Improvement of the ac PDP Performance by Simple Modification Of the Fence Electrode Structure

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Abstract
We propose modified fence electrode structure for manufacturing of ITO-electrode-free PDP. Luminance, luminance efficiency and addressing time for the proposed structure shows performance improvement about 25 percent. Our results can be used for the reduction of manufacturing cost without degradation of PDP performance.

1. Introduction
Plasma display panel(PDP) using surface discharge technology is the most promising candidate for large-screen high definition application such as wall-hanging HDTV and display for engineering workstations in the range of 40" ~ 60".[1] Intrinsically the plasma display has the properties such as emissive display with wide viewing angle, fast response time and high TV image quality. In the range of 40" to 60", where the CRTs are no longer easily usable due to its volume and weight, PDPs are surely the most interesting technology available today. Recently, a number of manufacturers have announced to offer a commercial wall-hanging color PDP with 42-inch model, and plan to mass production. For the mass production, the most serious problem is high cost and complex manufacturing process.[2-4] To solve these problems, Fence electrode structure, which eliminates the need for expensive transparent electrodes, has been newly suggested. However, luminance and luminous efficiency of Fence electrode should be improved.

In this paper, in order to improve the luminance and luminous efficiency of ac PDP with fence electrode structure, the new fence electrode structures are proposed and the electro-optical and sustain margin are also investigated

2. Experimental

2.1 Structure and specification of test panels
4" size ac PDP model was fabricated as shown in Fig. 1 with the panel specification of Table 1, which has been well-known 3-electrode reflection type. Several pairs of parallel display sustain electrodes X and scan electrodes Y are formed on the front glass substrate. Each display electrode is composed of transparent and narrow bus electrode. These electrodes are covered by a dielectric layer and a thin MgO layer. On the other rear substrate, striped address electrodes are arranged. Striped barrier ribs are on both side of the address electrodes to separate the adjacent discharge cells and to eliminate the optical cross-talk between them. The substrates are assembled each other with about 130㎛ gap. A He-Ne-Xe(4%) mixture gas is injected into the gap.[5]

Fig. 2 shows conventional ITO structure and newly suggested Fence electrode structure. Fig. 3 shows the schematic diagram and dimensions of test samples used in the experiment. Fig3. (a) is the conventional fence electrode and (b),(c),(d) are suggested fence electrodes.

2.2 Experimetal Setup
Fig. 4 shows the schematic diagram of discharge test chamber used for measuring the discharge voltage, electro-optical and addressing time characteristics..

In this study, the test samples were installed to the discharge chamber. It was exhausted up to 10^{-8} Torr by molecular pump. The characteristics of samples were tested after 1hr aging process.

The electrical measurements consist of obtaining the minimum firing voltage Vf and maximum sustaining voltage Vs for the test panels applied the square wave voltage. The range of gas pressure was from 500 Torr to 100 Torr in decrement steps. The Vf was measured by progressively increasing applied voltage to initiate the discharge, and then the Vs was measured by reducing their applied voltage to the point at which the on cells begin to extinguish. The voltage were the average value over five measurements. The luminance was measured for the area of 10㎜ in diameter by colorimeter. The measurements of applied voltage and current waveform were carried out using the digital storage oscilloscope and current probe. The power consumption was calculated from the multiplication of the instant values of voltage and current.

$$Power\ consumption = \frac{1}{T}\int_0^T i(t)v(t)dt$$

The luminous efficiency of ac PDP is defined as follows

$$Luminous\ efficiency = \frac{\pi \times B(cd/m^2) \times S(cm^2)}{power\ consumption(W)}$$

Fig. 5 shows time chart of applied voltage used in the measurement of discharge voltage characteristics.

Fig. 6 shows time chart of applied voltage used in the measurement of address time characteristics in address discharge. The time chart of applied voltage is followed the ADS method. One sequence of this driving scheme is about 2ms, and this sequence is infinitely repeated. The applied voltage conditions for each electrode are showed in the Fig 3-7.

Fig. 7 shows the typical waveform of addressing pulse voltage, displacement current and addressing discharge current by gas discharge. Addressing time is defined as the period between the 10% level of applied pulse voltage and the 10% level of addressing discharge current, that is, the sum of period of A, B, C.

3. Result and Discussion

3.1 The electric and optical characteristics of suggested fence electrodes.

Fig. 3 shows the proposed fence electrodes to improve the luminance and luminous efficiency. The figures (b), (c) and (d) are the suggested electrodes whose shorting bar is moved to the center of the cell. Fig. 8 (a) shows the discharge voltage characteristics of the conventional fence electrode and proposed fence electrodes as a parameter of gas pressure using the mixture of He-Ne(30%)-Xe(4%). The upper part is the firing voltage (Vf) and the lower part is the sustaining voltage (Vs). The discharge voltage characteristics of Vf and Vs are almost the same regardless of location of shorting bar.

Fig. 8 (b),(c),(d) shows the luminance, luminous efficiency and total charge as a parameter of gas pressure using the mixture of He- Ne(30%)-Xe(4%). The applied voltage and frequency are 200V and 50KHz, respectively. The luminance and luminous efficiency of suggested F-1 structure is highest. For the conventional fence structure, discharge plasma expands toward shorting bar on each barrier rib. As a result, the loss of plasma and light can cause low luminance and low luminous efficiency. For the suggested structure whose shorting bar is moved to center of cell, discharge plasma is concentrated and has higher chance to drift along the shorting bar. This can help ionization and excitation process in the cell. As a result the luminance and the luminous efficiency are improved 32%, 25%, respectively.

The F-2 structure shows high luminance and luminous efficiency compare with conventional structure but luminous efficiency is lower than F-1 structure about 7%-8%. Because For the F-2 structure, shorting bar is close to electrode gap, so the large portion of the visible light can be shadowed. F-3 structure are almost same as that of conventional structure.

3.2 Addressing time characteristics of suggested fence electrodes.

Fig. 9 shows the addressing time characteristics of the conventional electrode and proposed F-1, F-2 electrodes in addressing discharge. The addressing time characteristics of the proposed F-1, F-2 electrodes have reduced about 13%, 17% as compared to that of the conventional electrode, respectively.

Because the shorting bar of suggested structure has moved center of cell, the probability of addressing discharge is increased. As a result, addressing time of suggested structure is faster than that of conventional structure.

Fig. 10 shows the addressing current waveform of the conventional electrode and proposed F-1, F-2 electrodes in addressing discharge. The address current waveform has two peaks. The first big peak is the displacement current. This displacement current is determined by the geometric structures, including the thickness of dielectric layer, the sort of gas, the height of ribs, the address electrode area. So, the displacement current of the conventional electrode and proposed F-1, F-2 electrodes has almost the same because of almost the same discharge cell structure. The second peak is the address discharge current in address discharge time. The proposed F-1, F-2 electrodes have convenient structure for addressing discharge, so they have short discharge time.

4. Conclusion

In this paper, in order to improve the luminance and luminous efficiency of ac PDP with fence electrode structure, the new fence electrode structures are proposed and the electro-optical and addressing time characteristics are also investigated. The results may be summarized as follows.

1. The proposed three kinds of structure (F-1, F-2, and F-3) show almost the same discharge voltage characteristics compared with the conventional electrode as a parameter of gas pressure because of the same electrode gap.

2. At suggested structure (F-1) whose shorting bar is located at center of cell, discharge plasma is concentrated and diffused along the shorting bar, ionization and excitation are activated; as a result the luminance and the luminous efficiency are improved 32%, 25%, respectively.

3. At suggested structure (F-1 and F-2) whose shorting bar is located at center of cell, probability of addressing discharge is increased. As a result, addressing time of suggested structures are reduced about 13% and 17% compared with conventional fence electrode structure, respectively.

5. References

[1] Larry F. Weber, The Promise of Plasma Display for HDTV. *Information Display (SID)*, vol. 16, no. 12, pp16-20, 2000

[2] C. H. Park et al, A New Method to Reduce Addressing Time in a large AC Plasma Display Panel, *IEEE Transactions on Electron Devices*, vol 48, no. 6, pp1082-1086, 2001

[3] C. H. Park et al, An Electrical and Optical Characteristics of Color ac Plasma Displays with a New Cell Structure, *Journal of Information Display*, vol. 2, no. 1, 2001

[4] T. Kishi et al, "A New Driving Technology for PDPs with Cost Effective Sustain Circuit", *SID01 Digest*, pp1236-1239, 2001

[5] C. H. Park et al, A Study on new Shaped Sustaining Electrode Showing high Luminous Efficiency in AC PDP_, *Journal of Information Display*, vol. 2, no. 1, 2001

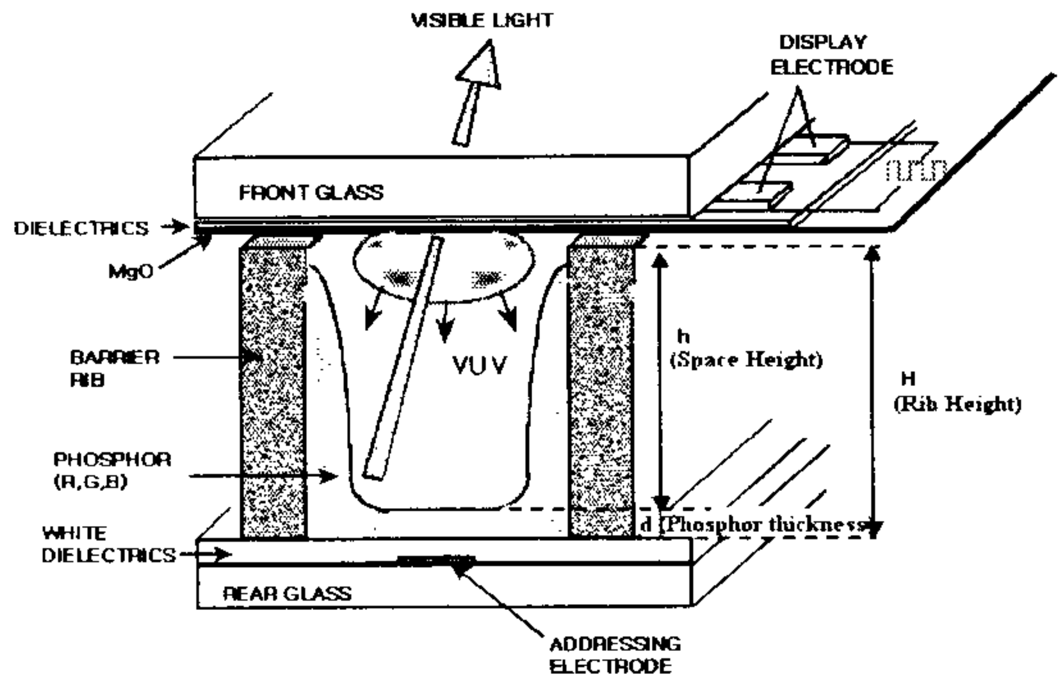


Fig.1 Schematic diagram of model ac PDP

Front Panel		Rear Panel	
Bus width	310μm	Address width	100μm
Bus qap	60μm	White back thickness	20μm
MgO thickness	5000 Å	Rib height	130μm
Dielectric thhickness	25μm	Rib pitch	360μm
		Phosphor thickness	30μm

Table 1. The specification of 4-inch Model PDP

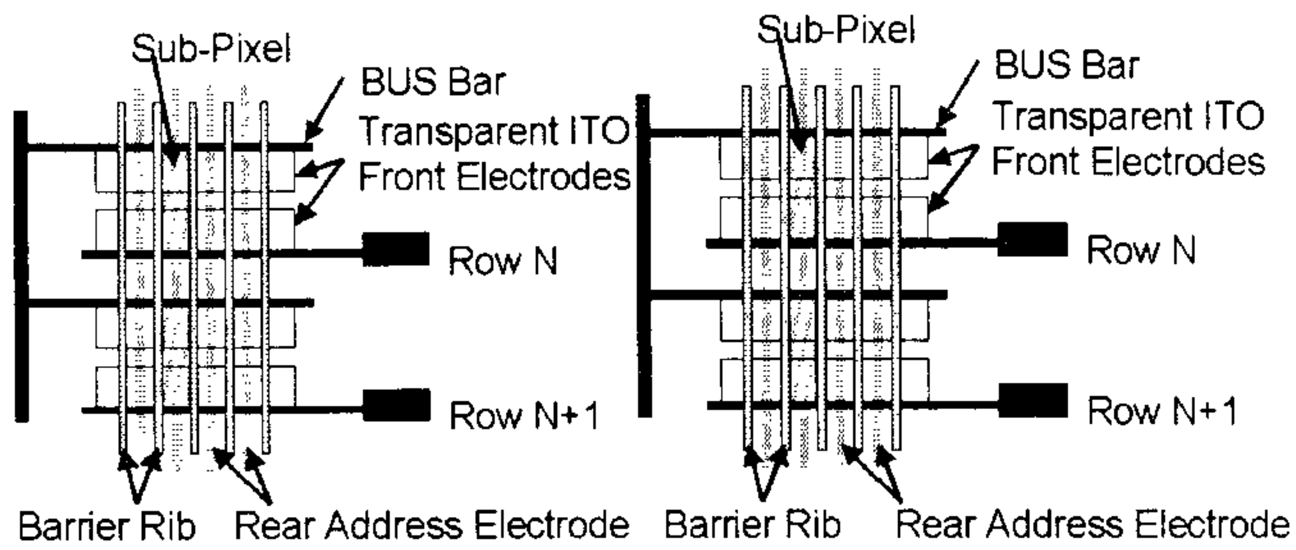


Fig 2. Conventional ITO structure and Fence structure

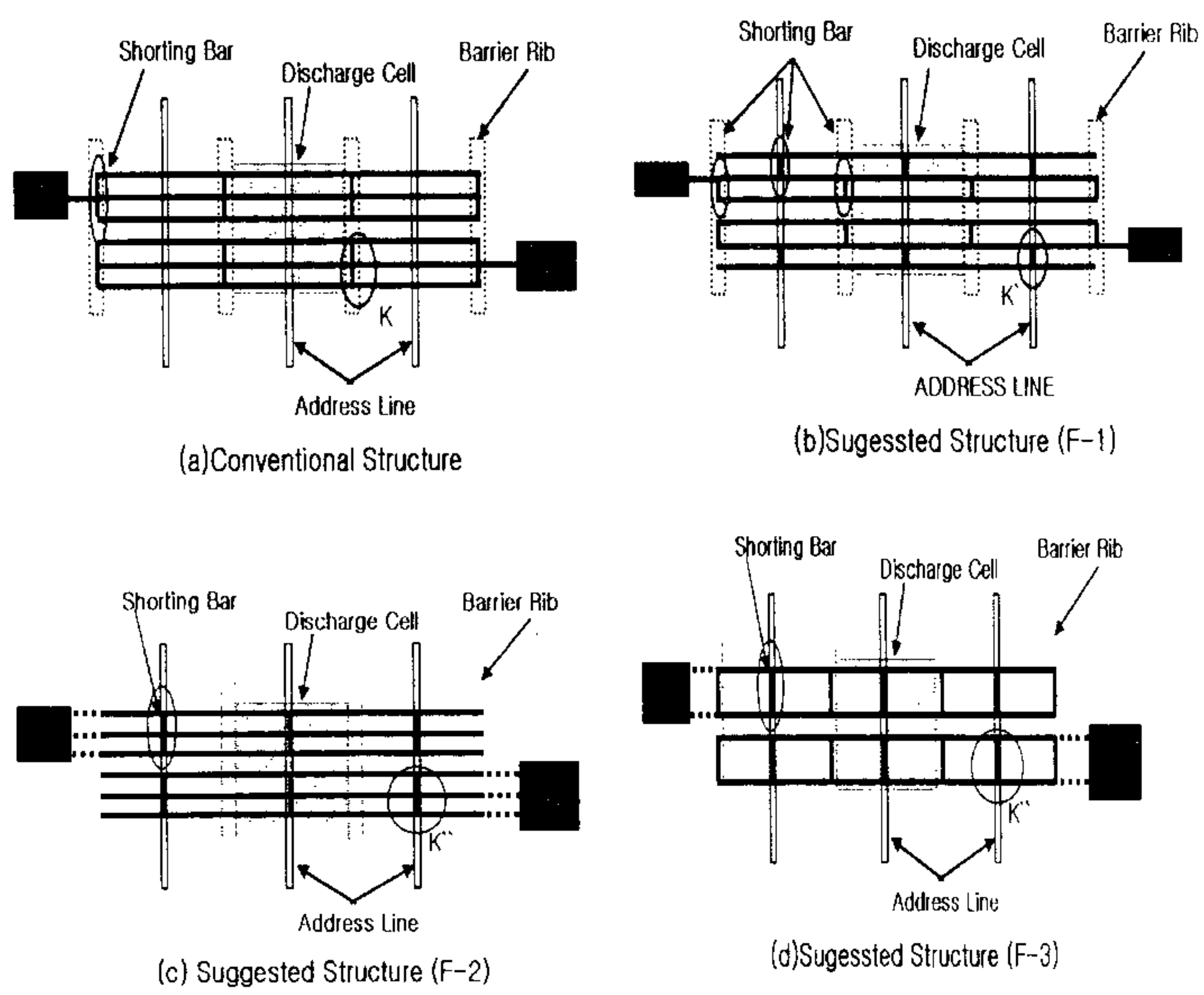


Fig. 3 Schematic diagram of Fence electrode structure

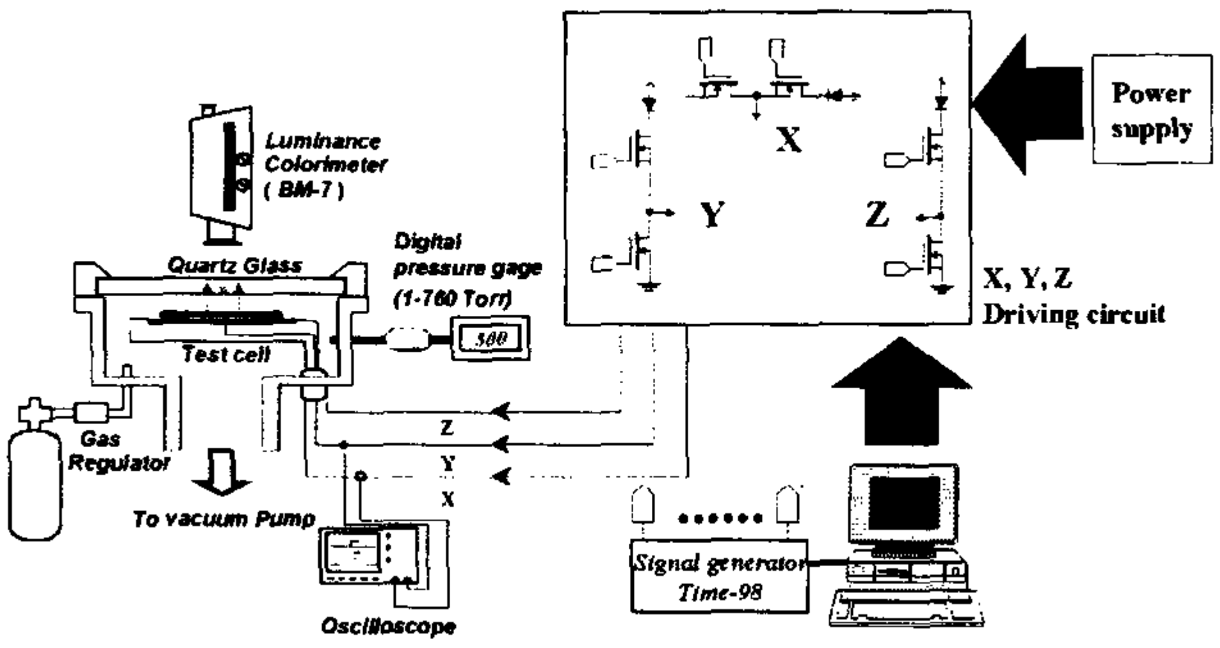


Fig. 4 Schematic diagram of discharge test chamber

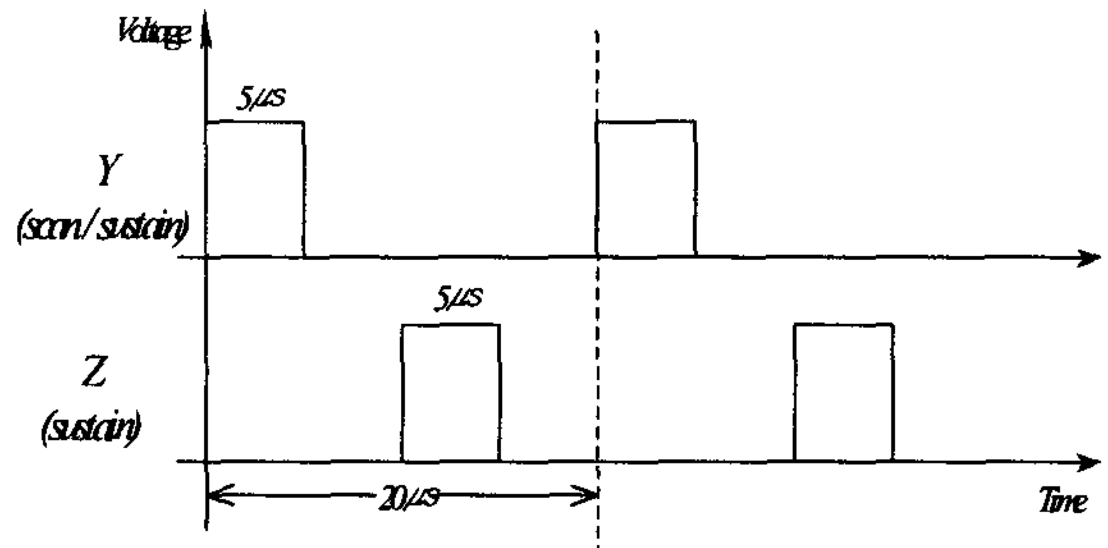


Fig 5. Applied voltage waveform for Discharge voltage characteristics

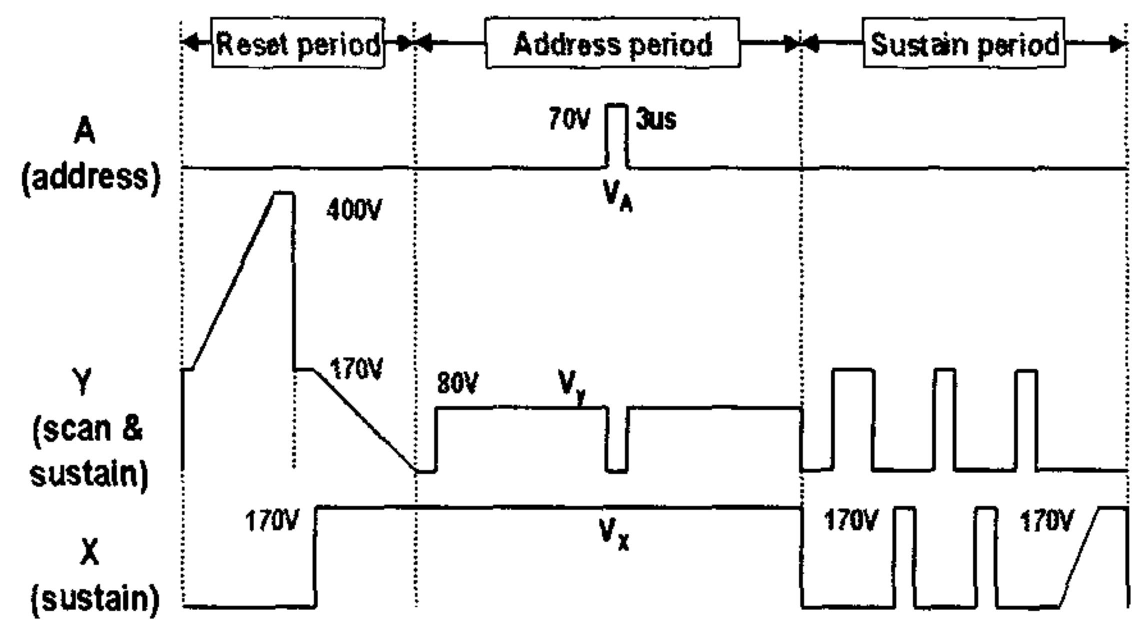


Fig 6. Applied voltage waveform for address time characteristics

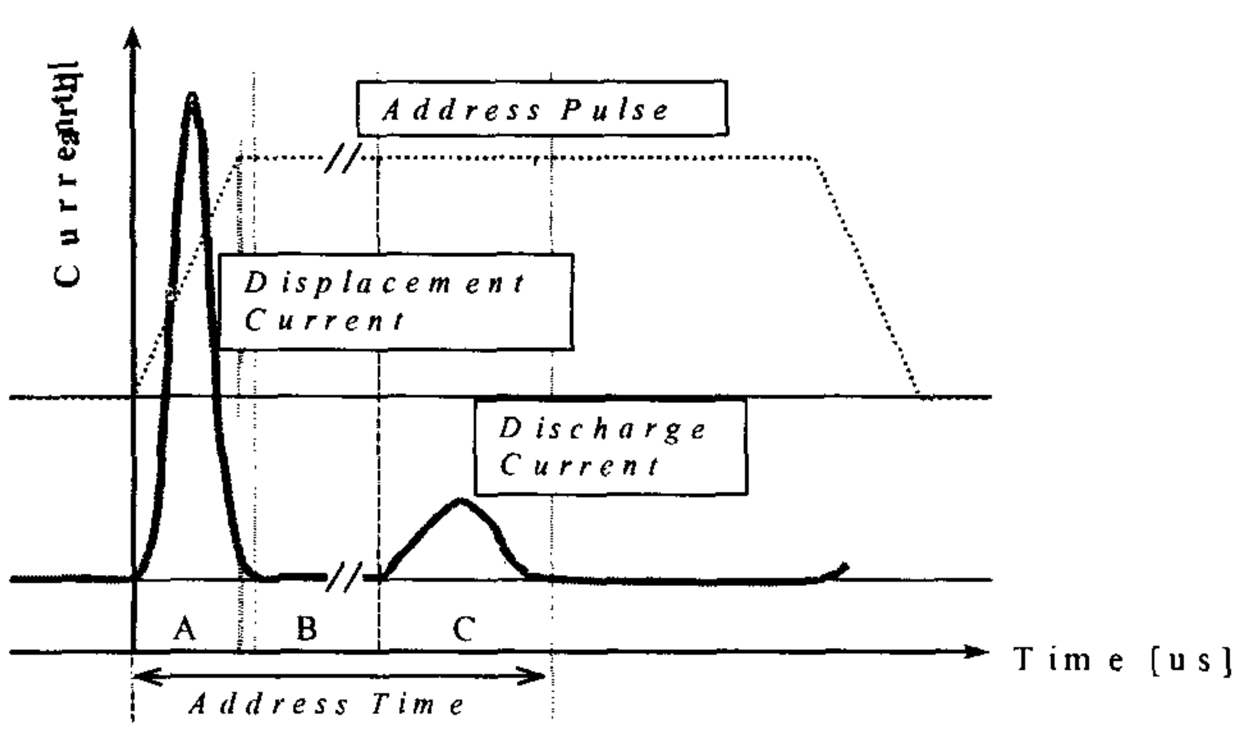
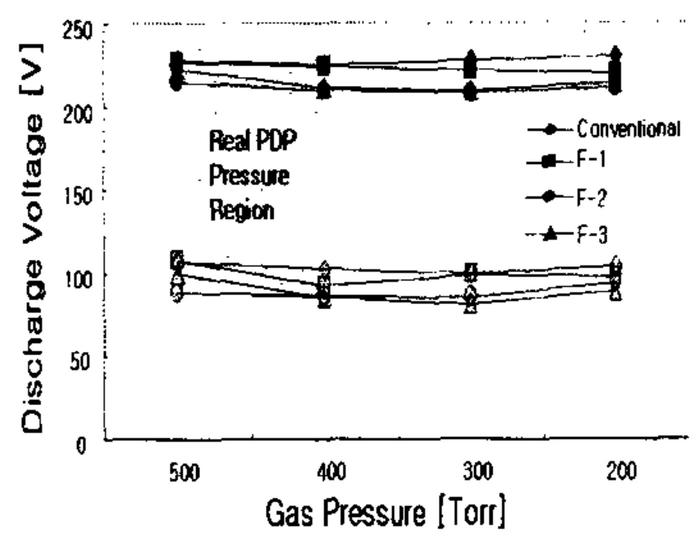
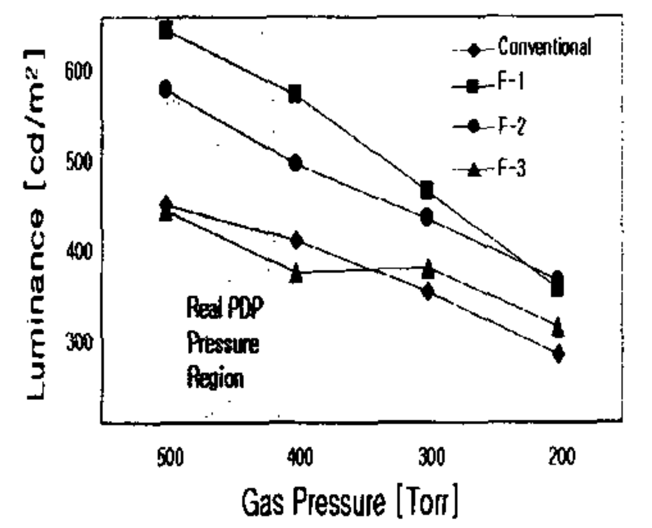


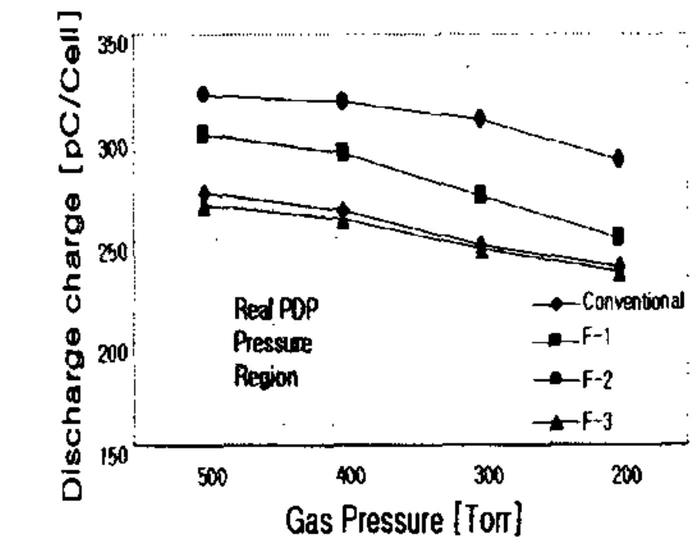
Fig 7. The Schematic diagram of applied voltage and Current in address discharge



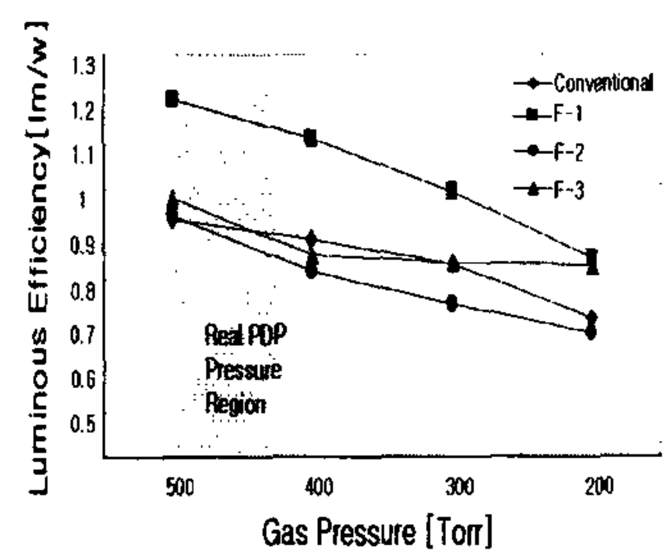
(a) firing & sustain voltage



(b) Luminance



(c) discharge charge



(d) luminance effeciency

Fig 8. Characteristic as a parameter of working gas pressure

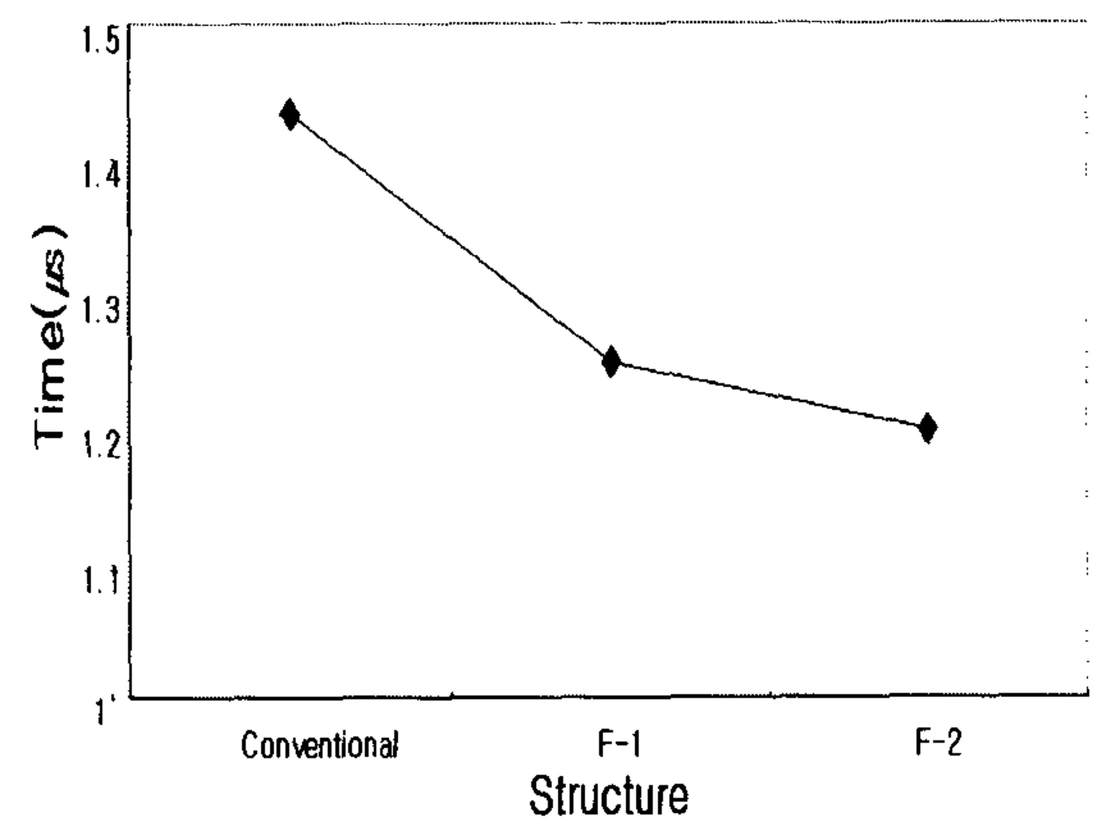


Fig 9. The address time characteristics as a parameter electrode structure

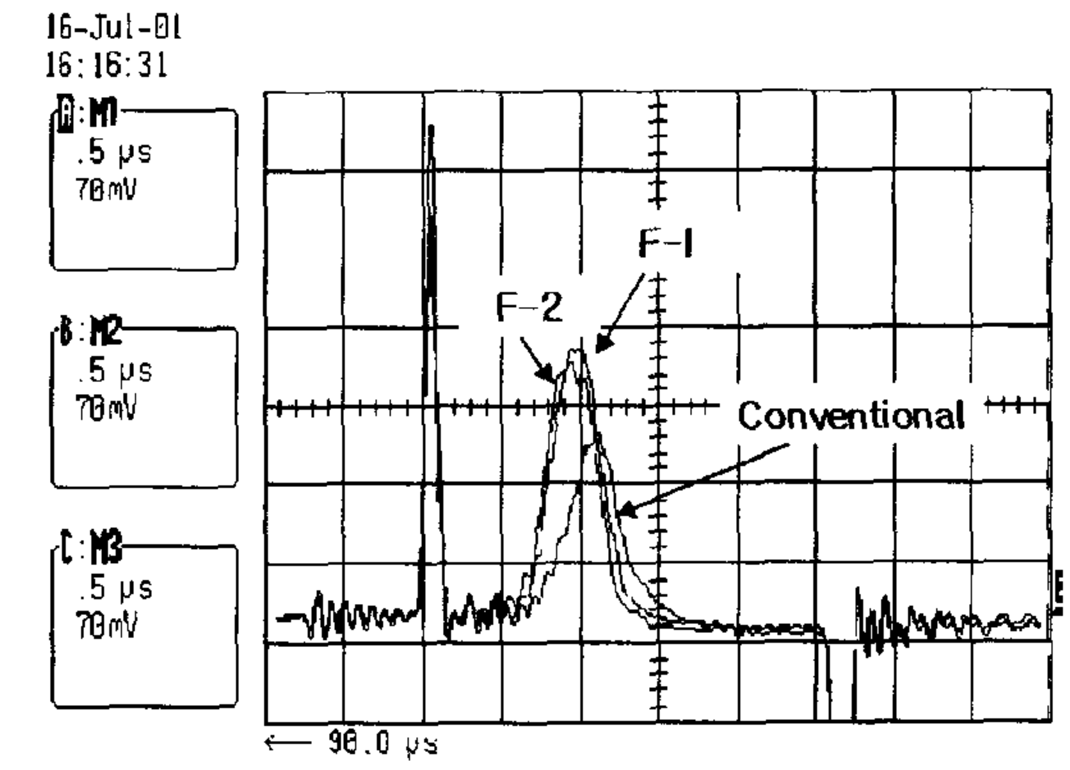


Fig 10. The current waveform as a parameter of electrode structure