Effect of Auxiliary Address Pulse on Face-to-face Sustain Electrode Structure in AC-PDP

Bo-Sung Kim and Heung-Sik Tae
School of Electrical Engineering and Computer Science, Kyungpook National University, Daegu, Korea
TEL:82-53-950-6563, e-mail: hstae@ee.knu.ac.kr.

Keywords : cell structure, long discharge path, auxiliary address pulse

Abstract

The discharge characteristics of the face-to-face sustain electrode structure employing auxiliary address pulse are investigated under a sustain driving frequency of 20 kHz and various auxiliary address pulse widths (500 ns, 1μs, 2 μs) in the 6-in. test panel (42-in. Full HD grade) with a pressure of 450 Torr and a 4 % Xe-content. The luminance and the luminous efficiency at the auxiliary address pulse width of 500 ns are improved more than these of 1 μs and 2 μs. At the auxiliary address pulse width of 500 ns, the luminous efficiency shows about 0.96 lm/W at the auxiliary pulse of 90 V and the sustain voltage of 260 V.

1. Introduction

It is well known that a long discharge path improves the luminous efficiency in the AC-PDPs [1], [2]. For that reason, many researches, such as cell structures of the large sustain gap and a development of a driving scheme for long discharge path, have been carried out intensively [3], [4]. The surface discharge-type coplanar structure employed in the current PDP structure with three electrodes has difficulty in the improvement of luminous efficiency due to the limitation of sustain gap distance, if the cell size is reduced further. However, the face-to-face sustain electrode structure has advantage to guarantee the large sustain gap in the small cell size due to the sustain electrodes in the barrier-ribs. The face-to-face sustain electrode structure shows a high luminous efficiency due to the large gap discharge distance and the improvement of the transmittance [5], [6]. Nonetheless, the discharge characteristics of face-to-face sustain electrode structures are still needed to understand the physical phenomenon of the face-to-face discharge. In addition, width and the amplitude of the auxiliary address pulse are very important

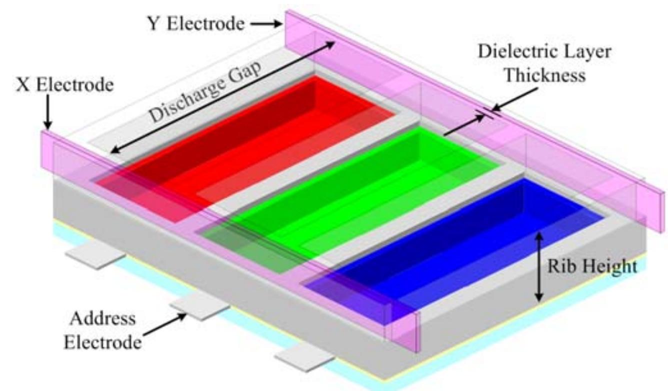


Fig. 1 Schematic diagram of the face-to-face structure

parameters in the large sustain gap. In this study, the effects of auxiliary address pulse on the discharge characteristics of face-to-face sustain electrode structure are investigated.

2. Experimental

Fig. 1 shows the schematic diagram of a single pixel in the proposed face-to-face sustain electrode structure employed in this study, and their detailed specifications are listed in Table 1.

Table. 1 Comparison of specifications proposed face-to-face sustain electrode structure

	Face-to-face sustain electrode structure
Discharge Gap	300 μm
Barrier-rib Width	70 μm
Barrier-rib Height	120 μm
Dielectric Layer Thickness	40 μm
Cell Pitch	480 X 160 μm
Gas Composition	Ne-Xe (4%), 450 Torr

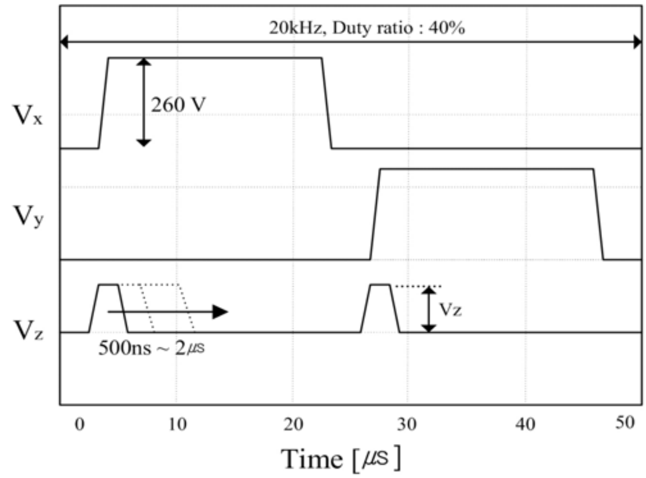


Fig. 2 Driving waveforms employed in current study

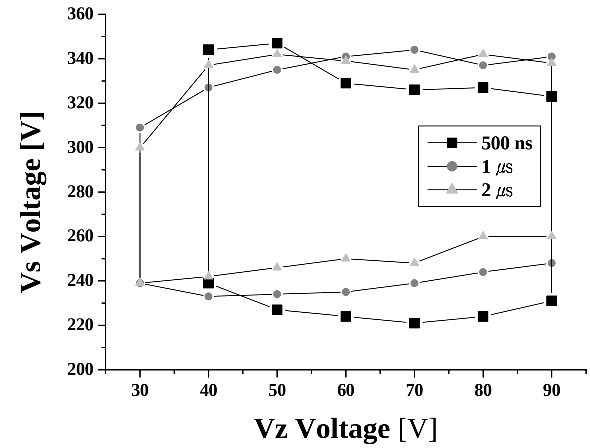


Fig. 3 Changes in the sustainable voltage region

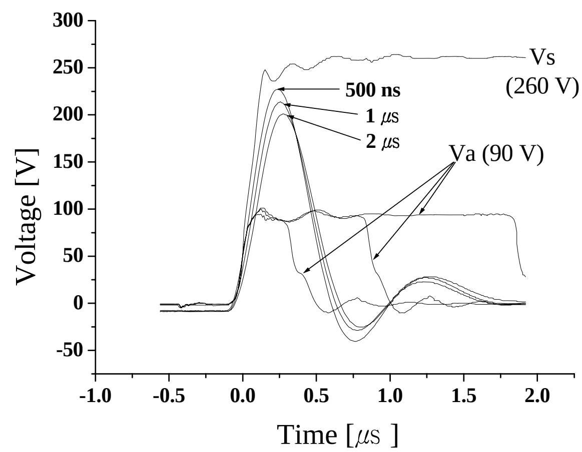


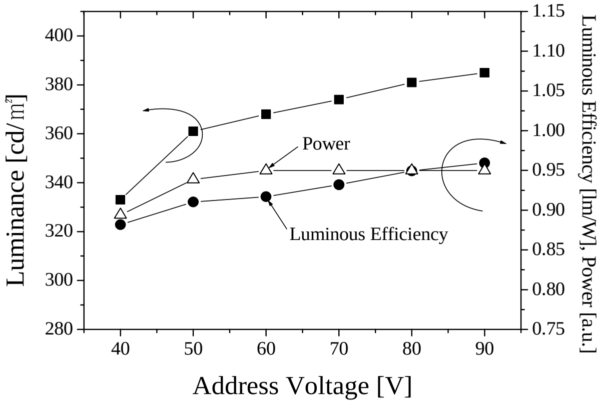
Fig. 4 Changes in IR intensity under various address pulse widths

As shown in Table 1, the vertical and horizontal cell pitches for a single subpixel are 480 and 160 μm, respectively. The width of the barrier-rib is 70 μm and the distance between the discharge gap is 300 μm. The height of the barrier-rib is 120 μm and the thickness of the dielectric layer is 40 μm. An MgO protective layer with a thickness of 0.7 μm is then deposited on the dielectric layer. The gas mixture of Ne-Xe (4 %) is filled under the pressure of 450 Torr. In general, the coplanar sustain electrodes consist of the opaque bus electrode made from the Ag paste and the transparent ITO (Indium Tin Oxide) sustain electrodes. Whereas, for the face-to-face sustain electrode, only the opaque sustain electrodes made from the Ag paste are immersed within the barrier-ribs with fine grooves fabricated by the sandblasting method, as shown in Fig. 1.

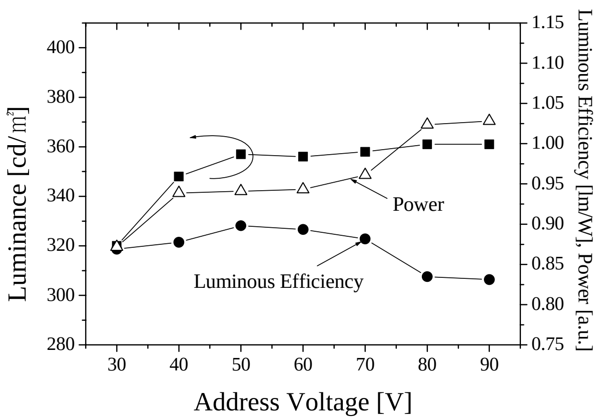
Fig. 2 shows the voltage waveforms Vx and Vy in the case of applying the auxiliary address pulse Vz to the address electrode (Z) during sustain-periods. The amplitudes of the sustain pulses applied to the two sustain electrodes, Vx and Vy, are 260 V. Vx and Vy with a duty ratio of 40 % are applied at the frequency of 20 kHz. The amplitudes of address pulse, Vz are varied at the intervals of 10 V from 30 V to 90 V, and applied auxiliary pulse width of 500 ns, 1 μs and 2 μs, respectively.

3. Results and discussion

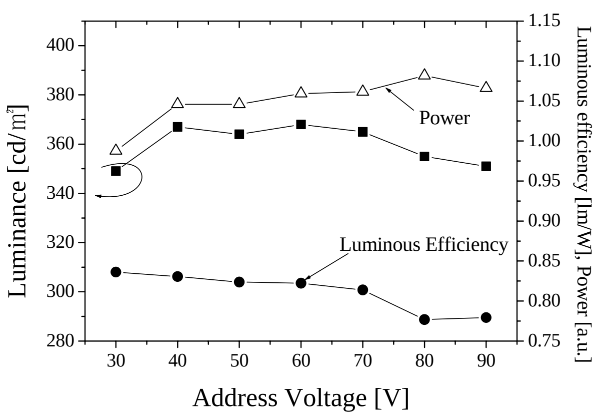
Fig. 3 shows the changes in the sustainable voltage region with a variation in the width of the auxiliary pulse at the sustain voltage of 260 V. In the width of 500 ns, the minimum sustain voltage region is lower than those of 1 and 2 μs, as shown Fig. 3. The long discharge path such as face-to-face sustain electrode structures needs a high sustain voltage due to the long distance between the X and Y electrodes. The application of auxiliary address pulse enables trigger discharge to occur between the X and Z electrodes prior to the main discharge between the X and Y electrodes, thereby lowering the sustain voltage. Fig.4 shows the IR emissions during the application of sustain pulse, Vx under three different auxiliary address pulses. As shown in Fig. 4, the IR emission time is for about 600 ns, which implies that the discharge is maintained just for 600 ns. As the auxiliary pulse width is increased, the sustain voltage



(a) 500ns



(b) 1 μs



(c) 2 μs

Fig. 5 Luminance and luminous efficiency characteristics

is increased and the corresponding IR intensity is decrease slightly. For the case of address pulse with

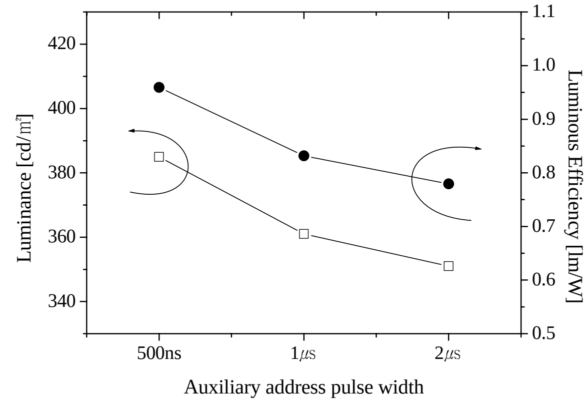


Fig. 6 Changes in luminance and luminous efficiency relative to auxiliary address pulse width at constant auxiliary address voltage of 90 V and sustain voltage of 260 V.

greater than 1 μs, the spaces charges produced during 600 ns-sustain discharge have already disappeared at the falling time of the auxiliary address pulse. Thus, it is difficult to accumulate the positive charges on the address electrode required for the next sustain discharge at the falling time of the auxiliary pulse. Accordingly, the low sustain voltage driving condition requires the shorter width of the auxiliary address pulse.

Fig.5 shows the luminance and luminous efficiency characteristics relative to the auxiliary address amplitude at various auxiliary address widths. As shown in Fig. 5 (a), the luminance at 500 ns is increased gradually with an increase in the amplitude of the auxiliary address pulse, whereas, the power consumption shows the saturation characteristics. Accordingly, the luminous efficiency is increased with an increase in the address pulse voltage at 500 ns. As shown in Fig. 5 (b), the luminance at 1 μs is increased gradually with an increase in the amplitude of the auxiliary address pulse. On the other hand, the power consumption is increased in proportion to the address pulse amplitude. Accordingly, the luminous efficiency has a peak value at an address voltage of 50 V and then, decreased gradually. As shown in Fig. 5 (c), the luminance at 2 μs has a peak value at near 60V, and then is decreased gradually. However, the luminous efficiency is decreased as the auxiliary address amplitude is increased due to the increase of power consumption.

Fig. 6 shows the Changes in luminance and luminous efficiency relative to auxiliary address pulse width at constant auxiliary address voltage of 90 V and sustain voltage of 260 V. The highest luminance (385 cd/㎡) and luminous efficiency (0.96 lm/W) are obtained at 500 ns condition.

4. Summary

The effects of auxiliary address pulse on face-to-face sustain electrode structure are investigated under various auxiliary address pulse widths and amplitudes in the 6-in. test panel. The luminance and luminance efficiency of the face-to-face sustain electrode structure are measured at a 4 % Xe content and a pressure of 450 Torr, and driving frequencies of 20 kHz with a duty ratio of 40 %. The luminance and luminous efficiency at an auxiliary address pulse width of 500 ns are improved more than those of auxiliary address pulse of 1 and 2 μs. As a result, in case of the auxiliary address pulse width of 500 ns, the luminance of 385 cd/㎡, and luminous efficiency of about 0.96 lm/W are obtained at an auxiliary pulse of 90 V.

5. References

1. J. D. Schemerhorn *et al.*, "A controlled lateral colume discharge for high luminous efficiency AC-PDP," in *Proc. SID Dig.*, 2000, pp.106-109.
2. J. T. Ouayng, Th, Callegari, B. Cailler, and J.-P. Boeuf, "Large gap plasma display cell with auxiliary electrode: Macro-cell experiment and two-dimensional modeling," *J. Phys. D: Appl. Phys.*, vol. 36, pp. 1959-1966, 2003.
3. L. F. Weber, "Positive Column AC Display," U.S. Patent 6 184 848B1, Feb. 6, 2001.
4. J.-Y. Kim, *et al.*, "Effect of Voltage Distribution Among Three Electrodes on Microdischarge Characteristics in AC-PDP With Long Discharge Path" *IEEE Trans. Plasma Science*, vol. 34, pp. 2579-2587, 2006.
5. H. Asai *et al.*, "Discharge Characteristics of a New Structure AC-PDP Using Thick Film Ceramic Sheet Technology," *SID 05' Digest*, pp. 210-213, 2005.
6. B.-S. Kim *et al.*, "A Study on Plasma Mode and Efficiency of Coplanar and Face-to-Face Electrode Structures in AC PDPs," *SID 06' Digest*, pp. 582-585, 2006.