Effect of auxiliary electrode on the discharge characteristics in AC PDP with long sustain-gap

Sang Dae Park, Seung Hun Lee, Nam Hoon Shin, Kyo Sung Lee, Sung Yun Park, Sang Ho Kim, Bhum Jae Shin, Kyung Cheol Choi
Department of Electronics Engineering, Sejong University, Seoul,143-747, Korea

Abstract

The effect of auxiliary electrode on the discharge characteristics in AC PDP with long sustain-gap was investigated. The auxiliary electrode was placed between scan and common electrode. When the pulse was applied to the auxiliary electrode during sustain period, the luminance of Ne + 13%Xe gas-mixture discharge increased and the discharge current decreased. The auxiliary pulse plays a role of improving electron excitation efficiency. When the auxiliary pulse was applied during address period, the address discharge time lag of Ne + 13%Xe gas-mixture could be reduced remarkably.

1. Introduction

The efficacy of AC Plasma Display Panels (PDPs) has been improved in the past several years. However, the efficacy of AC PDP is relatively low compared to that of other flat panel displays such as Thin Film Transistor Liquid Crystal Displays (TFT-LCDs) and Organic Light Emitting Diode (OLED). The most important thing in AC PDP technology is to improve the luminous efficiency. There are several mechanisms for improving the luminous efficiency [1,2]. The most promising approach to improve the luminous efficiency is to achieve higher vacuum ultra violet (VUV) efficiency[1] and electron excitation rate[2]. The low electron energy discharges resulted in high VUV efficiency [1]. The long sustain-gap discharge is one of examples of the low electron energy discharges[3,4]. The high Xe content discharge with high gas pressure can be adopted to improve electron excitation rate[5,6]. In the previous work, the AC PDP with 200μm sustain-gap and the auxiliary electrode was proposed and its discharge characteristic was investigated[7]. The luminous efficiency could be improved using 200μm sustain-gap discharge[7]. It was found that the pulse applied to the auxiliary electrode during sustain period helped to improve the luminous efficiency, which was believed that the auxiliary pulse lowered the electron energy in the long-sustain gap discharges. In this work, the timing of the auxiliary pulse during sustain period was varied and its discharge characteristics were investigated. The effect of the auxiliary pulse during address period on the address discharge time lag was also investigated. The Ne + 13%Xe gas-mixture was used as the discharge gas in the 200μm sustain-gap.

2. Experiment

Fig.1 shows the schematic drawing of the coplanar plate of a 3-inch test plasma display panel used in this work. The gap between scan and common electrode was 200μm. Each sustain electrode pair had the auxiliary electrode located between scan and common electrode. The width of the sustain electrode was 200μm and the width of the auxiliary electrode was 100μm. A transparent dielectric layer was coated with a 32μm thickness by using screen print and a 5000Å- thick MgO thin film was deposited by using electron-beam method. The green phosphor plate was adopted to investigate the luminance characteristics. The discharge gas was Ne + 13%Xe and total gas pressure was 450torr.

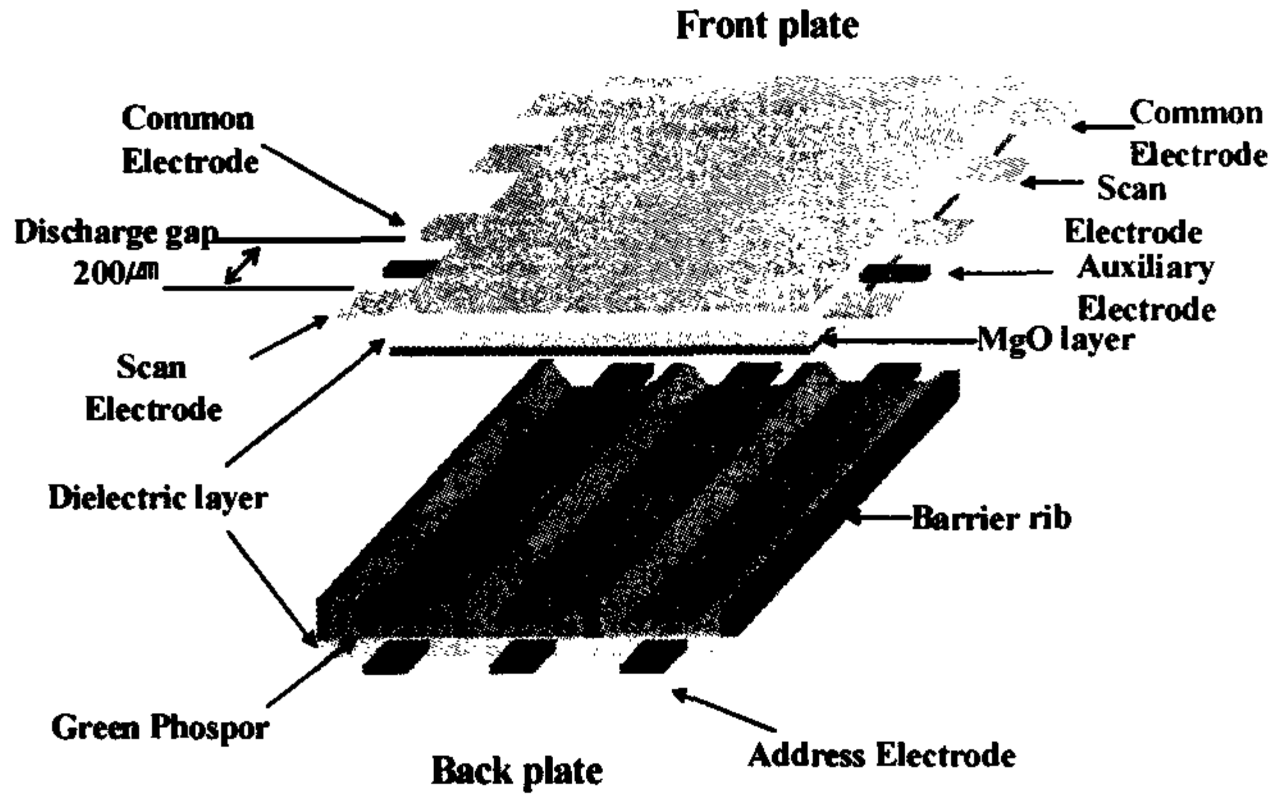


Fig.1 Schematic drawing of the coplanar plate of a 3-inch test plasma display panel

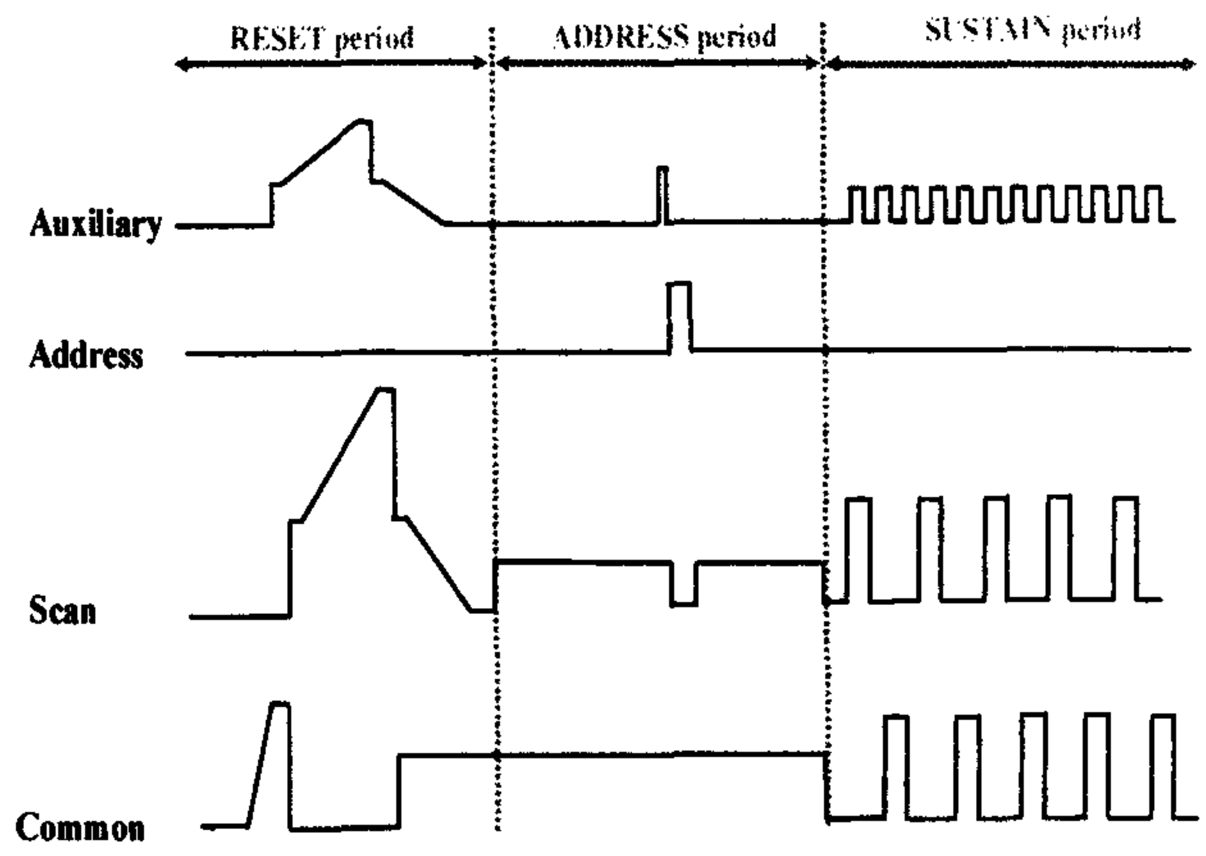


Fig.2 Schematic drawing of driving waveforms applied to the proposed panel

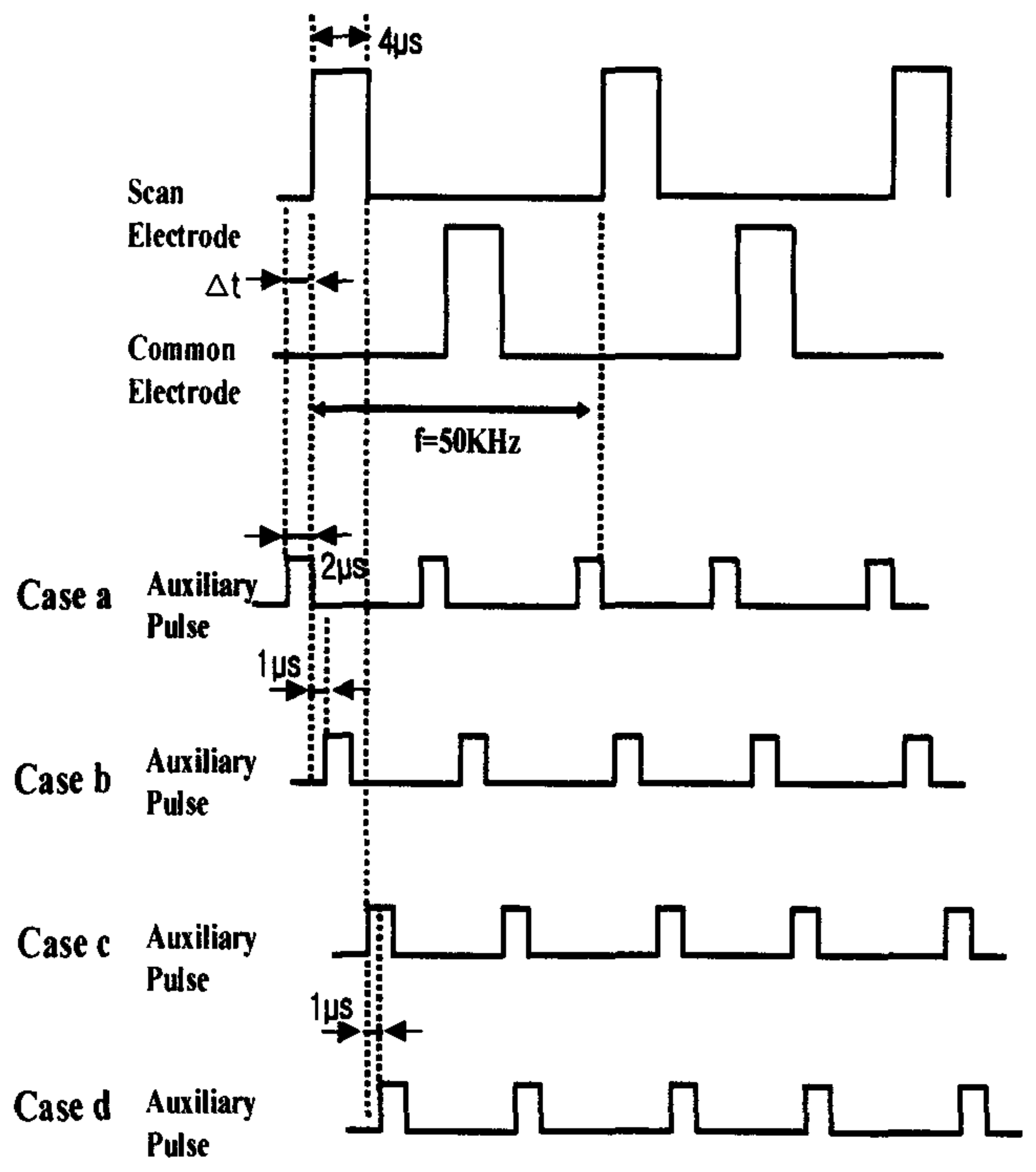


Fig.3 Pulse waveforms applied to the sustain and the auxiliary electrode during sustain period

Fig.2 shows the schematic during of driving waveforms applied to the new cell structure. The difference between the conventional and the proposed waveforms was the pulse applied to the auxiliary electrode during reset, address and sustain period. During the reset period, the pulses applied to the auxiliary electrode were designed to prevent the discharge between the auxiliary and other electrodes. During the address period, the pulse applied to the auxiliary electrode was designed to improve the discharge time lag of the address pulse. During sustain period, the pulses were supposed to control the wall and the space charge and consequently used to reduce the operation voltage and improve luminous efficiency.

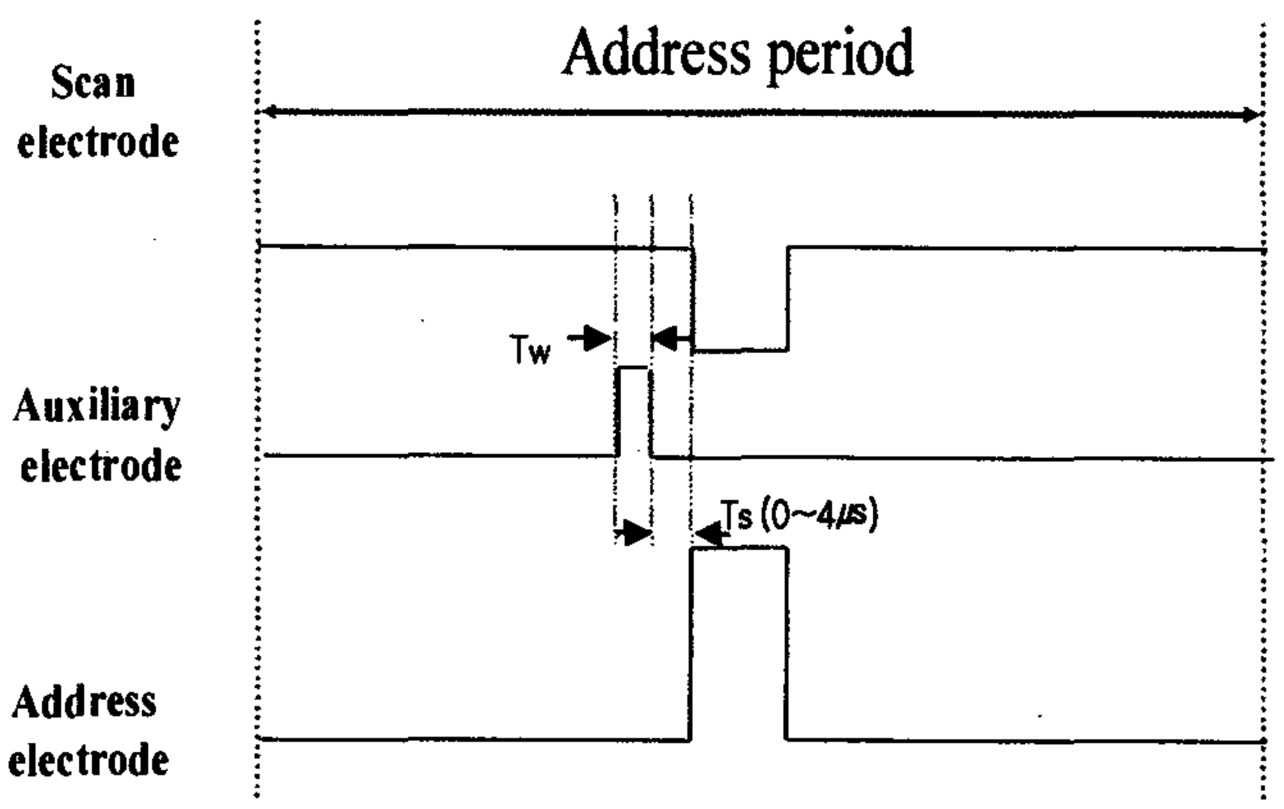


Fig.4 Pulse waveforms applied to scan, auxiliary and address electrode during address period

Fig.3 shows the waveforms applied to the sustain and the auxiliary electrode during sustain period. The width of sustain pulse was 4μsec and its frequency was 50kHz. The frequency of the pulse applied to the auxiliary electrode was 100kHz and its pulse width was 2 μsec. The voltage of the auxiliary pulse was fixed as 50V. The pulses applied to the auxiliary electrode during sustain period were varied as shown in Fig.3. In case a, the auxiliary pulse was applied just before the sustain pulse of scan electrode. In case b, the auxiliary pulse was overlapped with the sustain pulse of scan electrode. In case c, the auxiliary pulse was applied just after the sustain pulse. In case d, the auxiliary pulse was applied at 1 μsec after the sustain pulse of scan electrode.

Fig.4 shows the schematic drawing of the waveforms of the address and the auxiliary pulse during address period. T_s was the time between address and auxiliary pulse. Here, T_s is fixed as -1 μsec, which means that the auxiliary pulse is overlapped with address pulse and the best condition for the address discharge time lag[7]. T_w was the width of the auxiliary pulse and varied from 1 to 4 μsec.

3. Results and Discussion

Fig.5 shows the luminance of Ne + 13%Xe gas-mixture discharge according to the case a, b, c and d shown in Fig.3. The average value of the luminance was measured in the range of the driving voltage margin. Each case has the similar value of luminance. There was not much difference in the luminance among those 4 cases. However, the luminance of Ne + 13%Xe gas-mixture discharge in 200μm sustain-gap was improved using the auxiliary pulse. It was found that the timing of auxiliary pulse did not significantly affect on the luminance during sustain period.

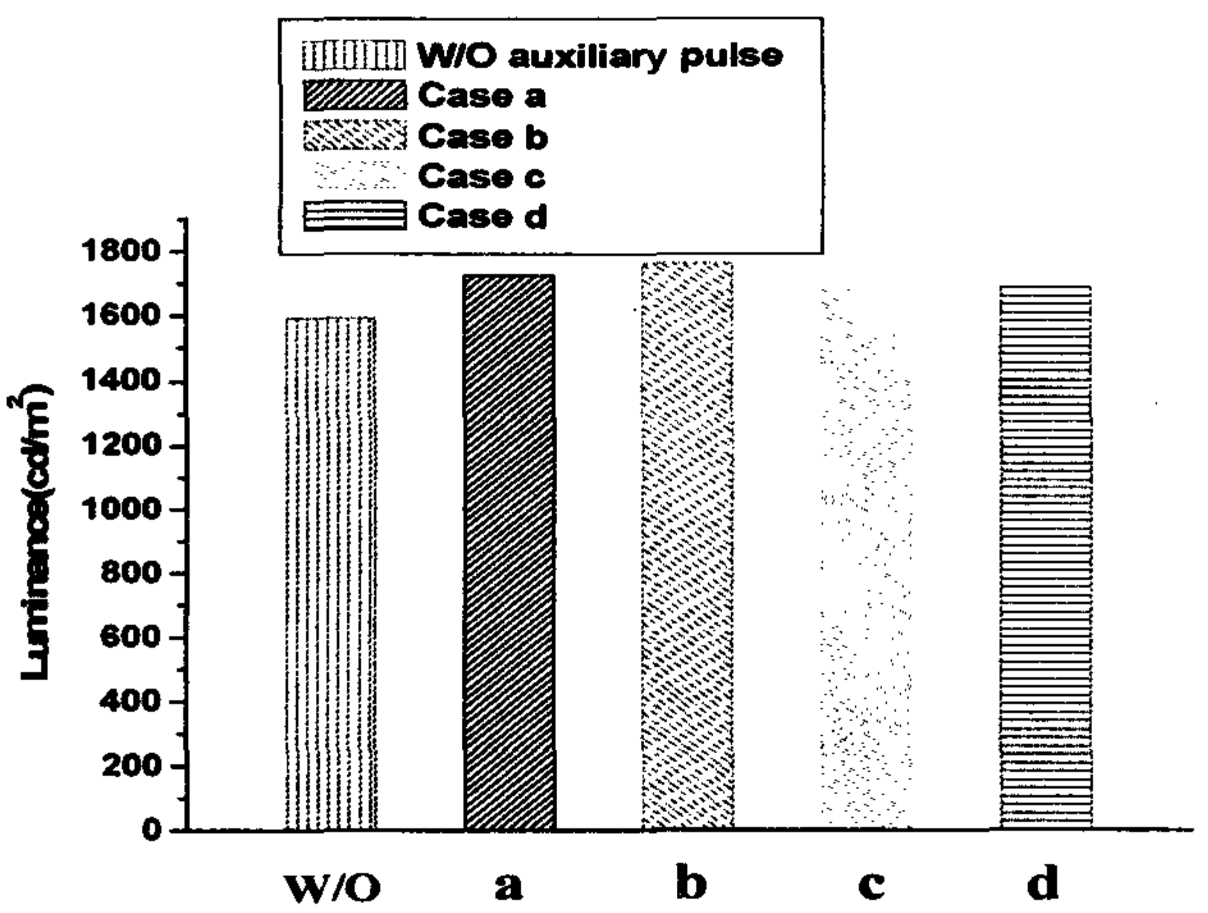


Fig.5 Average luminance during sustain period according to the auxiliary pulse timing

Fig.6 shows the average discharge current of Ne + 13%Xe gas-mixture during sustain period according to the auxiliary pulse timing. The average discharge current of the case c has the lowest value among those 4 cases. When the auxiliary pulse was applied just after the sustain pulse as shown in the case c of Fig.3, it was supposed to control space charges and metastable particles to reduce the discharge current.

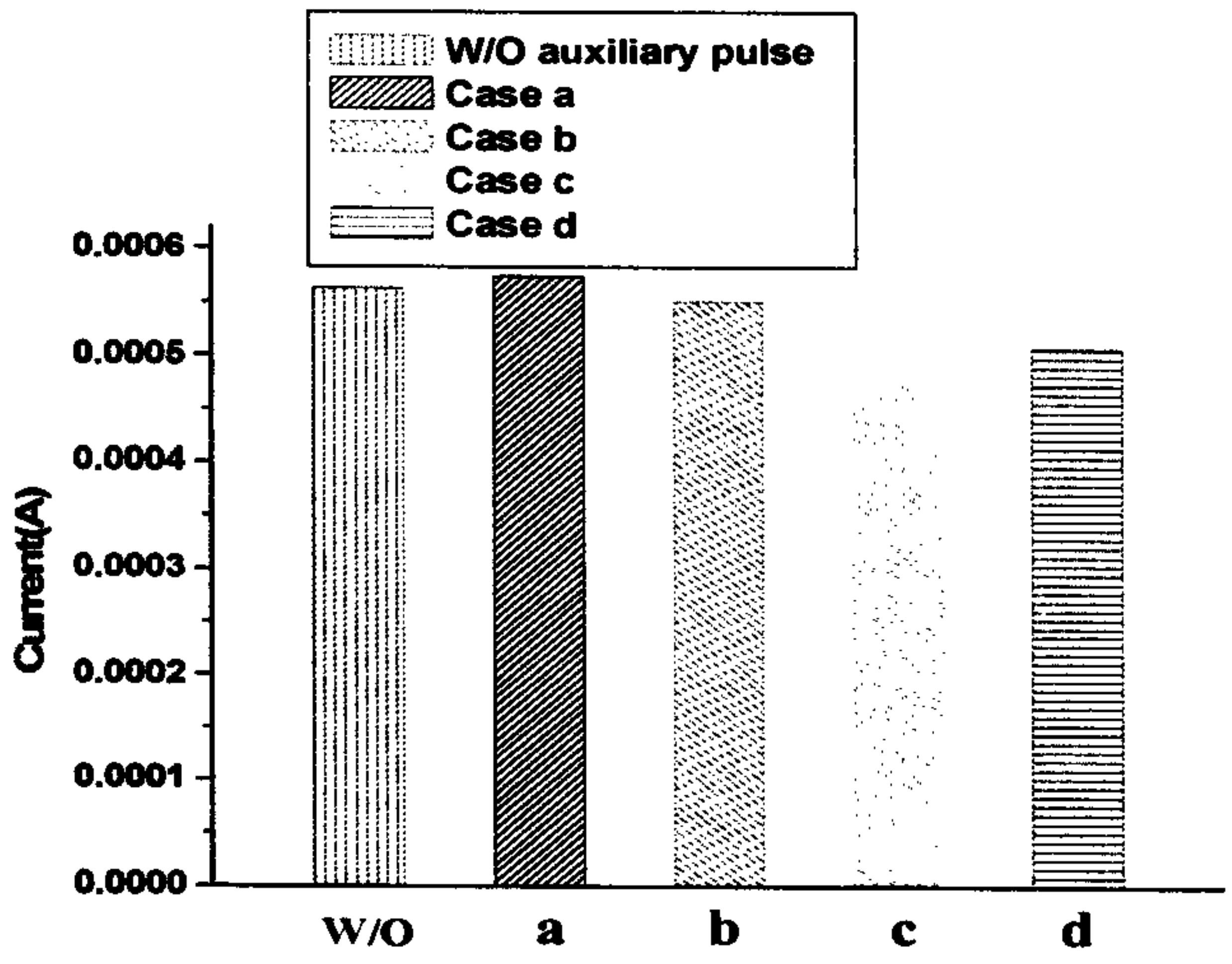


Fig.6 Average discharge current of Ne + 13%Xe gas-mixture during sustain period according to the auxiliary pulse timing

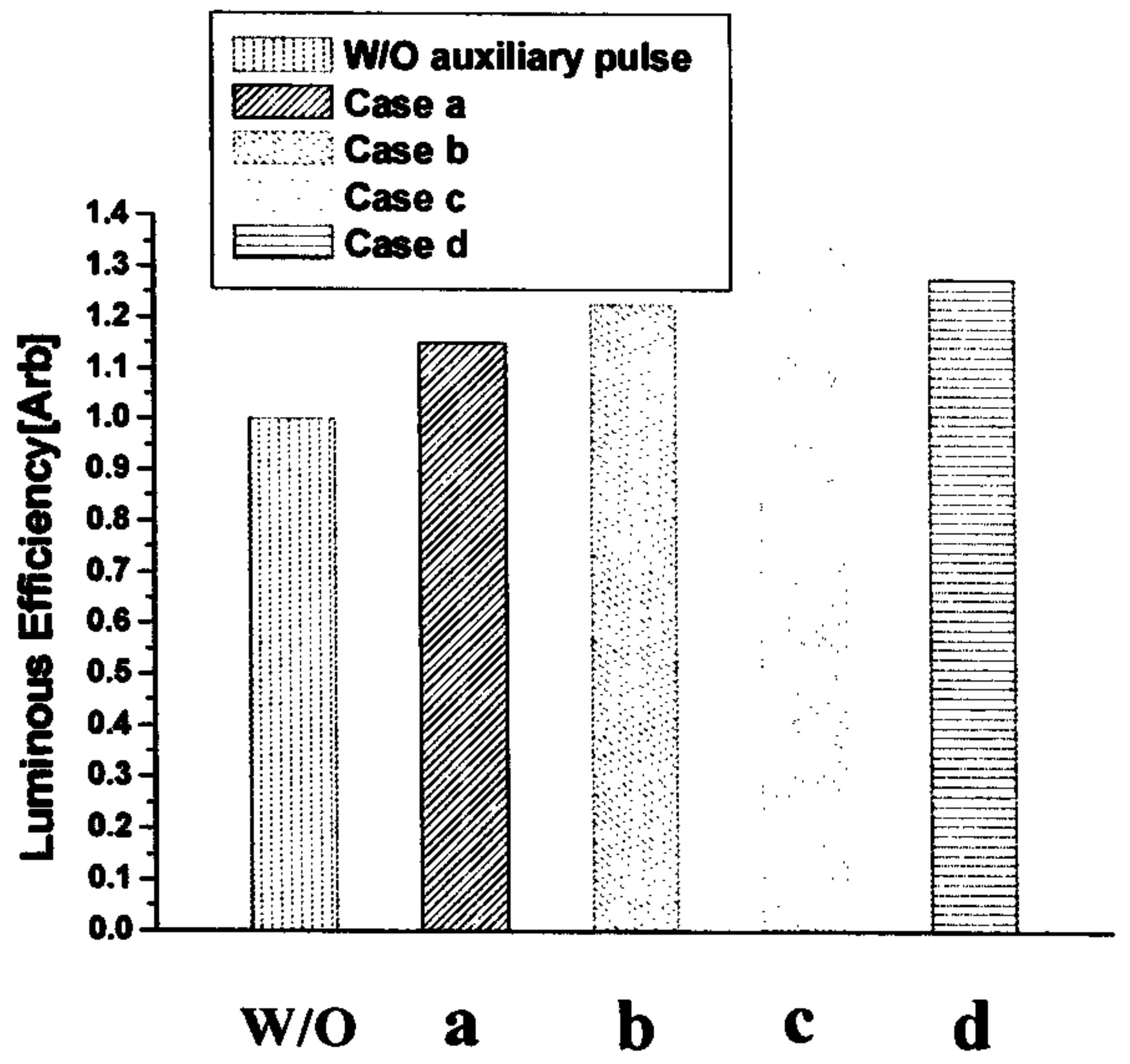
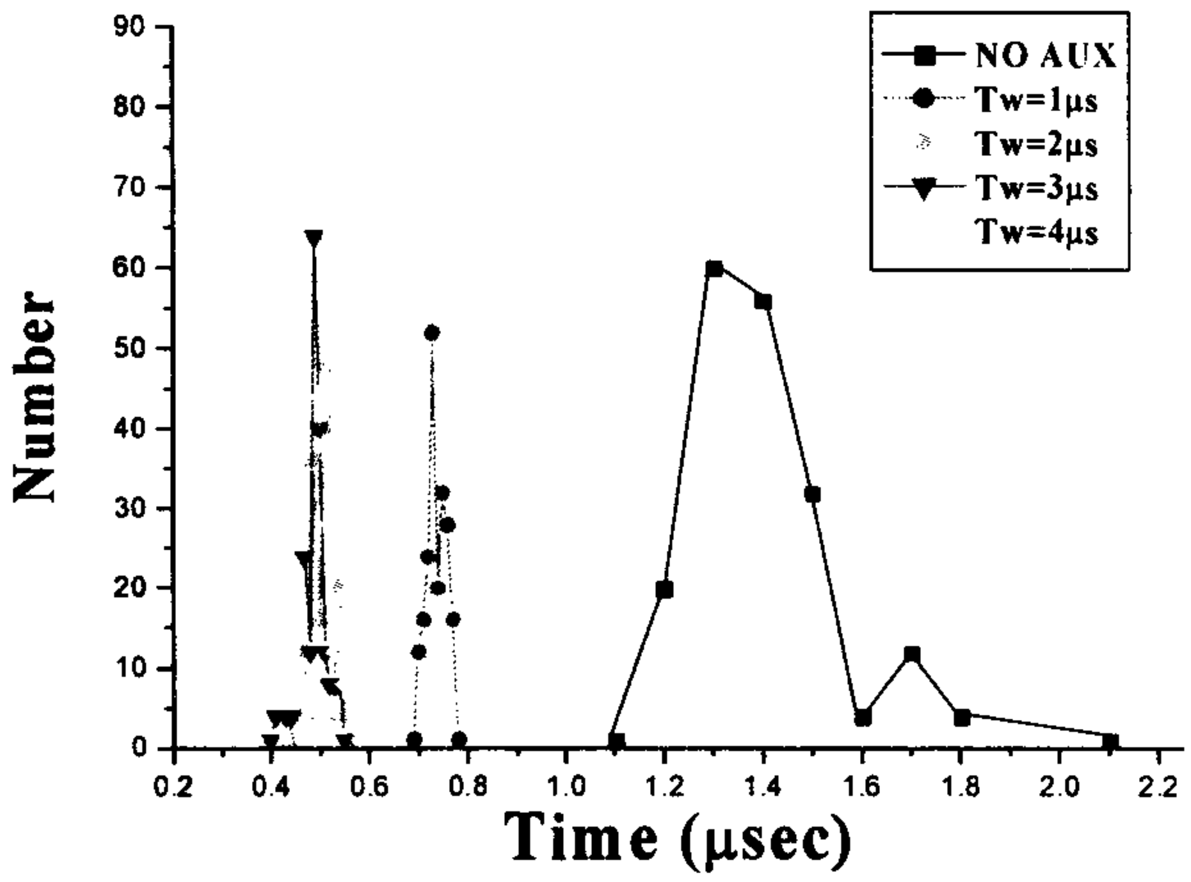
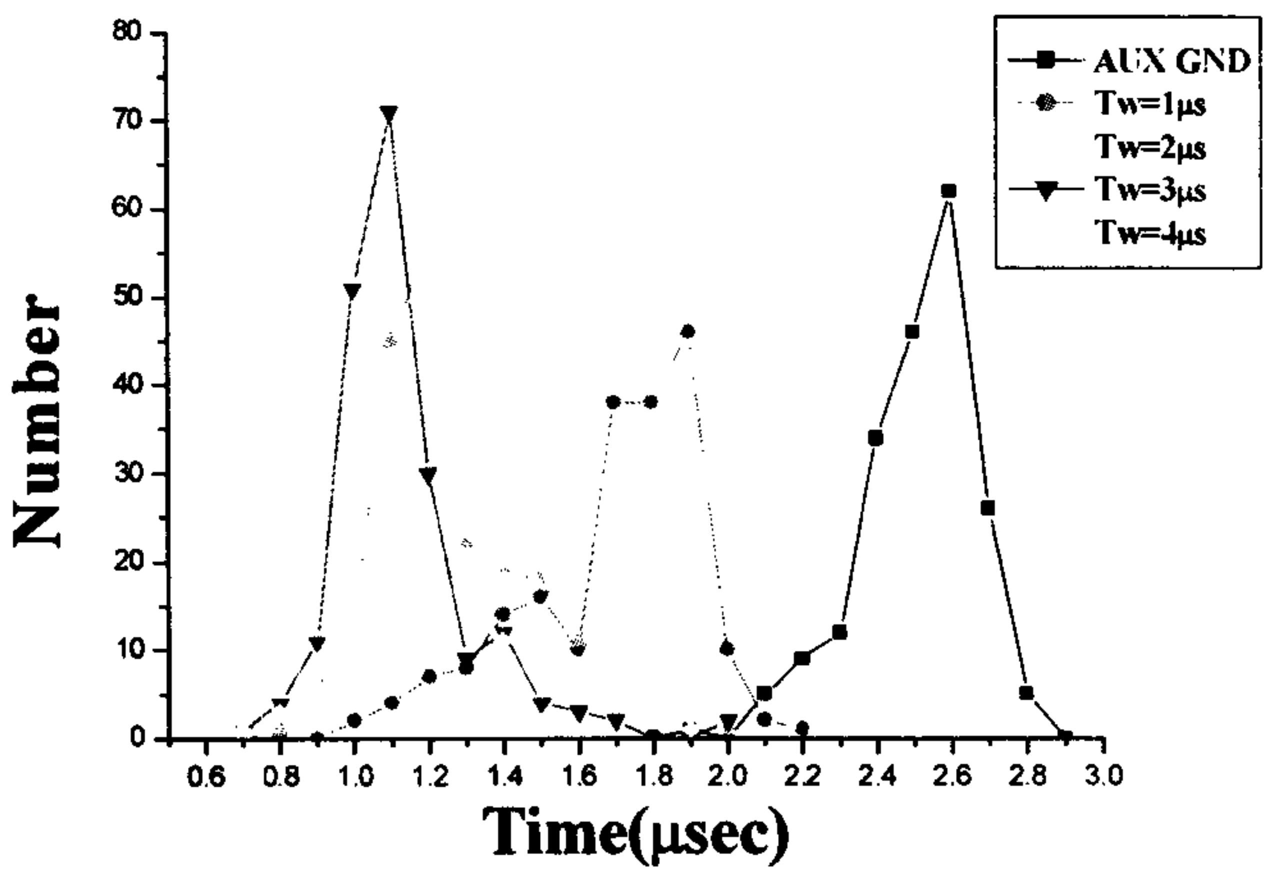


Fig.7 Average luminous efficiency of Ne + 13%Xe gas-mixture discharge according to the auxiliary pulse timing

Fig.7 shows the average luminous efficiency of Ne + 13%Xe gas-mixture discharge according to the auxiliary pulse timing. From the result, the luminous efficiency was improved when the pulse was applied to the auxiliary electrode during sustain period. Among those 4 cases shown in Fig.3, the luminous efficiency of the case c had the highest value. Because the discharge current of case c had the lowest value, the luminous efficiency of Ne +13%Xe gas-mixture discharge in 200μm sustain-gap showed the most improved value when the auxiliary pulse was applied just after sustain pulse. From the result, it was found that the auxiliary pulse affect on the discharge current and finally the luminous efficiency. The auxiliary pulse perturbed the space charge and metastable particle. It can reduce the discharge current but not reduce the photons. It means that auxiliary pulse make the excitation efficiency higher.



(a)



(b)

Fig.8 (a) Address discharge time lag (Ne+4%Xe)

(b) Address discharge time lag (Ne+13%Xe)

The effect of the auxiliary pulse on the address discharge time lag was also investigated. Fig.8 shows the address discharge time lag of Ne + 4%Xe and Ne + 13%Xe gas-mixture discharge in 200μm sustain-gap. Two hundred infra red signals of address discharges for each measurement were recorded and analyzed to determine the discharge time lag of address pulse. Usually, the address discharge time lag of Ne + 13%Xe gas-mixture is much longer than that of Ne + 4%Xe. When the pulse was applied to the auxiliary electrode as shown in Fig.4, the discharge time lag could be reduced remarkably. In the case of Ne + 4%Xe gas-mixture, the address discharge time lag is reduced by 61% when the width of the auxiliary pulse is 4μsec. In case of Ne + 13%Xe, the discharge time lag is reduced by 58% when T_w is 3 μsec.

4. Conclusion

In this work, the effect of the auxiliary electrode on the discharge characteristics in AC PDP with 200μm sustain-gap was investigated. During sustain period, the luminous efficiency of Ne + 13%Xe gas-mixture discharge in 200μm sustain-gap was improved using the auxiliary pulse. When the pulse was applied to the auxiliary electrode just after sustain pulse, the most improved luminous efficiency of Ne + 13%Xe gas-mixture was obtained. The discharge current was reduced and the luminance was not much charged using the auxiliary electrode. During address period, the discharge time lag of address pulse of Ne + 4%Xe and Ne + 13%Xe gas-mixture discharge was reduced by 61% and 38%, respectively. The auxiliary electrode seems to play a role of providing prime particles with a pixel during address period.

5. References

[1] K. Suzuki, Y. Kawanami, SoHo, N. Vemura, YoYajima, N. Kouchi, Y. Hatano, "Theoretical formation of the vacuum ultra violet production efficiency in a plasma display panel", J. of applied physics, Vol.88, No.10, pp5605~5611, 2000.

[2] W. J. Chung, B. J. Shin, H. S. Bae, J. H. Seo, K. W. Whang, "Mechanism of high luminous efficient discharge with high pressure and high Xe content in AC PDP", IEEE , Trans. on Plasma Science, Vol.31, No.5, pp1038~1043, 2003.

[3] J. H. Lee, B. J. Kim, S. M. Hong, K. C. Choi, "Discharge Characteristics of the AC PDP with Coplanar long-gap Electrodes",SID'03, pp426~429,2003.

[4] L. F. Weber, "Positive Column AC Plasma Display", IDRC'03, pp119~124, 2003.

[5] G. Oversluizen, T. Dekker, M. F. Gillies, and S.T. de Zwart, "High Efficacy PDP",SID'03, pp28~31, 2003.

[6] T. Minami, M. Ishii, K. Igarashi,T. Shiga, S. Mikoshiba, "Low Voltage Drive of High Xe- Content, High-Efficiency PDPs",EURO'2002, pp65~68,2002.

[7] S. D. Park, N. H. Shin, B. J. Shin, K. C. Choi, "Luminance and Luminous efficiency of AC PDP with coplanar long-gap and high Xe content gas-mixture",SID'04, pp506~509, 2004.