# Control of Blue Phosphor Layer Cross-section and Its Improved Discharge Characteristics

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## Abstract

*The effects of phosphor properties such as the granular sizes and shape on the crosssectional shape of phosphor layer and plasma discharge characteristics for improving the luminance and luminous efficiency in ac PDP have been investigated. As the granular size decreases, the thickness of vertical side of barrier rib in blue cell decreases, and wheras the thickness of bottom side increases due to increased dispersibility. In addition, the phosphor with round granular shape showing good dispersibility shows better voltage margin and higher luminous efficiency due to their improved discharge volume and packing density.*

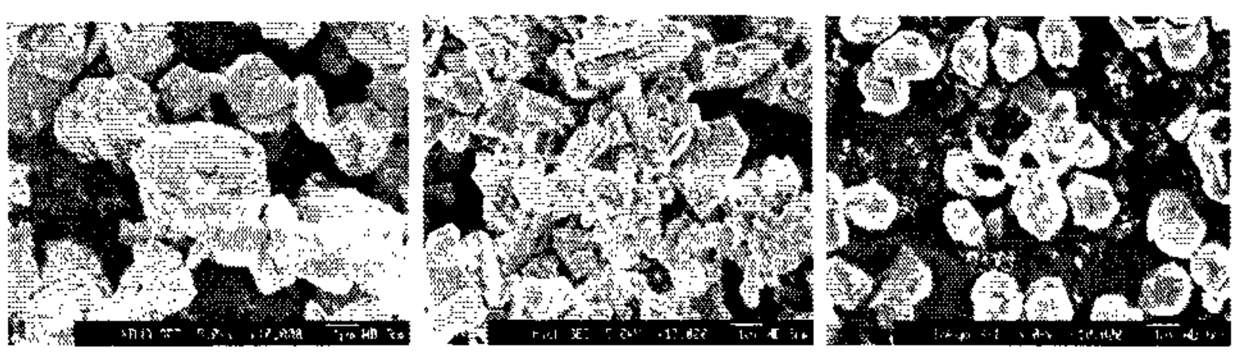
## 1. Introduction

PDP(Plasma Display Panels)s are one of the most promising flat panel devices for large area wall-hanging high definition television (HDTVs)[1,2]. However, the luminous efficiency is still one of the major technical issues to be solved in current PDP technology. High luminous efficiency of more than 2lm/W is required if new PDP TVs are to come into widespread use in the near future. Recently, many studies on improving the luminous efficiency such as by using high Xe gas content and new cell structure have been reported[3,4]. In order to give the high luminous efficiency of ac PDP, the depth profile of phosphor layer related the discharge volume should be optimized[5]. In addition, the discharge characteristics are dependent upon the changes in the discharge volume surrounded by the barrier rib and phosphor layer. Most previous research to optimize the depth profile of phopshor layer has been done by controlling the granular content within phosphor paste and phosphor printing process. But there is some limitation to make fine phosphor layer in high definition PDP. Meanwhile, high efficiency phosphor has been being continuously developed by varying the physical properties such as the granular size and the shape for improving the dispersibility of paste suitable for high definiton PDP.

In this work, we examined the effects of phosphor layer formed with various granular size and shape on the luminance and the discharge characteristics of blue cell in ac PDP.

## 2. Experiments

Asymetric 42-inch panels were employed to evaluate the effects of blue phosphor granular on the depth profile of phosphor layer in this work. $BaMgAl_{10}O_{17}:Eu^{2+}$ was used as blue phosphor. Red and Green phosphors were taken as the same one in all panels. Figure 1 shows SEM images of blue phosphor samples with various granular size and shape. Figure 1(a) and (b) have same hexagonal phase with different granular sizes, whereas Figure 1(c) shows a round shape for improving the granular dispersibility within phosphor paste. ICP-AES(Inductively Coupled Pasma-Atomic Emission Spectrometer) was employed to investigate the combination ratio of phosphor samples. The europium content of blue phosphor is found to have the similar intensity(about 2wt%) at 381.960nm peak, based 10ppm europium as the standard. It reflects that the samples are only different from granular size and shape with each other.



(a) 3.5μm (b) 2.0μm (c) 3.5μm

Figure 1. SEM images of blue phosphor with various granular sizes and shape.

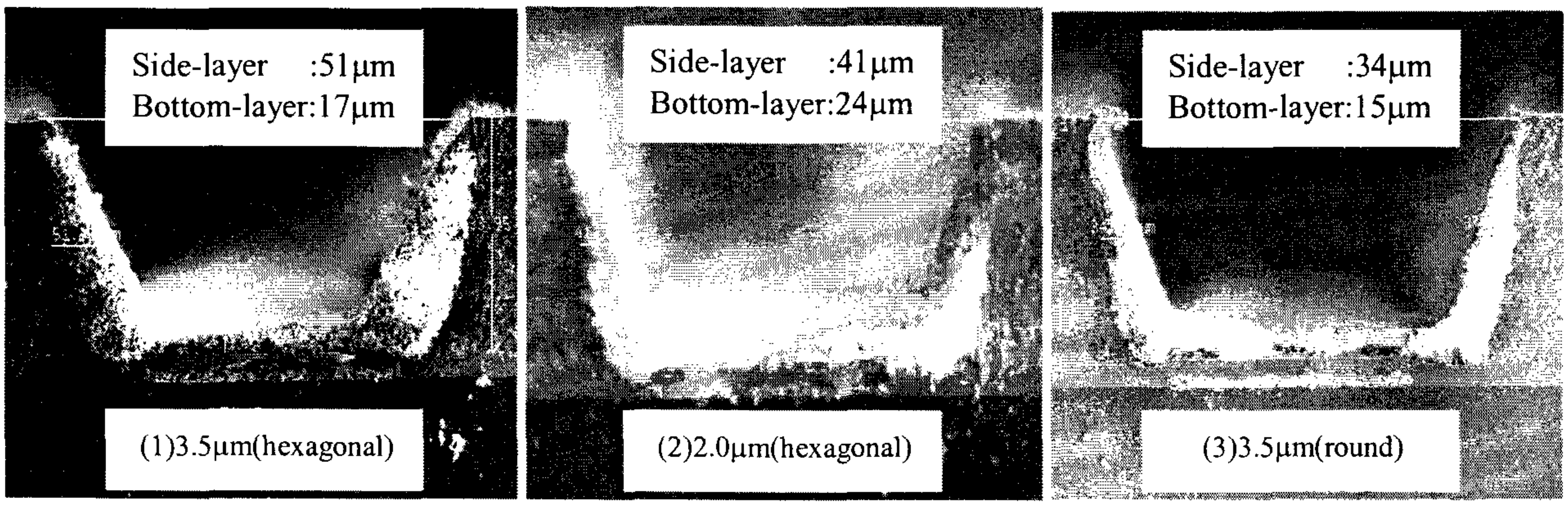



Figure 2. SEM images of blue cells formed with various phosphor granular.

## 3. Results and Discussion

The color temperature of PDP is usually low because of the blue phosphor's relatively weak emission in comparison with those of red and green for the TV set requirement[6]. In order to meet the requirements of light color temperature, the techniques such as the asymmetric cell design with larger blue cell is used for a given subpixel. Therefore, the crosssectional shape of blue phosphor layer may affect the discharge characteristics of ac PDP because it determines the discharge volume[7]. The thickness of phosphor layer is defined as the side-layer thickness at the half height of barrier rib and the bottom-one, respectively. The rib height is formed in the range of 130±10μm which is used in the real PDP. SEM images of crosssection of phosphor layer for blue cell formed with various phosphor granular sizes and shape for 42-inch PDP are shown in Fig. 2. The discharge volume increases with an decrease in the granular size, and also increases due to an decrease in the thickness of phosphor layer formed with the round granular type having the same size. Figure 3 shows the thickness change of the phosphor layer formed with various particle sizes. As the granular size increases, the phosphor thickness of side-layer of blue cell in barrier ribs increases and whereas the thickness of bottom-layer decreases due to better dispersibility of phosphor granular within their paste. Luminance and discharge characteristics of PDP panels with various depth profile of phosphor layer have been examined. Figure 4 shows blue luminance as a function of the side-thickness of blue phosphor cell formed with various granular sizes. Because the europium content as a phosphor activator for the generation of visible-light are same with each other from ICP-AES measurement, the luminance is thought to increase due to the improved surface area of phosphor layer. The discharge characteristics of 42-inch ac PDP having various depth profile of blue cell was measured with conventional discharge condition filled with Ne-Xe(5%) gas mixture under the pressure of 450torr.

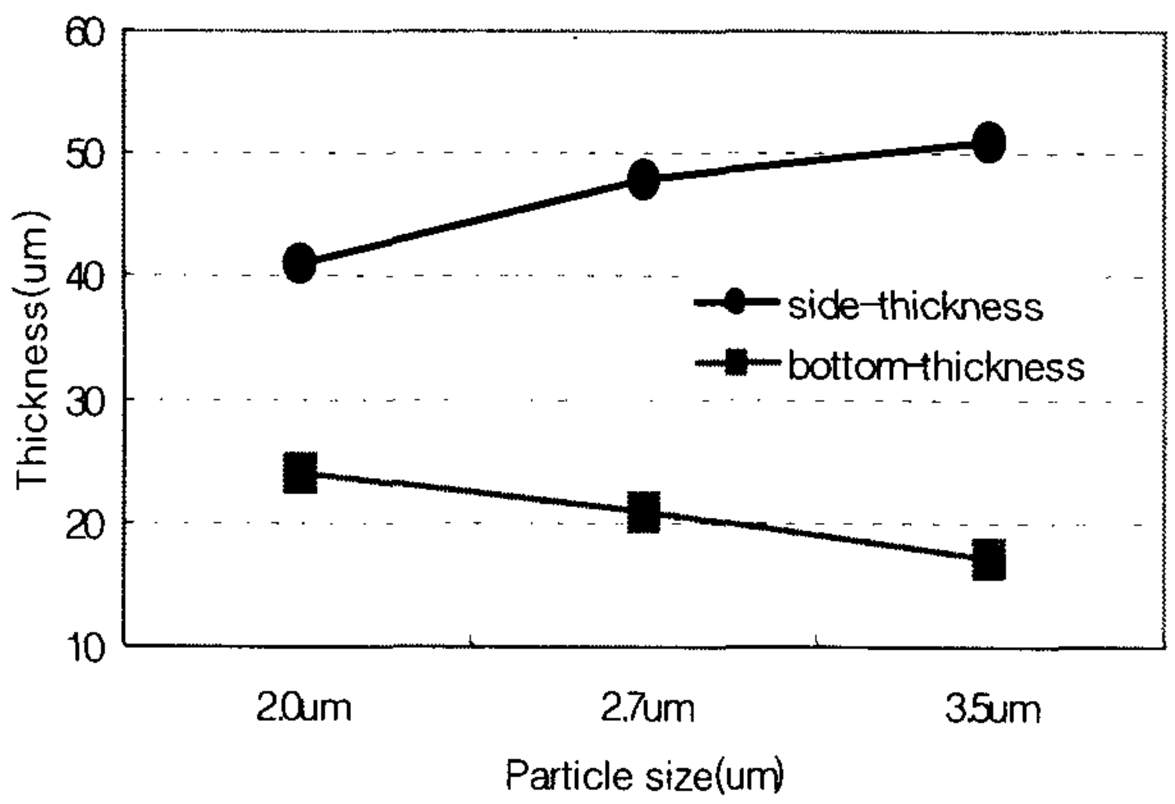



Figure 3. Thickness of phosphor layer as a function of particle sizes.

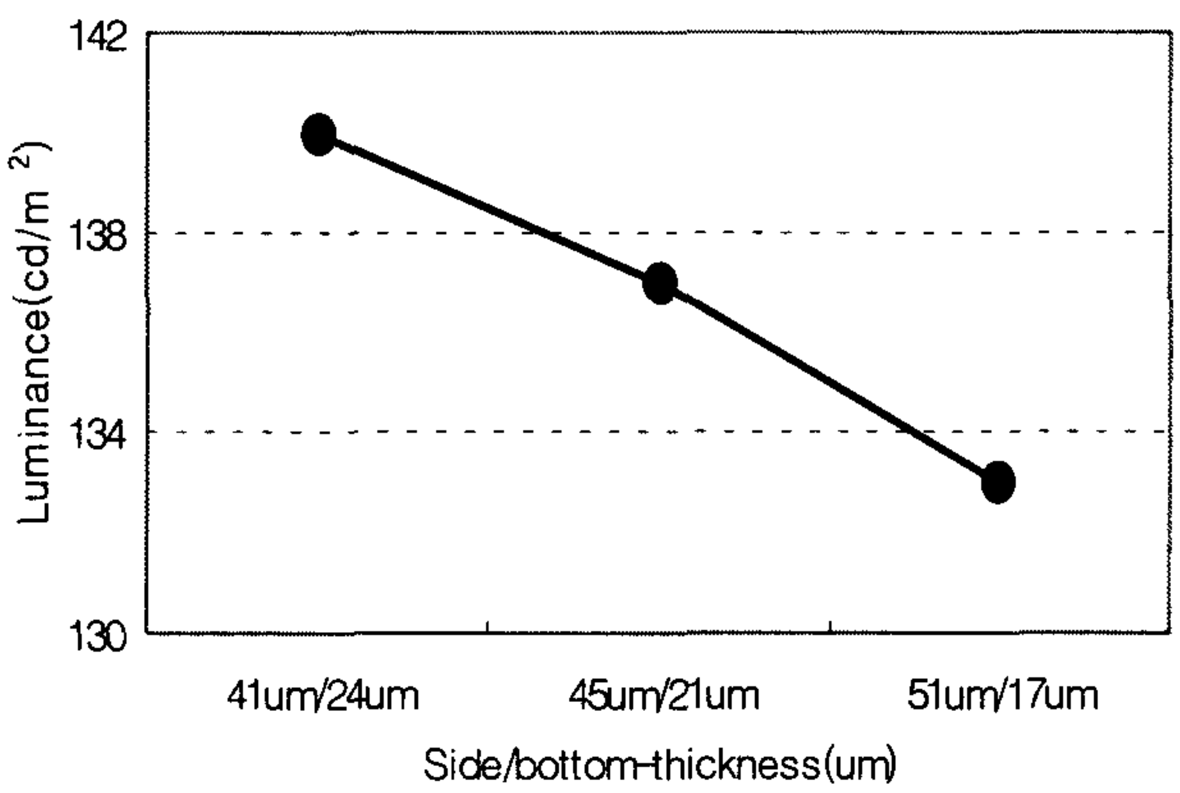



Figure 4. Luminance as a function of side-thickness of phosphor layer formed with various granular sizes.

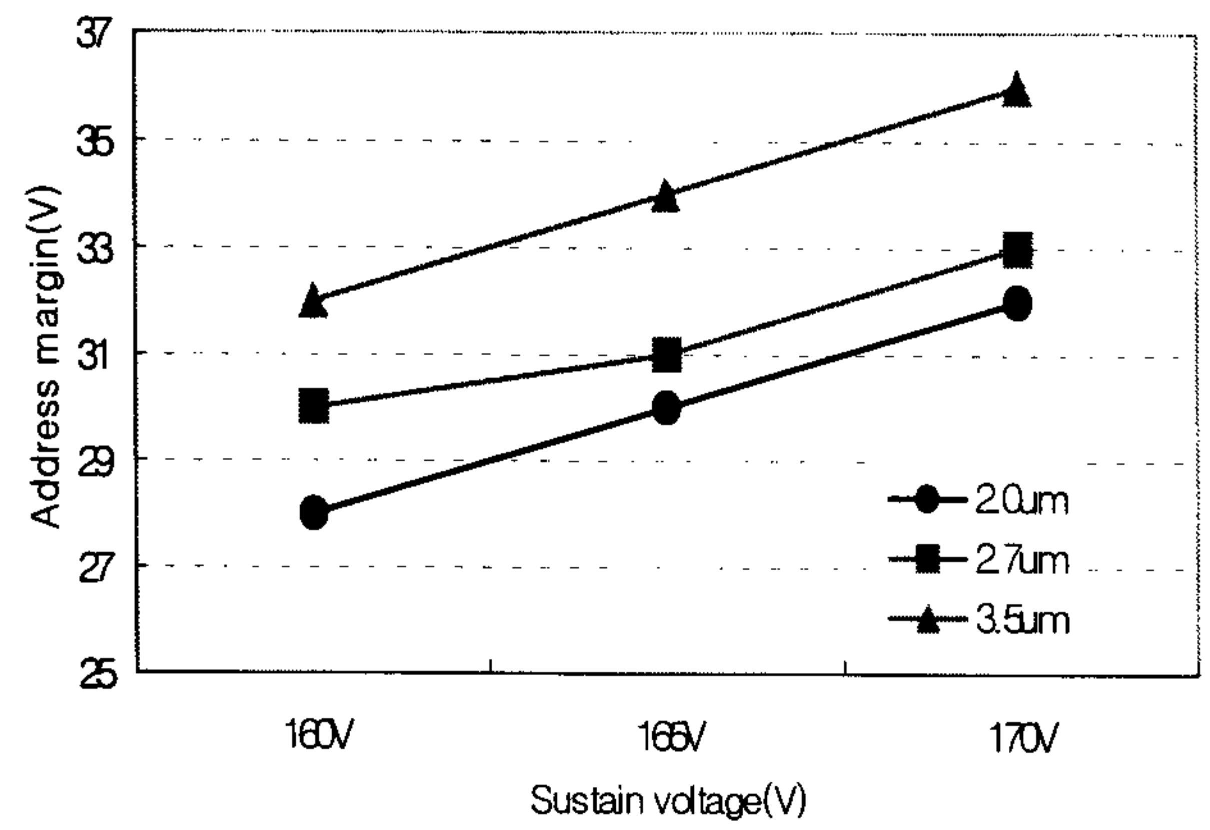



Figure 5. Change of address margin for blue cells with various granular sizes.

The sustain voltage is varied from 160V to 180V with a ramp setting waveform. Figure 5 shows the change of the address margin between the address electrode and the sustain electrode, measured from 42-inch ac PDP panel with blue cell formed with various granular sizes. As shown in the SEM images of Fig. 3, as the granular size is small, the bottom-thickness of the phosphor layer increases, which results in the decrease of the address voltage. The address voltage is thought to be dependent upon the bottom-thickness of phosphor layer. Figure 6 shows luminance maintenance as a function of accelerated discharge time(six times over the regular lifetime of PDP panel) for PDP panel formed with various phosphor granular types. The initial luminance of panel is found to increase due to the improved surface area of blue cell formed with smaller granular size and round shape. The increase of initial luminance may depreciate the luminance maintenance defined as panel lifetime.

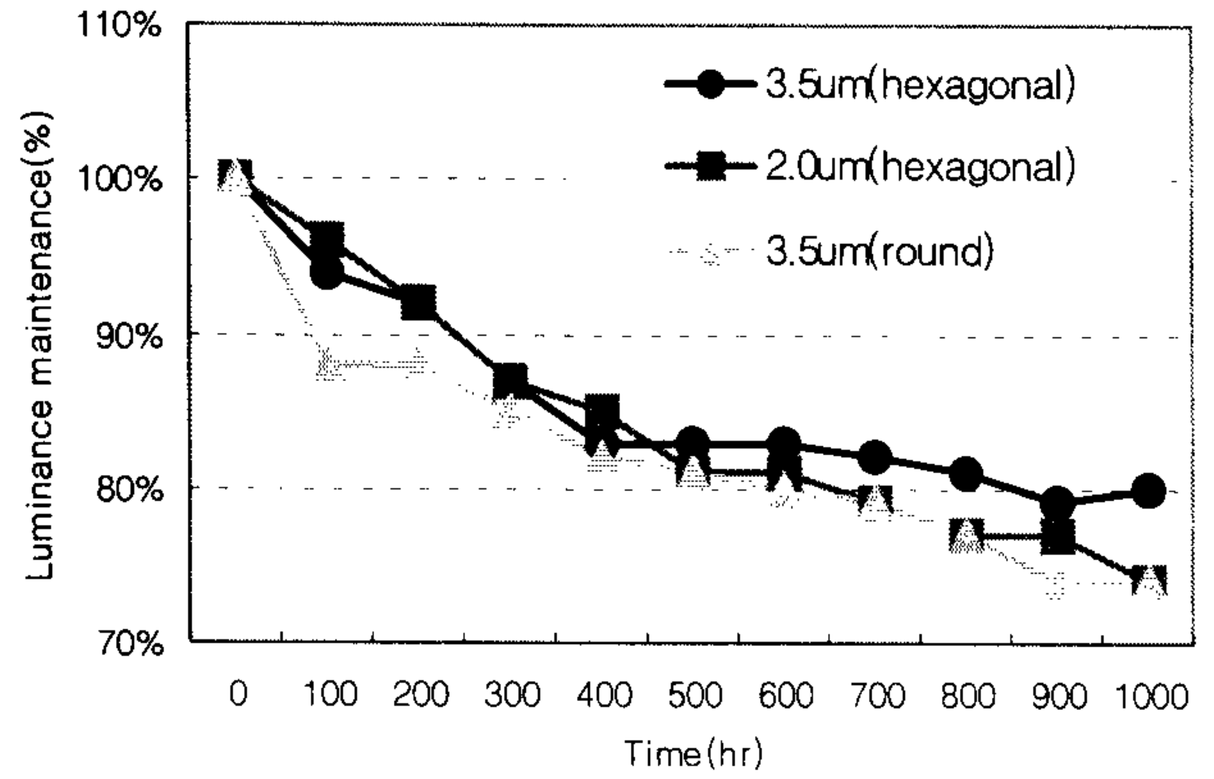



Figure 6. Luminance maintenance as a function of time for PDP panel with various granular sizes.

## 4. Summary

In this paper, the depth profile of blue phosphor layer formed with various granular sizes and shape for the enlargement of the phosphor surface area and discharge gap was examined using a 42-inch ac PDP. The phosphor properties such as the granular size and shape were found to be dependent on the luminance, voltage margin, and panel lifetime. Especially, the optimum phosphor layer profile by controlling the granular sizes would be able to improve the luminance and voltage margin. The effects of phosphor layer profile modification using the round and hexagonal shape phosphor on the discharge charscteristics of high definition PDP will be shown in this presentation.

## 5. References

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