Improvement in the Contrast Ratio of PDPs in the Bright Room using Pigmented Phosphors with Effective Reflectance

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Abstract

In order to improve the contrast ratio of PDPs in the bright room, we decreased the panel reflection by coating phosphors with pigments. In this work, we investigated the panel reflectance with various sizes of the blue pigments and obtained good results by reducing the size of the pigment properly.

1. Introduction

Luminance and contrast ratio in the bright room are the two most important and fundamental aspects of every display. Unfortunately, these two things have been reported as the weakest points of the plasma display panel. In order to overcome these weaknesses, many researchers have studied methods to achieve higher brightness and lower panel reflectance since the contrast ratio in the bright room depends on these two factors. The most powerful conventional method for improving the contrast ratio is using the front filter located on the PDP front panel. However, this method has some limitations: in order to increase the contrast, which is achieved by lowering the transmittance of the front filter, the brightness is also decreased. Due to this fact, it is nearly impossible to obtain the higher contrast while keeping the same level of brightness intact.

In our previous work, we suggested a new technology which could increase the contrast ratio in the bright room with a minimal loss of luminance. The newly developed contrast enhanced phosphor (CEP) could dramatically decrease the panel reflectance while only slightly sacrificing brightness in exchange. We also compensated for this slight loss of brightness by adjusting the transmittance of the front filter. We applied this technique to a 50" PDP panel, which resulted in an increase of the contrast ratio in the bright room by 15% with almost no change in luminance.

This time, in order to minimize the loss of brightness, we investigated the various pigments, especially the blue pigments. Since the blue phosphor contributes to the panel brightness by only 10%, the blue phosphor coated with the blue pigments can effectively decrease the panel reflectance, resulting in the minimal loss of the panel brightness. In this research, we investigated the panel reflectance with various sizes of the blue pigments and obtained good results by reducing the size of the pigment properly

2. Experimental

In order to investigate the reflectance of the CEP itself, we applied the CEP paste on a bare glass in a pattern of 4" squares by using the screen printing process and firing it at 500℃. Then we measured its reflectance using a spectrophotometer. Fig. 1 shows the schematic diagram of measuring the reflectance of the CEP. The CEP layer with the thickness of 15 ㎛ was exposed to an incident light, varying the wavelength from 380 nm to 780nm. The reflected light from the CEP layer was gathered in the integrating sphere.

The evaluation of the effects of the CEP on the contrast ratio was carried out with a 50" XGA panel. To determine the contrast ratio in the bright room, the white luminance and the black luminance are measured by the CS-1000 under the 100-lux light.

3. Results and discussion

Fig. 2 clearly shows the different effects on reflectance between the different colors of pigments. We set the photoluminescence efficiency of all CEP to the same level by varying the contents of the pigments. However, their reflectance decreased with the different aspects as shown in Figure 3. The green CEP decreased in the reflectance by only 2%, but the red CEP decreased in the reflectance by more than 20%.

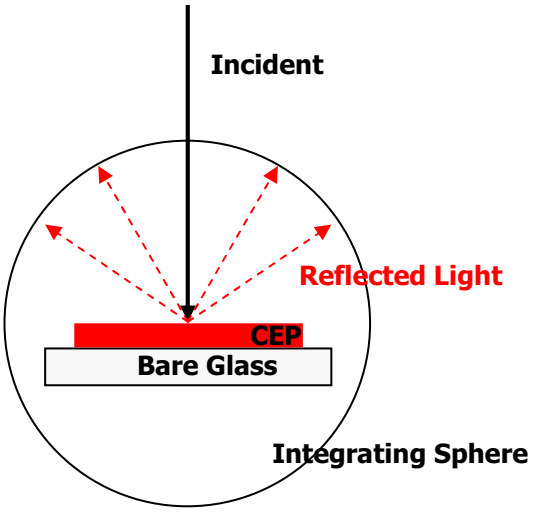


Fig. 1. Schematic diagram of measuring the reflectance of the CEP.

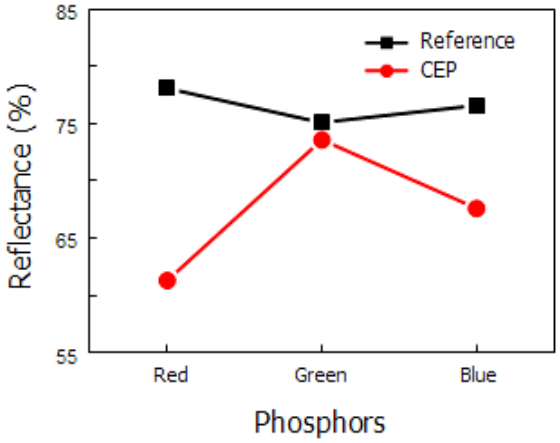


Fig. 2. The reflectance of the phosphors at 550nm. Each CEP has the same photoluminescence efficiency.

As illustrated in Figure 4, each phosphor contributes the same portion to the PDP's reflectance, but it contributes different portions to the PDP's brightness. Green phosphor is the most important emission material for the brightness of the PDPs, taking over 65%. Thus, we did not coat the green phosphor with green pigment, because the green phosphor is the most important material in regards to brightness, while the green pigment is the most ineffective material in lowering the reflectance.

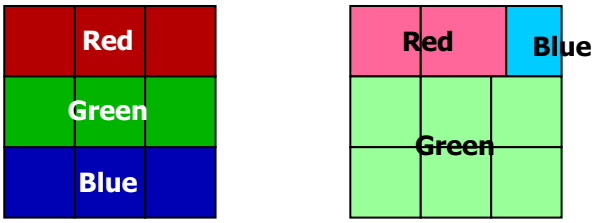
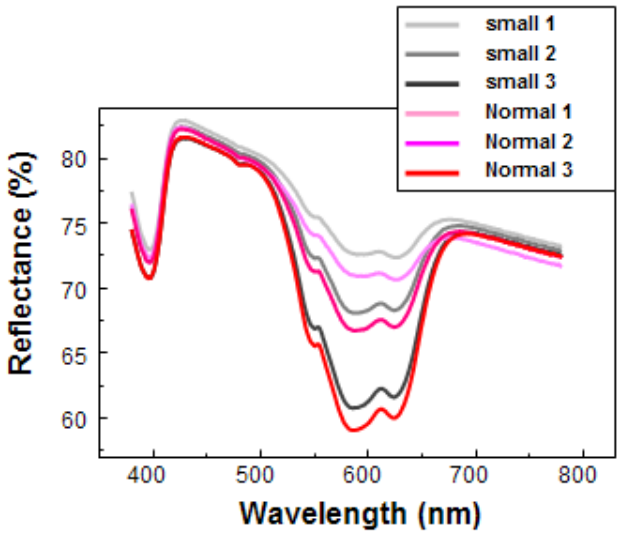


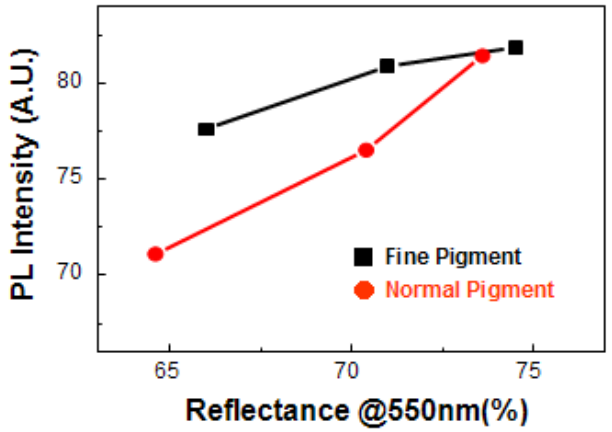
Fig. 3. The schematic illustration of (a) the contribution weight of each phosphor to the reflectance and (b) the contribution weight of each phosphor to the luminance for PDPs.

In order to minimize the loss of brightness, we investigated the various pigments, especially blue pigments. Since the blue phosphor contributes to the panel brightness by only 10%, the blue phosphor coated with the blue pigments can effectively decrease the panel reflectance, resulting in the minimal loss of the panel brightness. In our investigation, we examined the panel reflectance with various sizes of the blue pigments and obtained good results by reducing the size of the pigment properly. As shown in figure 6 (a), the blue CEP with the small blue pigment shows lower reflectance than the blue CEP with the large blue pigment, although their contents of pigments are the same. Figure 6 (b) shows their photoluminescence efficiency with their reflectance. As a result, with the pigment with small size CEP can decrease more effectively the panel reflectance with much lower expense of brightness.



(a)

Fig. 4. (a) The reflectance of blue CEP with different size pigments and contents.



(b)

Fig. 4. (b) The reflectance of blue CEP with different size pigments and contents

4. Summary

Conventional methods such as the black matrix, front filter, or colored dielectric material can decrease the panel reflectance. However, these methods can not increase the contrast ratio while keeping luminance intact. This is due to the fact that if the transmittance of the front filter is increased to obtain the same brightness, the contrast ratio stays at the same level. CEP can improve the contrast ratio by 15% without any loss of luminance. We obtained the results that the pigments on a small size CEP can decrease the panel reflectance more effectively with a much lower expense in brightness.

5. References

1. E.A. Moon, B.W. Jeong, B.J. Bae, J.S. Kim, B.G. Ryu, SID'08 Digest, p186 (2008).
2. S.H. Yoo, T.J. Kweon, H.K, Kwon, SID'06 Digest, p1217 (2006)).