A study on the electrode-structure for the high luminous efficient PDPs

Byoung-Kuk Min, *Jun-Young Yoo, Jung-Hun Kim, Kwang-Yeol Choi, Eun-Ho Yoo*
Myoung-Ho Park
Digital Display Research Lab., LG Electronics, Seoul, Korea

Abstract

We developed three kinds of electrode-structures for high luminance and luminous efficiency. Also, we optimized the mixture gas. Three kinds of 7.5-inch experimental panels having a pixel pitch of 0.864mm were evaluated, and high efficiency of 1.6lm/W was obtained in the panel type2.

1. Introduction

Recently, the demand for high-resolution display is becoming lager and larger, recently. Several companies have released the high-resolution plasma display panels from 42XGA to 63XGA. But the PDPs have some problems such as low luminous efficiency, high cost, poor picture quality up to now. As the resolution of display becomes higher, the problem of the luminous efficiency becomes more serious. It is because the discharge volume is small in the cell of high-resolution display. The small discharge volume causes the large charge loss such as diffusion to the wall. Therefore, the luminous efficiency becomes lower in the higher resolution display. The low luminous efficiency can cause large power consumption and high cost of the driving circuit.

We developed new electrode structures that are suitable for the high resolution PDP with the high luminous efficiency.

2. Experimentals

There are many methods to improve the luminance and luminous efficiency such as the optimization of the gas composition, cell structure, phosphor, and etc. Among these factors, we chose the improvement of the electrode structure and contrived new electrode structures that can generate the long path discharge. Among the many studies of long gap discharge, the lateral volume discharge developed by LG shows the feasibilities of application to manufactures, called 'Lateral Volume Discharge'[1].

But it is difficult to produce the long gap discharge in the range of low voltage. So we would like to make long gap discharge in low voltage level. We added one or more bridge electrodes to the previous LG lateral volume discharge structure. Fig. 1 shows newly devised electrode structures for high luminous efficient PDPs by the long path discharge and LG lateral volume discharge structure. The bridge electrodes are located in the center of the cell. It connects gap electrode and sustain electrode and help the spread of the charged particles from the gap electrode to sustain electrode. The charged particles produced at the gap electrode spread easily to sustain electrode. Along the bridge electrode, the long path discharge between two sustain electrodes can be easily produced than LG lateral volume discharge structure. All electrodes were made of the bus material (Ag) by the electroplating without ITO electrode.

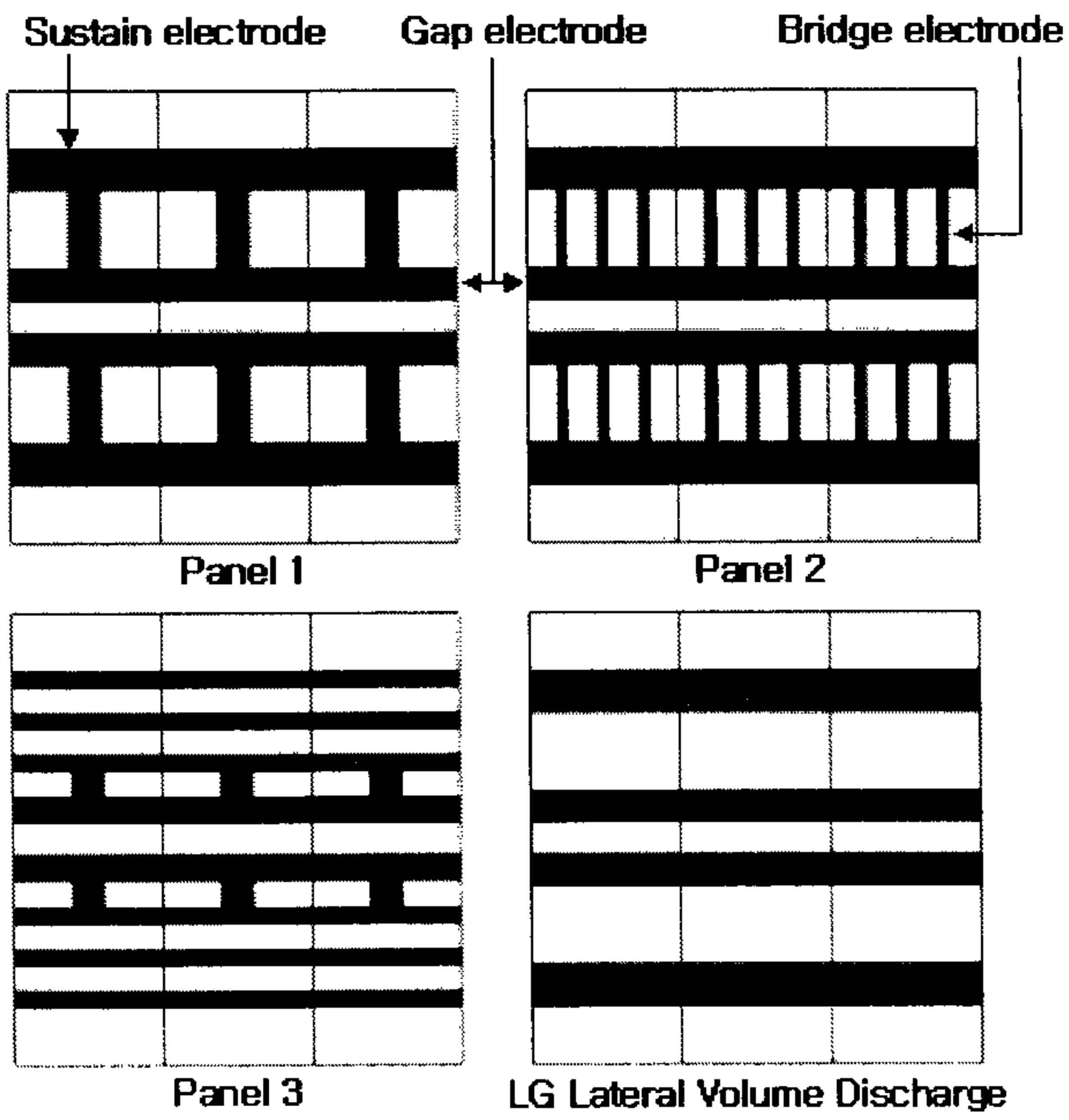


Figure 1. New Electrode Shapes and LG lateral volume discharge structure

The width of the gap electrode is smaller than that of the sustain electrode. In case of using wider gap electrode than sustain electrode, main discharge is very likely to occur not between two sustain electrodes but between two gap electrodes. The test panel specifications are summarized in table 1.

Color cell arrangement	Parallel stripe
Tricolor pitch	0.864mm
Thickness of dielectric layer	42 μm
Width of gap electrode	60 μm
Width of sustain electrode	80 μm
Width of bridge electrode	60 μm

Table 1. Specification of 7.5 in. diagonal test panel

3. Results and Discussions

Figure 2 shows the comparison of characteristics between each electrode-structures. The used gas composition in the test panel is Ne-Xe(7%), 500torr. Though the panel type 3 has the highest value of luminance (465cd/m^2, 270V), the panel type 2 has the highest value of luminous efficiency (1.46lm/W, 270V). In the case of the panel type 1, the charged particles produced at the gap discharge converges at the bridge electrode. So, the discharge between both sustain-electrodes forms narrowly along the bridge electrode. But in the case of panel type 2, the effective electrode area forms around three bridge electrodes, so discharge can generate in the wider area than the case of panel type 1 in spite of same electrode area. Therefore the luminance and luminous efficiency of panel type 2 are larger than those of panel type 1. In the case of panel type 3, luminance is the highest due to the widest effective electrode area including the imaginary electrode area. But because the increase of current surpasses that of luminance, the luminous efficiency is lower than that of panel type 1 or panel type 2.

Figure 3 shows panel the characteristics as a function of various gas compositions at the panel type 2. The open symbols represent the luminous efficiency and the closed symbols represent the luminance of the panel. Three-component gas (He-Ne-Xe) has better characteristics than that of two-component gas (Ne-Xe). The luminous efficiency reaches to 1.6lm/W with three-component gas (He(3)-Ne(7)-Xe(6%)).

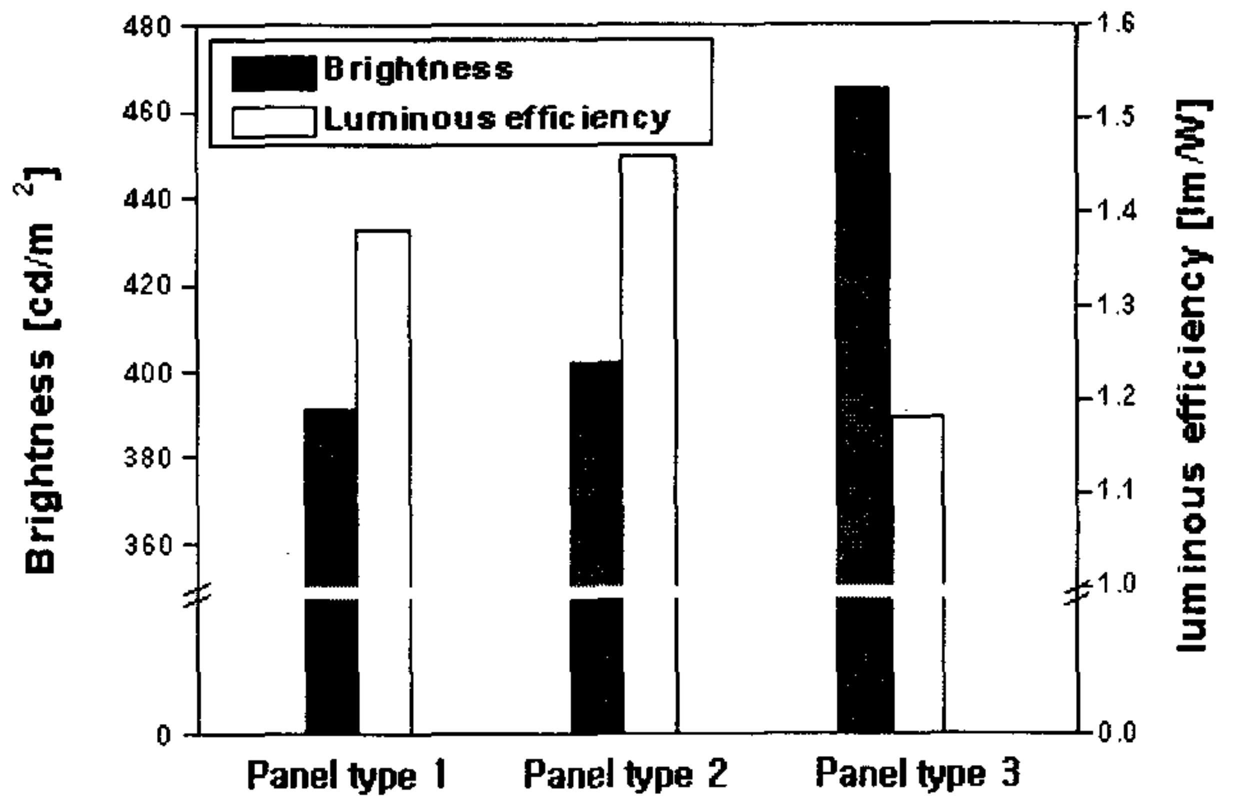


Figure 2. The comparison of characteristics between each electrode structure

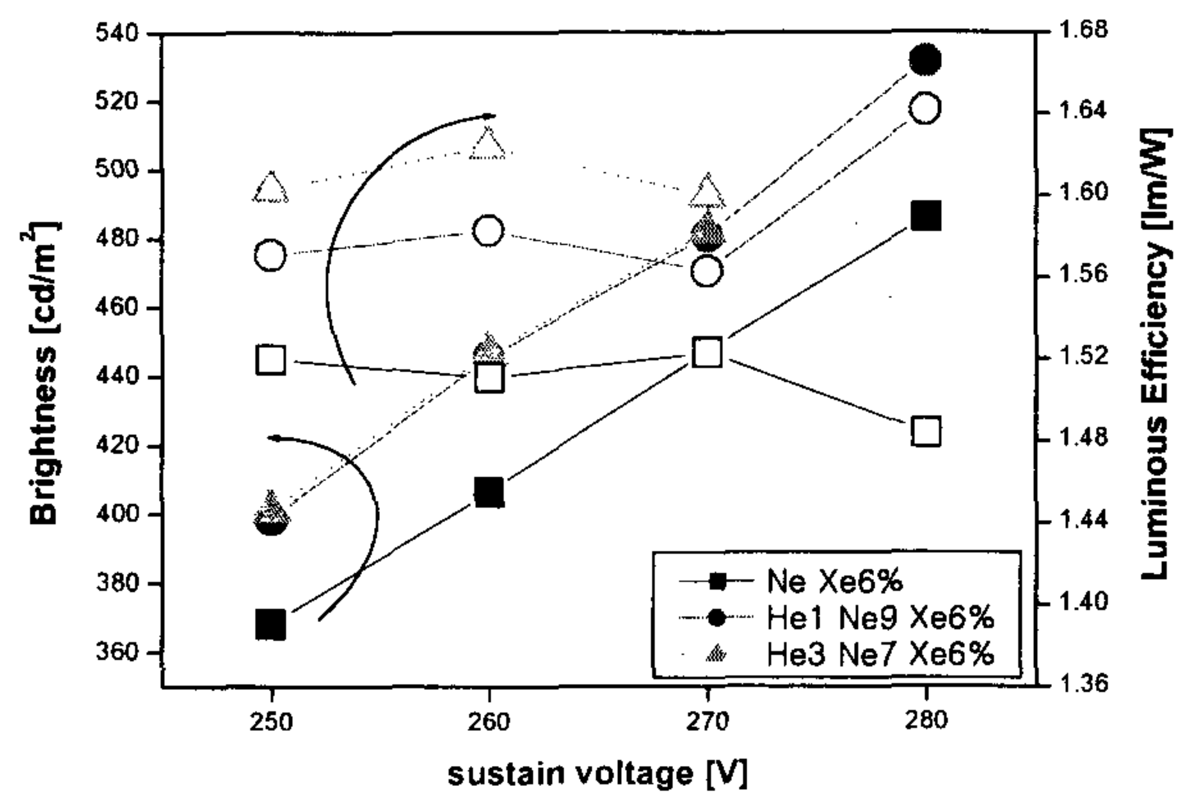


Figure 3. The dependence of luminance and luminous efficiency on sustain voltage with various electrode structures

(Ne-Xe(6%), He(1)-Ne(9)-Xe(6%), He(3)-Ne(7)-Xe(6%))

Figure 4 shows the panel characteristics according to the distance between the bridge electrodes at the panel type 2. The luminous efficiency in the case of 30um distance is larger than that of 20um distance. But the luminance of two panels is same. The reason why the phenomenon occurs is still under the investigation.

Figure 5 shows the comparison of luminous efficiency and dissipated power of panels between the simulation results and the experiment results. The three dimensional code was used in the simulations[3]. As shown in Fig. 5, the simulation results are similar to the experiment results. In the simulation and the experiment, the panels that have the split bridge electrodes have higher luminous efficiency than the panel that has the one bridge electrode. The power consumption of the panels that have the split bridge electrodes is higher. This is because the effective electrode area of panel 2 including imaginary electrode area is larger than that of panel 1, so the discharge current of panel 2 is more than that of panel 1. As the distance between bridge electrodes is wider, the luminous efficiency is higher in panel 2. In the simulation, the power consumption of wider distance between bridges is larger. But in the experiment, the opposite result was obtained. We think that the additional experiment and simulation are needs for this phenomenon.

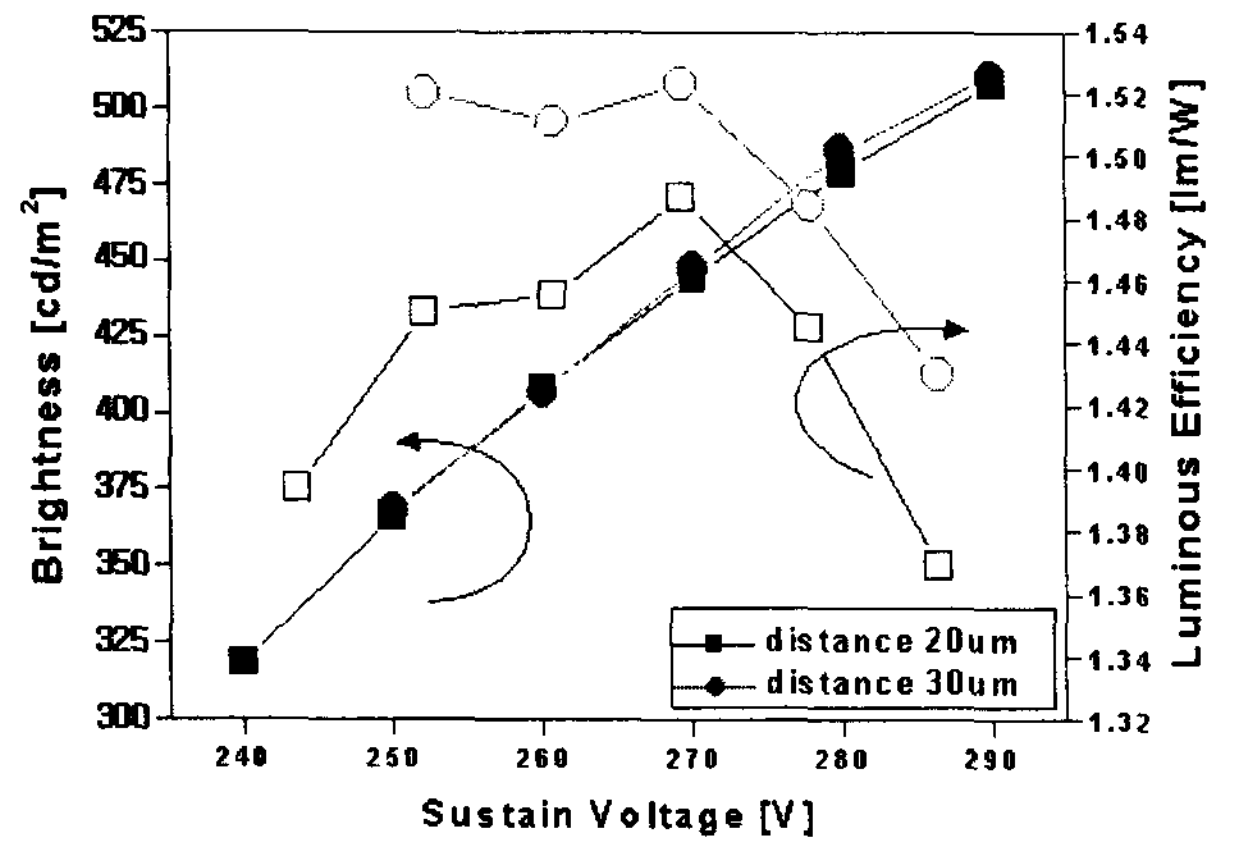


Figure 4. The dependence of luminance and luminous efficiency on sustain voltage with different distance between the bridge electrode

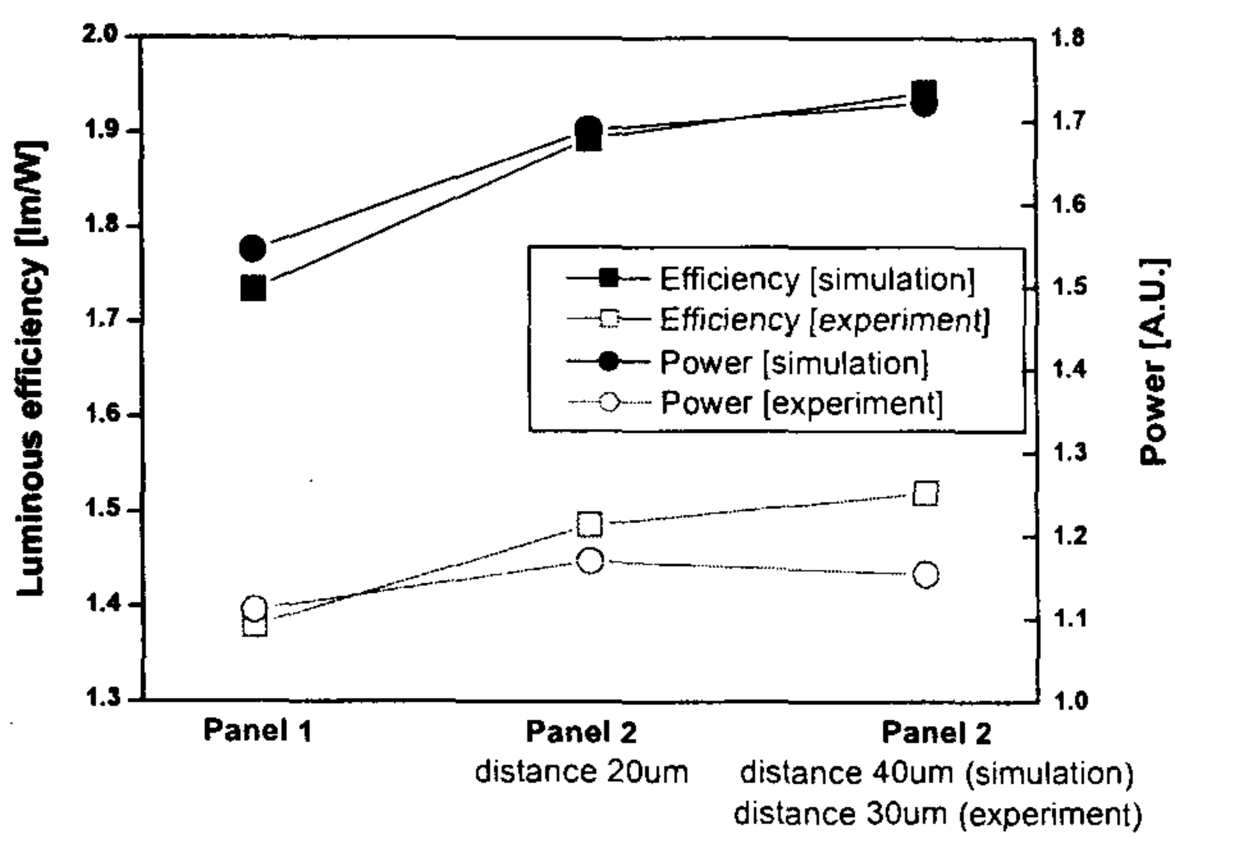


Figure 5. The comparison between the simulation results and the experiment results

Figure 6 shows the results the distributions of IR in red cell and visible light in green cell photographed by ICCD camera. Panel 1 has two distinct discharge modes. The first mode comes out in the low voltage range. In this mode, the discharge is confined between two gap electrodes. The second mode appears in the high voltage range. In this mode, the discharge spreads from gap electrode to sustain electrode. But the only one mode exists in the panel 2.

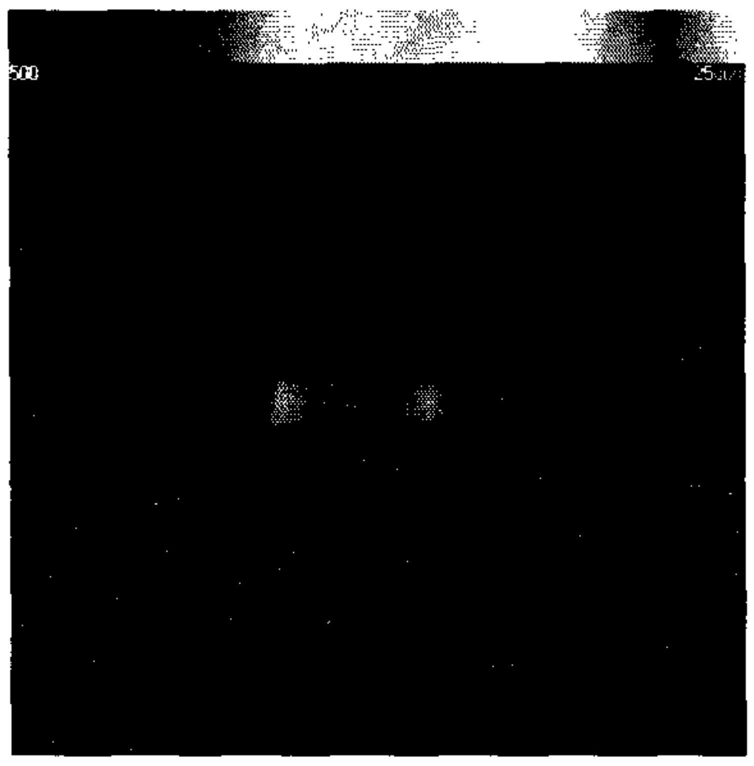
In the case of Panel 1, the distribution of IR converges around the gap electrode, and that of visible light in the green cell converges in the gap of gap electrodes and around ribs that is near to gap electrode. On the other hand, the distributions of IR and visible light are distributed uniformly in the whole cell in the panel 2. Owing to splitting the bridge electrode, discharge forms uniformly in the cell, so long path discharge can form easily between two sustain electrodes and the luminance and luminous efficiency is able to increase.

4. Conclusion

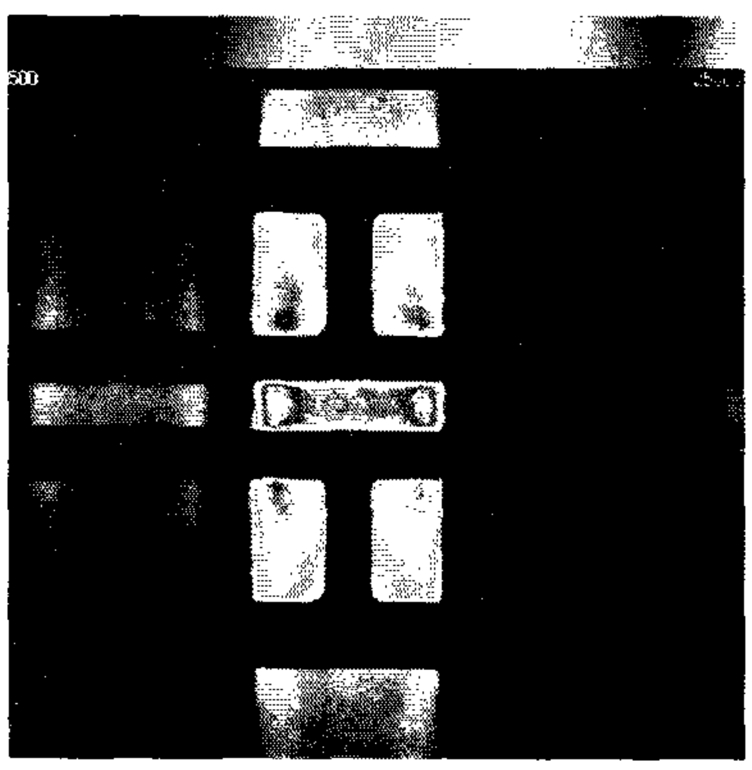
We designed new electrode structures for high luminous efficient AC-PDPs. By means of new electrode structures, we realize the luminous efficiency of 1.6lm/W (He(28.2%)-Ne(65.8%)-Xe(6%), 500torr), especially at the panel type 2. We have also discussed the reason of high luminous efficiency of new electrode structures using ICCD images.

5. Reference

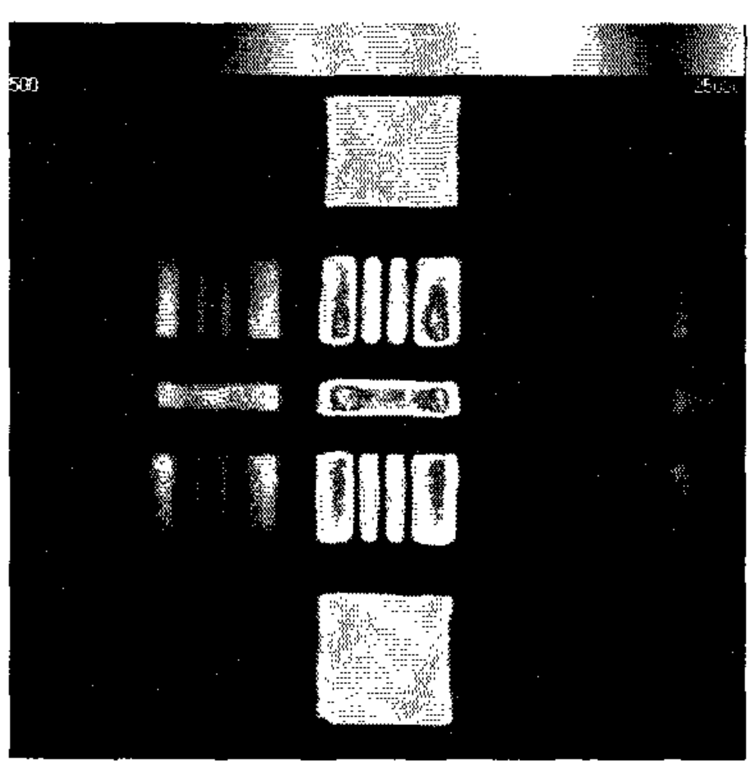
1. Jerry Dean Schemerhorn, etc. SID00 Digest, pp 106~109
2. K.Amemiya, etc. Asia Display 95',pp 965~966
3. H. C. Kim et al., J. Appl. Phys. 91, 9513 (2002)



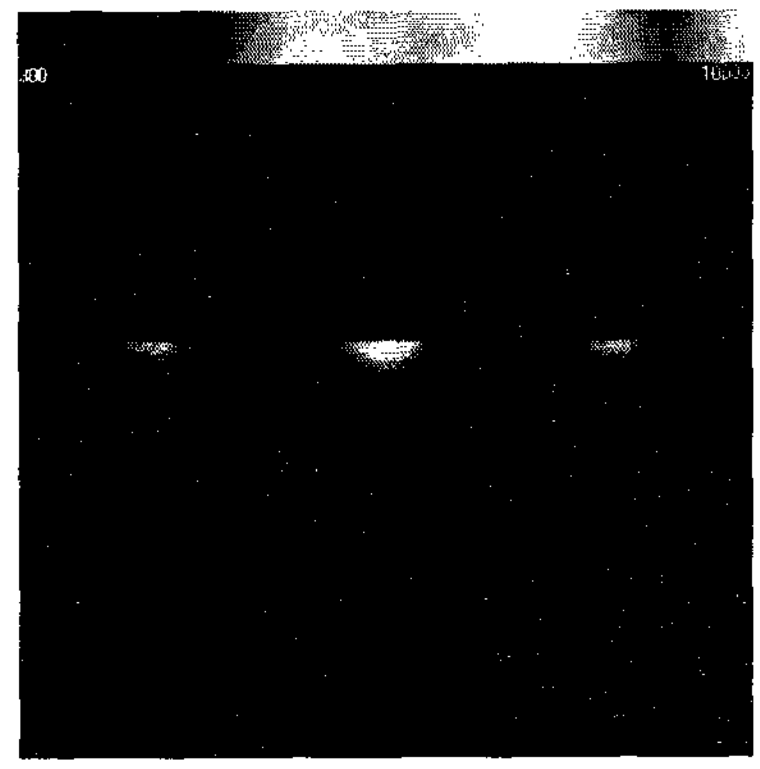
(a) The distribution of visible light in the panel 1
(weak discharge mode in the range of low voltage)



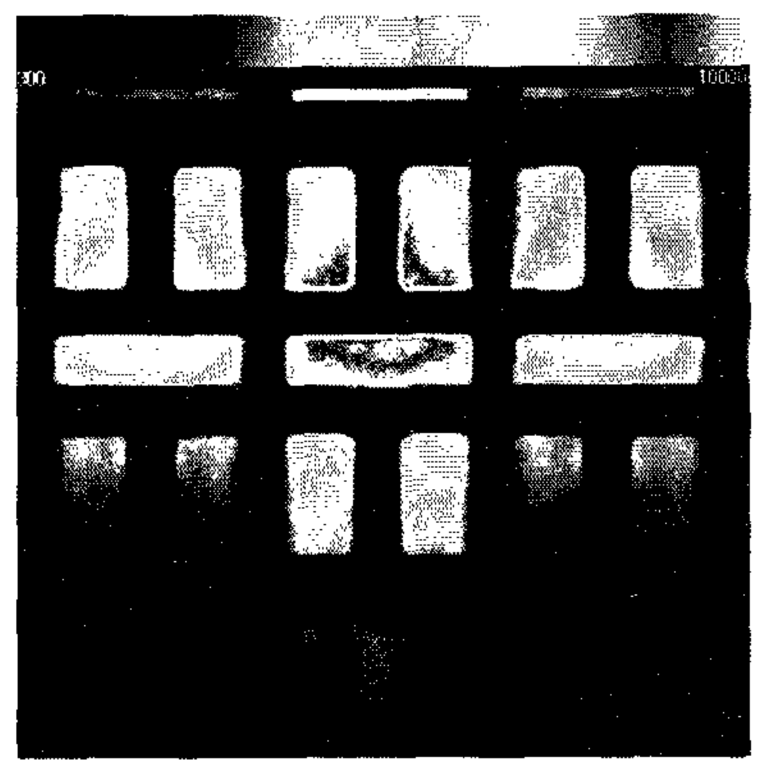
(b) The distribution of visible light in the panel 1
(strong discharge mode in the range of high voltage)



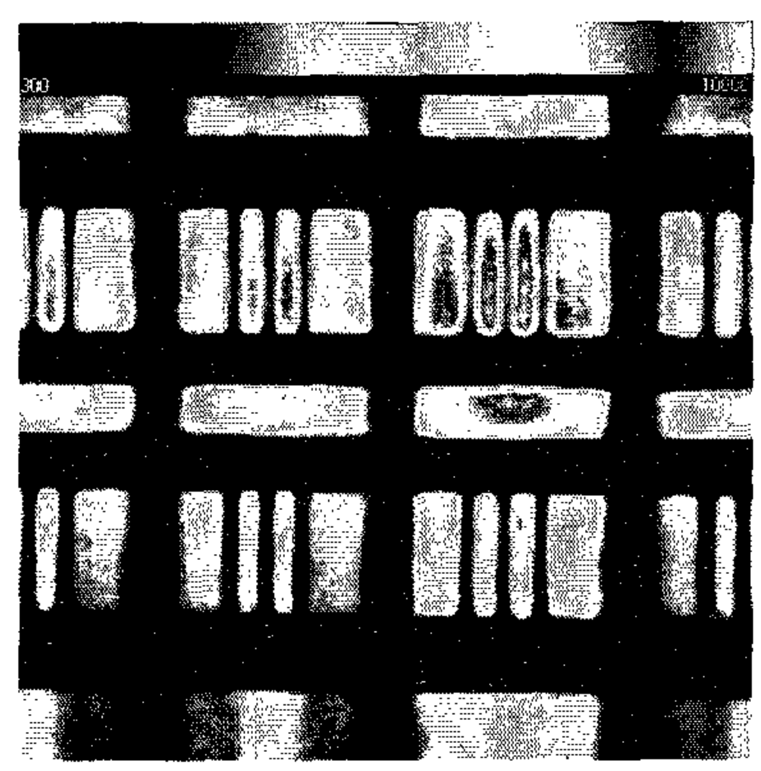
(c) The distribution of visible light in the panel 2



(d) The distribution of IR in the panel 1
(weak discharge mode in the range of low voltage)



(e) The distribution of IR in the panel 1
(strong discharge mode in the range of high voltage)



(f) The distribution of IR in the panel 2

Fig. 6 The distribution of IR and visible light in the panel 1 and panel 2