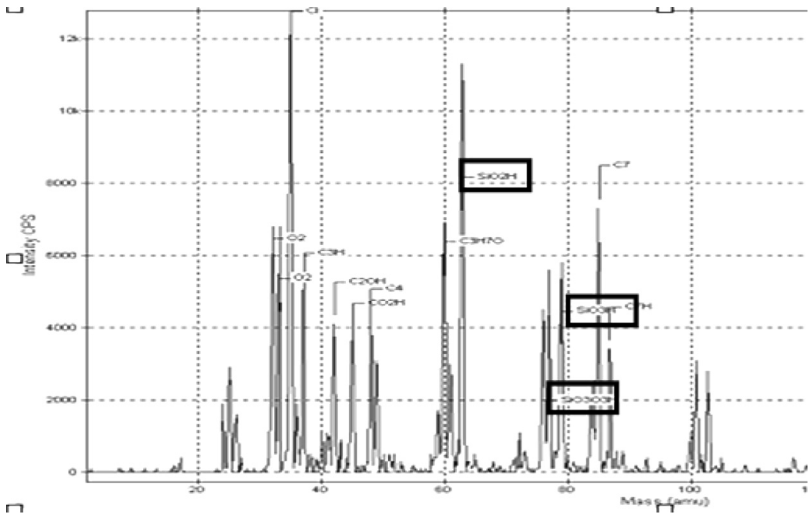


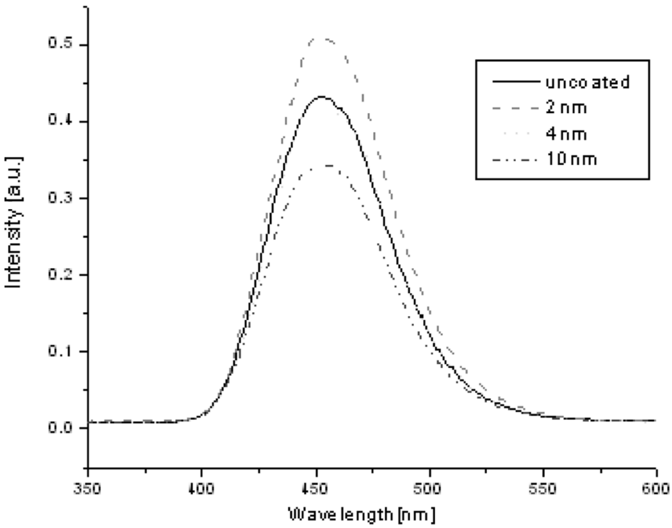
FIGURE 2 SIMS quantitative analysis of 2 nm SiO_2 film on BAM phosphors.

Figure 5 shows that the reflectivity of the VUV between air and BAM phosphor is about 0.067 while the total reflectivity of the VUV between air and SiO_2 (0.040) and SiO_2 and BAM phosphors (0.004) sums to 0.044. Therefore, more excitation VUV light could be transmitted into the BAM phosphors because of the SiO_2 coating. And the decrease in luminance seen in thicker SiO_2 films may be explained simply by the interruption of thick SiO_2 film in VUV penetration.

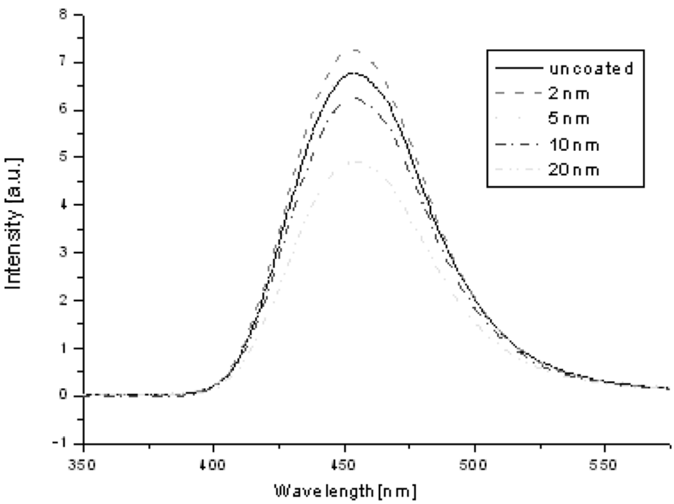
Figure 6 shows the color coordinate according to the thickness of SiO_2 film. We could find that the thickness of SiO_2 film make little influence on the color coordinate.

CONCLUSIONS

BAM phosphors were coated with SiO_2 nano film by using a RF sputtering method and, we investigated their electro-optical characteristics. The optimized thickness of 2 nm SiO_2 film exhibited a maximum of emission spectra and luminance. The reason for the improvement is due to the increase of the effective excitation light transmitted into the BAM phosphors via SiO_2 film. Thus, nanocoated SiO_2 film may be useful for enhancing the luminance.



(a)



(b)

FIGURE 3 (a) Emission spectra of BAM phosphors according to SiO_2 thickness under Xe (3%)-He (97%). (b) Emission spectra of BAM phosphors according to SiO_2 thickness under pure Xe.

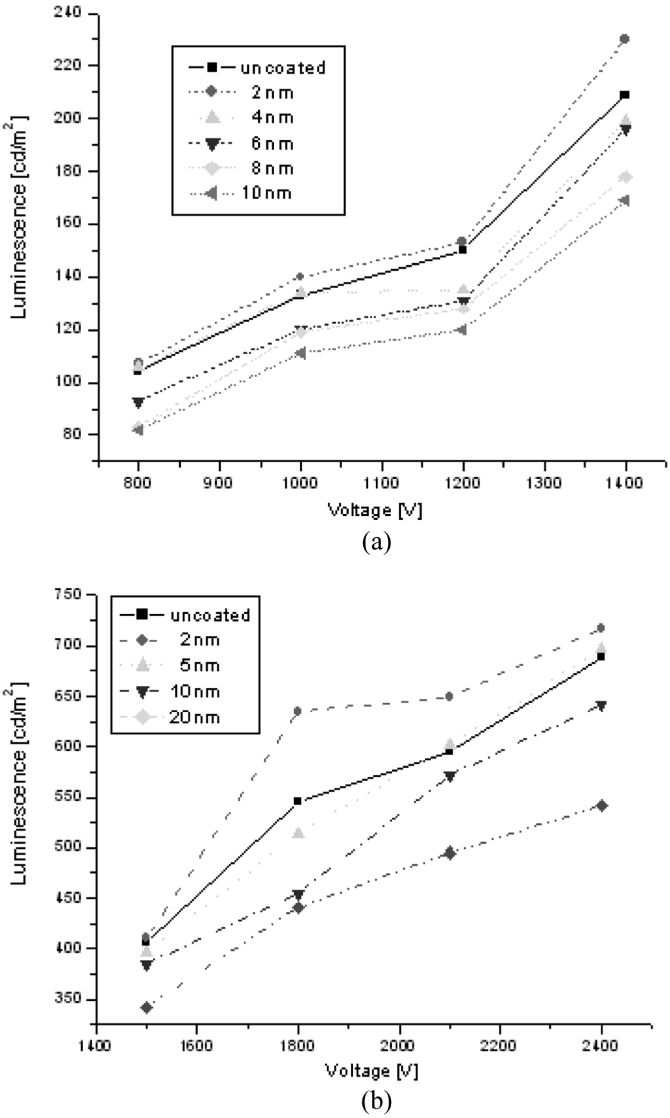


FIGURE 4 (a) Luminance of BAM phosphors according to SiO_2 thickness under Xe (3%)-He (97%). (b) Luminance of BAM phosphors according to SiO_2 thickness under pure Xe.

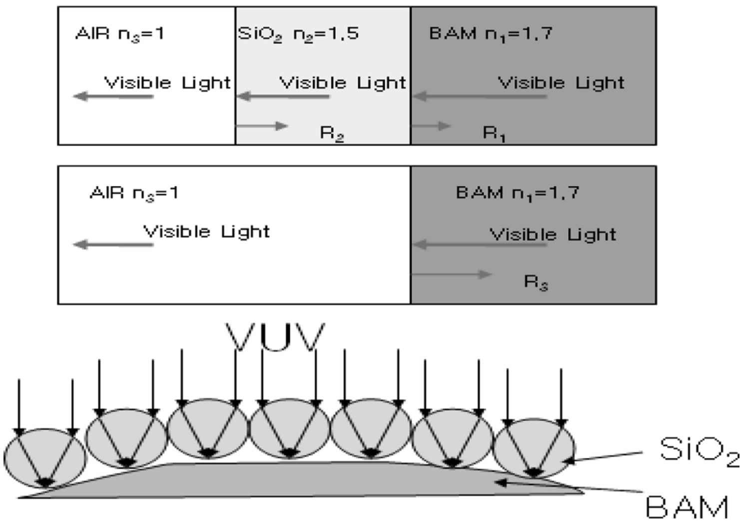


FIGURE 5 Difference of refractive index (n) of air (n = 1), SiO_2 (n = 1.5), and BAM phosphors (n = 1.7) around 254 nm.

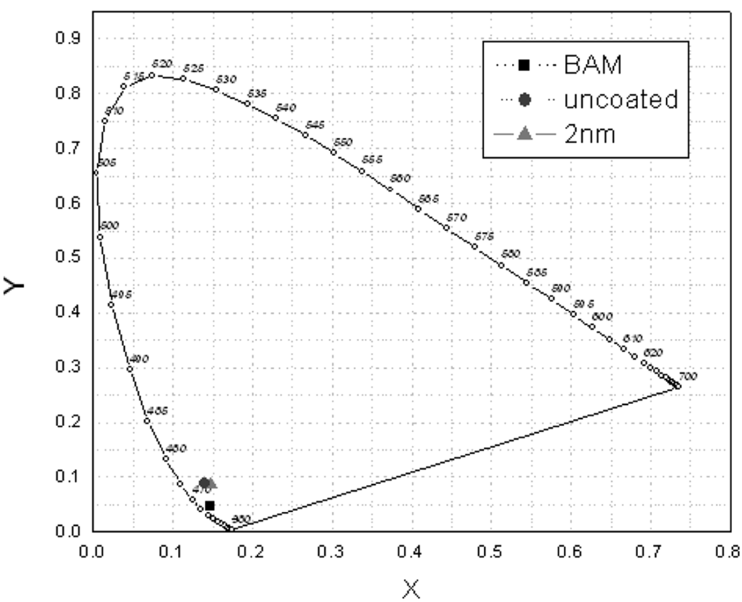


FIGURE 6 Color coordinates of the coated and un-coated BAM phosphors.

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