Recent Improvement of Luminous Efficacy for AC-PDP with Tilted Facing Electrode

Jung-Woo Ok, Deok-Won Kim, Jeong-Hwan Lim, Dong-Hyun Kim, Ho-Jun Lee and Chung-Hoo Park

Dept. of Electrical Engineering, Pusan National University, Busan, Korea

TEL:82-51-510-1544, e-mail: jwok@pusan.ac.kr.

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Abstract

In this study, in order to improve luminous efficacy of AC-PDP, the new facing discharge structure has been suggested. The suggested structure has tilted facing electrode. It shows lower discharge current, higher luminance and luminous efficacy compared with those of reference structure with coplanar electrode structure.

1. Introduction

Recently, FPDs (Flat Panel Displays) have been developed to replace the CRT (Cathode Ray Tube) as technology continued to improve. There are many kinds of FPDs such as LCD (Liquid Crystal Display), OLED (Organic Light Emitting Diode), AC-PDP (AC Plasma Display Panel), FED (Field Emission Display) [1]. Commercial AC-PDP is rapidly growing in the digital TV market as large flat displays all over the world. The advantages of AC-PDP are memory function to realize continuous discharge, strong nonlinearity in on/off operation, long span of life, wide optical viewing angle, easier full colorizing, magnetic resistance, low manufacturing price, heat and cold resistance. However, there are still some problems which are awaiting solutions to improve the performance of PDP technology, such as luminous efficacy, power consumption, contrast ratio, long address time in address display separated (ADS) scheme. Especially, the problem concerned with low luminous efficacy and power consumption should necessarily be solved to lead the digital TV market [2~7].

In this study, in order to improve the luminance and luminous efficacy of AC PDP, the new facing discharge structure has been suggested. In advance, we had reported a new PDP cell structure using facing discharge and having an advantage of low discharge current, high luminance, and high luminous efficacy [8~9]. The suggested structure with facing electrode showed low discharge current, high luminance, luminous efficacy, low plasma surface loss, long discharge time, high excitation efficiency compared with reference structure with coplanar electrode.

2. Experimental setup

Fig. 1 shows schematic drawing of the proposed facing Electrode structure. There is only one layer bus electrode and no transparent ITO electrodes on the front glass. Dielectric layer on the front glass should not be necessarily transparent. Protective layer also should not be necessarily transparent. In proposed structure, bus electrode is tilted shape between ridged dielectric layers. The discharge gap size between electrodes is 250, 300, 350 μm in design. All samples have the same cell pitches. Table 1 shows the specification of the test panel having proposed structure. The thickness of dielectric layer between front glass and bus electrode is 35μm. To prevent breakdown of insulation at discharge, thickness of top dielectric layer is set to 35μm. Total electrode thickness is 70μm.

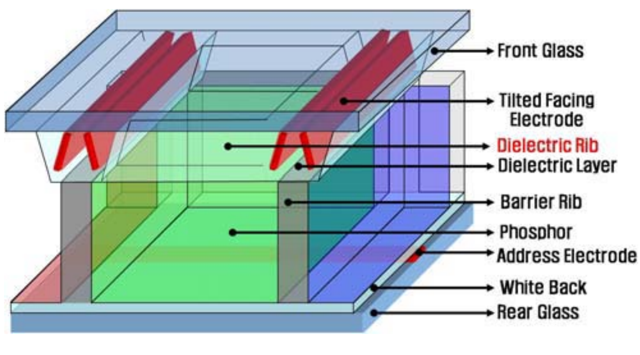

Fig. 1. Schematic drawing of the proposed structure.

The cell size of a sub-pixel is 300×676 μm which is the dimension of one sub-pixel in 42-inch PDP with XGA resolution. The ITO electrode gap of co-planar type used as reference is 60 µm.

Table 1. Specification of test panel

Working Gas : Xe(8%) + Ne, 400Torr			
Front Plate		Rear Plate	
Discharge Gap	250, 300, 350 µm	Address Electrode Width	100 µm
Bus Electrode Width	80 µm	White-Back Thickness	25 µm
Dielectric Thickness	70 µm	Phosphor Thickness	25 µm
MgO Thickness	5000 Å	Rib Width	60 µm

To evaluate effect of dielectric rib on front plate, also, test panels with no dielectric rib which have same discharge gap were fabricated. SEM images of fabricated structures both dielectric rib (Matrix) and no dielectric rib (Stripe) structure are shown in Fig. 2.

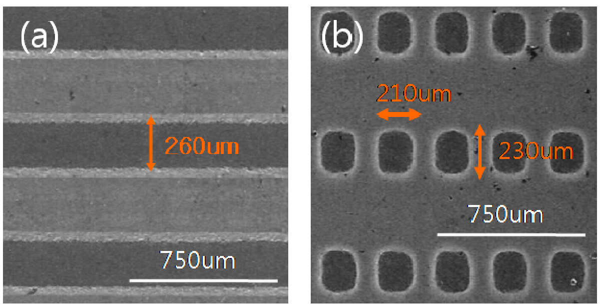

Fig. 2. SEM images of fabricated structures on front plate (a) Stripe type (b) Matrix type.

The Matrix type has reduced discharge area to 77% for one cell than that of the Stripe type, because of dielectric rib and its flow during annealing process.

3. Results and discussion

Fig. 3 shows firing voltage and sustain voltage of reference and proposed structures. In the proposed structure, firing voltage of Matrix type is higher 4% than those of Stripe type but sustain voltage is almost same. All proposed structures have higher firing voltage than reference structure and the larger discharge gap, the higher firing voltage. The luminance characteristic of proposed and reference structure is shown in fig. 4. The more the discharge gap is extended, the higher the luminance increment is obtained in the same structure. In the comparison of Stripe and Matrix type with facing electrode, Matrix type has higher luminance than that of the Stripe type. The luminance of the suggested structure with same type of facing electrode is higher than that of reference structure with coplanar electrode.

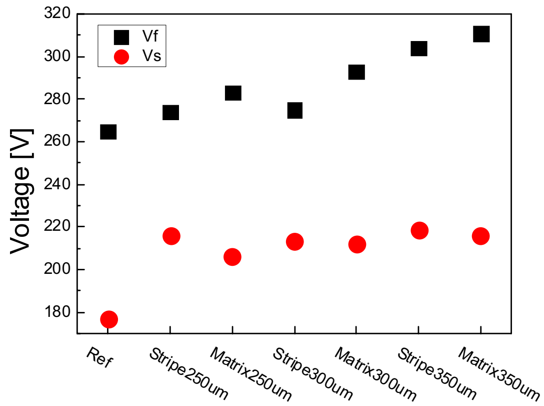

Fig. 3. Discharge voltage characteristic of proposed and reference structure.

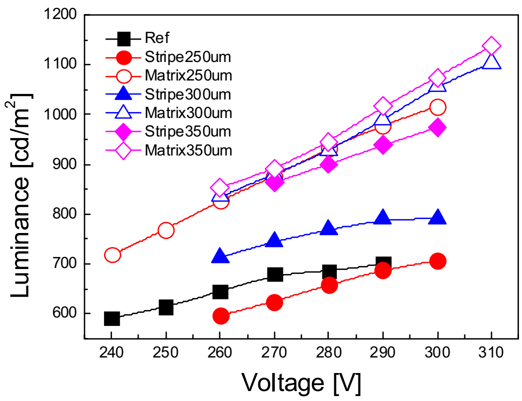

Fig. 4. Luminance characteristic of proposed and reference structure.

Fig. 5 shows that the discharge current on discharge per unit cell. The discharge current for all of the proposed structure is lower than that of reference structure. For the Matrix and Stripe type, decrement of discharge current is about 30% and 50% compared with reference structure at the same voltage (270V), respectively. Decrement ratio of the Matrix type is lower, which is thought to be the smaller discharge area than that of the Stripe type. The luminous efficacy of the proposed structure with increasing sustain voltage in comparison with the reference structure is shown in fig. 6. The luminous efficacy for all of the proposed structure with over 300μm discharge gap was higher 2 times higher than that of the reference structure at 270V. From this result, in spite of the long gap length, the proposed structure shows a high luminous efficacy which is thought to be one of the advantages of facing electrode structure. In spite of reduction of discharge area, luminous efficacy of Matrix type is still high.

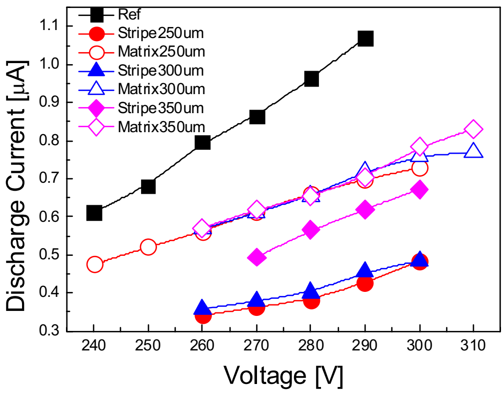

Fig. 5. Discharge current characteristic of proposed and reference structure.

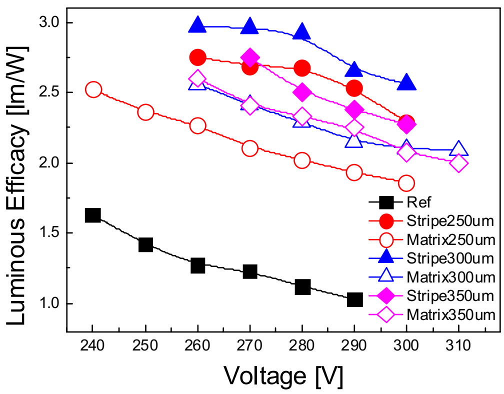

Fig. 6. Luminous efficacy characteristic of proposed and reference structure.

In order to analysis increment of luminous efficacy of proposed structures, optical emission was measured. The spectrum peak of the 703nm, 823nm and 828nm for the reference structure and proposed Matrix types was shown in the fig. 7. By comparison with the intensity of Ne exited state (703nm), intensity of transition of Xe exited state Xe** to meta-stable state is vary large for proposed structure. This implies low field discharge since threshold energy of Ne exited state (18.9eV) is much higher than that of Xe** state (10.3eV),[7] and causes of improvement of luminance. The emission spectrum shows that the proposed structure is operated in low electric field, low electron energy conditions and therefore we can obtain high excitation efficiency

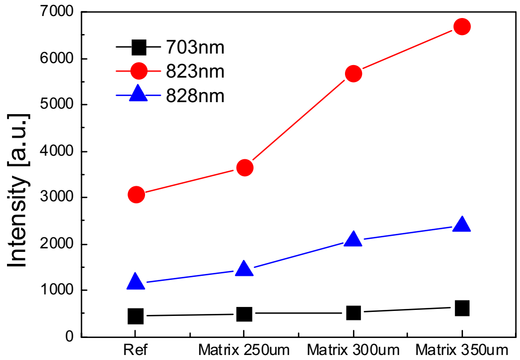

Fig. 7. Optical emission characteristic of reference structure and Matrix types.

Fig. 8 shows ICCD image of reference structure and Matrix type. At the same voltage, discharge start of Matrix type is delayed to 100nsec but discharge duration is longer 120nsec than that of reference structure. This is indication that improvement of both luminance and luminous efficacy.

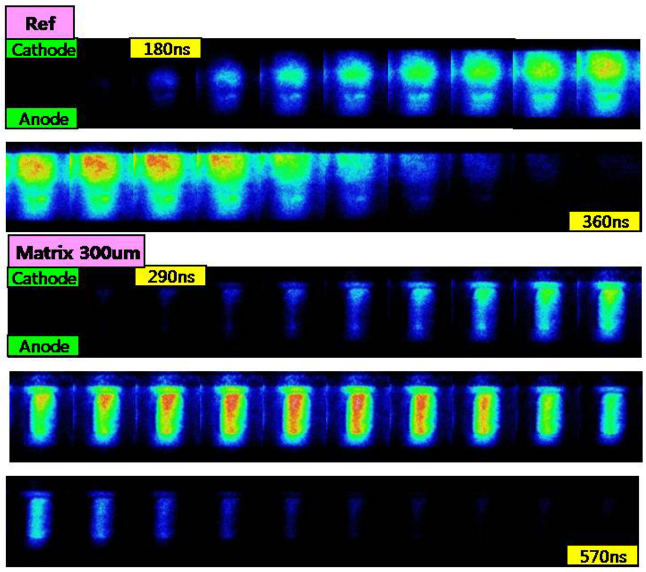

Fig. 8. ICCD image of reference structure and Matrix types.

Fig. 9. shows discharge time in accordance with

discharge gap in both Matrix type and reference structure. Matrix types have longer discharge duration than that of reference structure.

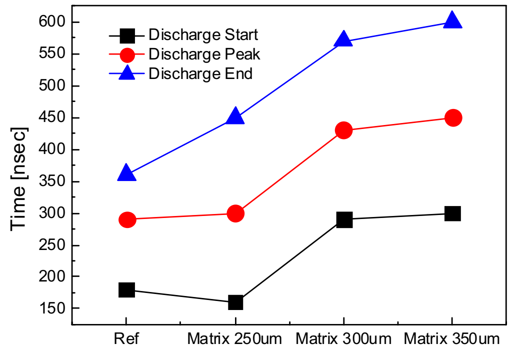

Fig. 9. Discharge time of reference structure and Matrix types.

4. Summary

In this work, as making bus electrode on the front glass leaned, we have proposed a more simplified and practical PDP structure, which have dielectric rib on the front plate and can have more stable discharge characteristics using facing discharge mode. The 4-inch test panel of Stripe and Matrix types was fabricated. The proposed Matrix type showed higher luminance, luminous efficacy, wider voltage margin, and lower electric power consumption than those of the co-planar electrode structure. Through analyzing optical emission and IR image using ICCD, we have known that proposed structure not only can be operated at the low electric field and low plasma loss condition but also has long discharge time. Because of those reasons, proposed structure has enhanced performance.

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