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New Shaped Electrodes to Reduce Addressing Time in a Large AC Plasma Display Panel

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Abstract

The addressing time can be reduced by modifying cell structure and/or driving circuits in order to replace the dual scan system by single scan in large ac plasma display panel(PDP). Moreover, the luminance of the PDP can also be increased by decreasing the addressing time. In this paper, various shapes of bus and address electrodes have been investigated with the aim of reducing the addressing time in ADS driving method. The experimental results show that the addressing time can be reduced by more than 30% compared with the conventional type by modifying the electrodes without reducing the luminance of the PDP.

Keywords : Ac PDP, addressing time

1. Introduction

One of the most severe problems in address-display separated(ADS) scheme[1-2] in ac plasma display panels(PDP) is that they have too long addressing period. One line scanning time takes up about 3 μs, such that the time for 480 lines in VGA resolution takes 1.4ms.

A frame consists of 8 sub-field for 256 gray level. Therefore, the total addressing time is 11.52 ms, which is about 70 % the time taken for one frame. As the addressing time increases, the sustaining period for display image should decrease. As a result, the luminance of the PDP decreases.

The dual scan method was adopted to solve this problem in a large ac PDP. In this case, the scanning period can be reduced by half compared to a single scan. However, the driving circuit cost increase is inevitable. In the case of HDTV whose scan line is more than VGA resolution, the addressing speed will be a big issue[3]. Therefore, the addressing time should be reduced by modifying cell structure and/or driving circuit[4].

In this paper, in order to reduce the addressing time, we have modified the shapes of bus and address electrodes in various ways and have investigated the addressing time with a 4-inch model ac PDP using the selective writing method of ADS.

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2. Experimental

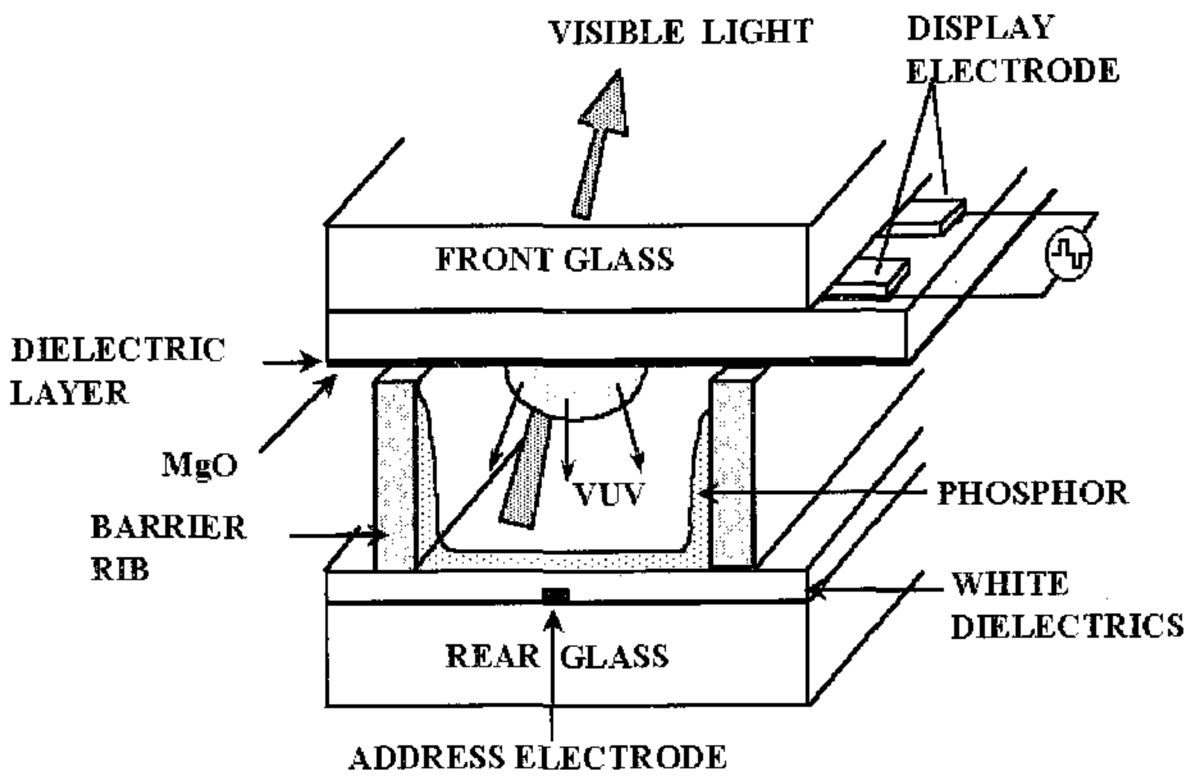
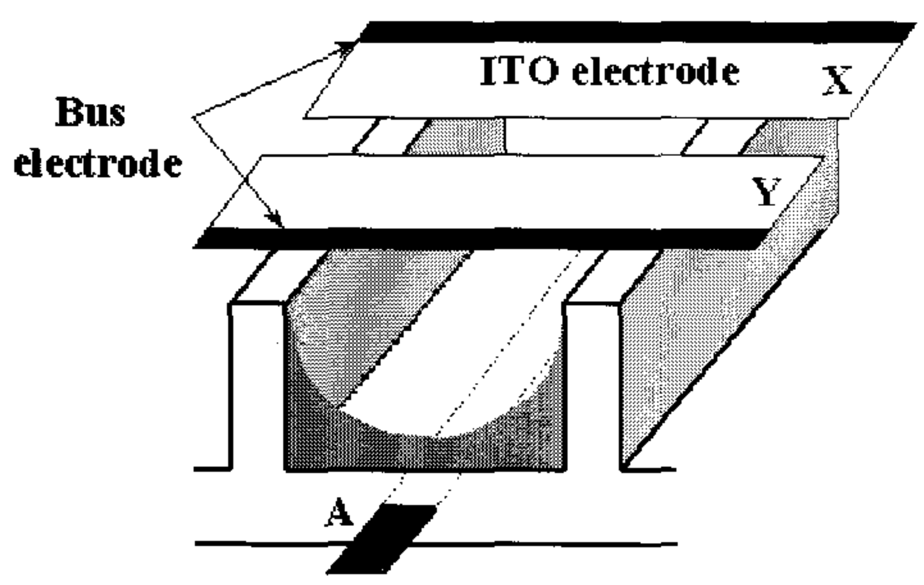


Fig. 1. The schematic diagram of model ac PDP.

TABLE 1. Specification of 4-in ac PDP.

Front panel		Rear panel	
ITO width	310 ㎛	Address electrode width	100 ㎛
ITO gap	60 ㎛	White back thickness	15 ㎛
Bus width	100 ㎛	Rib height	150 ㎛
Dielectric thickness	25 ㎛	Rib pitch	360 ㎛
MgO thickness	5000 Å	Rib width	70 ㎛
		Phosphor thickness	20 ㎛



X : Discharge sustain electrode
Y : Scan / discharge sustain electrode
A : Address electrode

Fig. 2. The arrangement of conventional electrodes in a cell of ac PDP.

TABLE 2. The conditions of applied voltage.

V_Y	-150 V
V_Y scan base	-50 V
V_A	100 V
V_X	40 V
V_X reset	350 V
V_S sustain & swing	130 V
Rising time of addressing pulse	100 ns/100 V

Fig. 1 shows a well-known ac PDP cell and Table 1 shows the spec. of a 4-inch model PDP used in this study with VGA resolution. The electrode shapes of the conventional discharge sustain electrode X, scan/ discharge sustain electrode Y and address electrode A are shown in Fig. 2, which is well known as 3 electrodes stripe structure [5-6].

Fig. 3 shows the driving waveform in order to detect the addressing time in the addressing period. The applied voltage for each electrode is listed in Table 2. One sequence of this driving scheme is about 2ms, and this sequence is repeated. In order to eliminate the cross-talk phenomena, the address electrodes are addressed in alternate lines. The number of cells to be address is 300 ea.

Fig. 4 shows a typical waveform for addressing pulse voltage V_A, charging current I_0 (displacement current) and addressing discharge current I_a by gas discharge. The discharge time lag T_l and the duration of discharge current T_d are also denoted in Fig. 4. T_l is the period of time that elapses between the application of an electric field and the onset of a breakdown, and T_d is the sustained time of the addressing discharge current. Since the addressing discharge process is

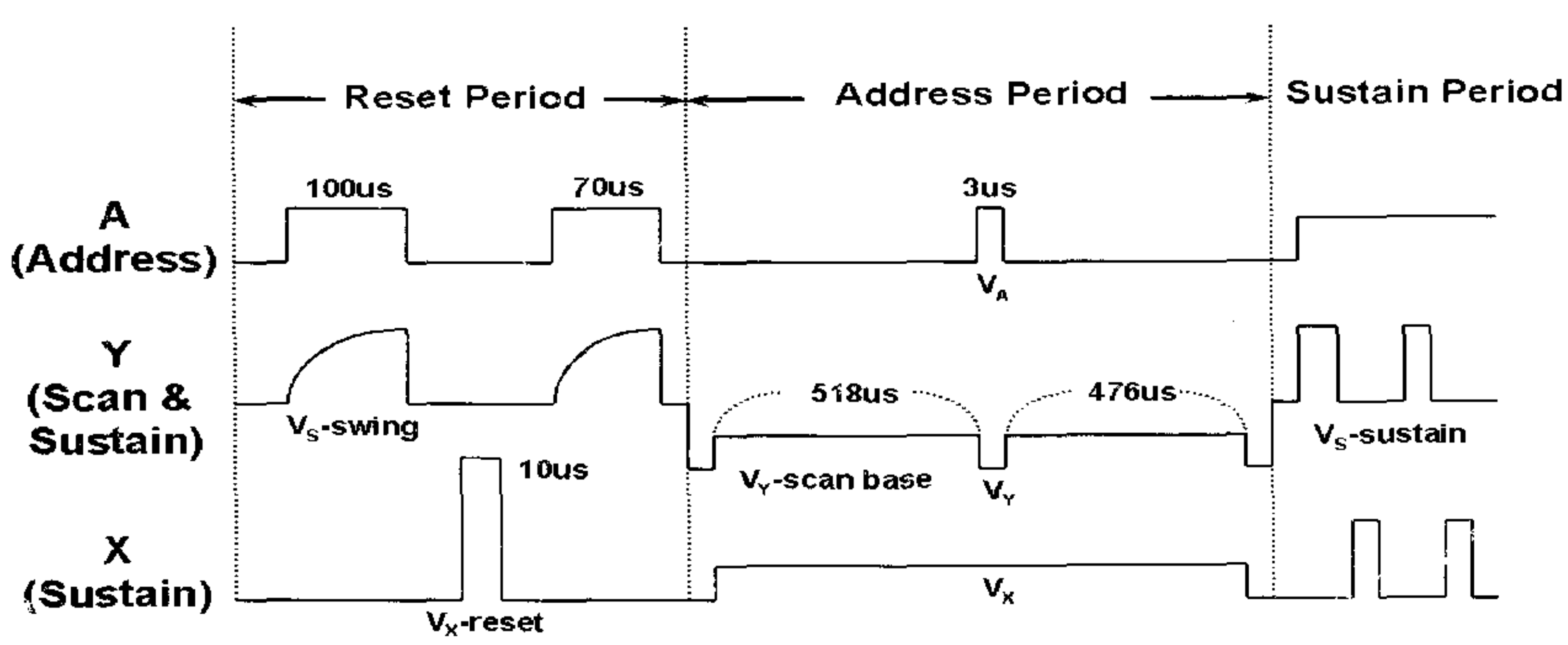
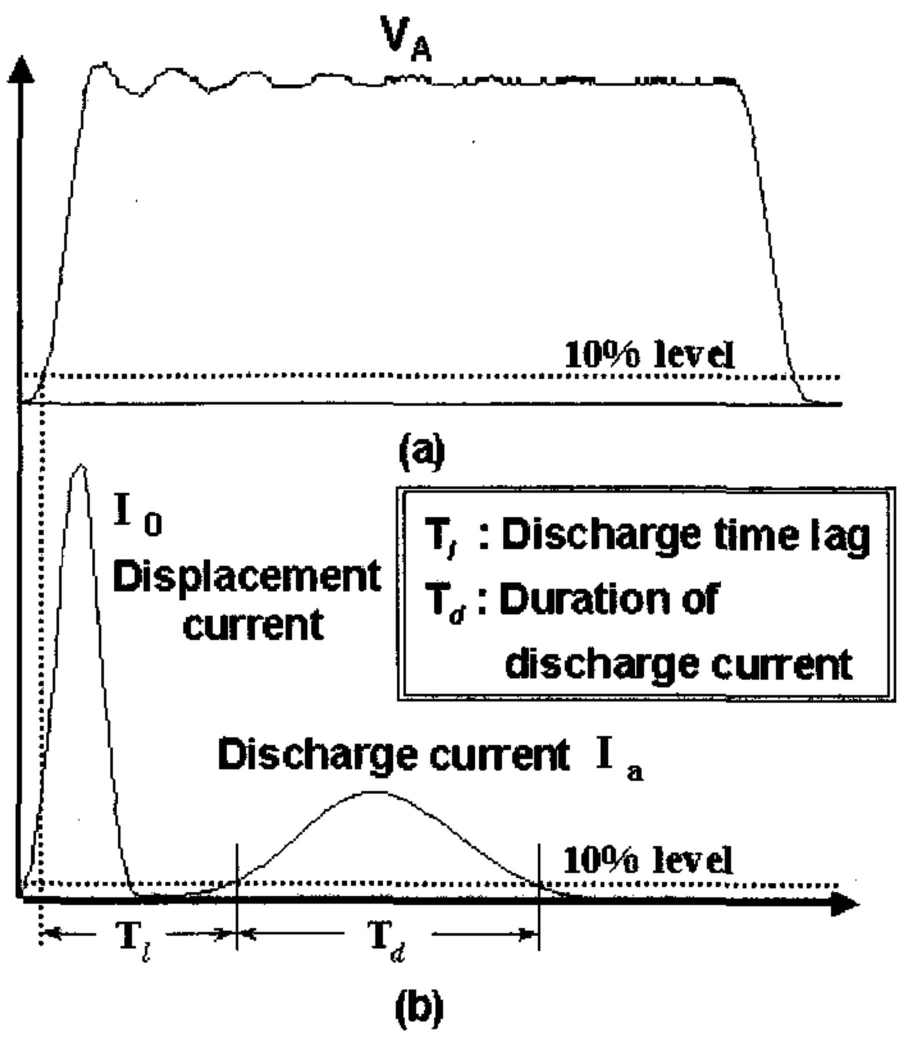


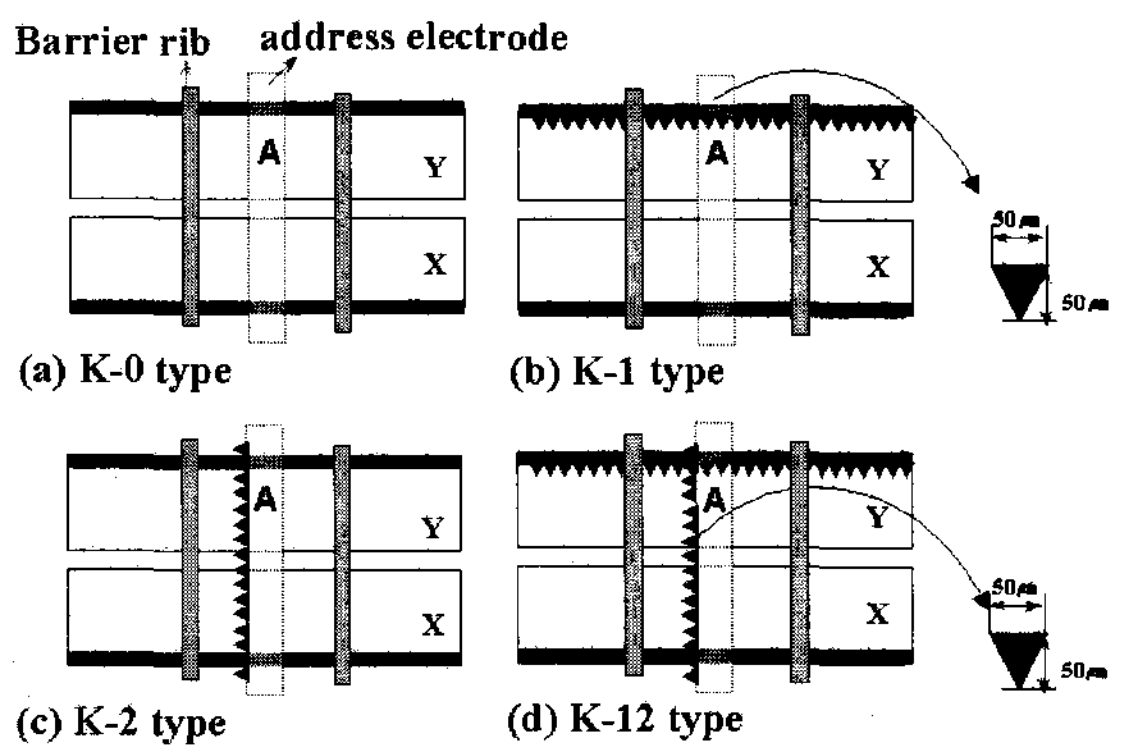
Fig. 3. The schematic diagram of driving waveform in the experimental (ADS method).

finished in the time of the $T_l + T_d$, the addressing time is determined by the $T_l + T_d$[7]. The discharge current waveforms are detected by a memory oscilloscope.



(a) Applied voltage waveform
(b) Displacement and Discharge current waveform

Fig. 4. The definition of T_l and T_d.



K- 0 : Conventional electrode
K- 1 : Modified bus electrode
K- 2 : Modified address electrode
K-12 : Modified bus and address electrodes

Fig. 5. The shapes of conventional and modified bus electrodes and address electrodes.

Fig. 5 (a) shows conventional shapes of bus and address electrode denoted as K-0 type. Figs. 5(b), (c) and (d) show the modified Y and A electrodes in order to reduce the addressing time by the concentration of electric field at the tips of protrusion parts denoted as K-1, K-2 and K-12, respectively. The average width of the modified address electrode is 100 ㎛, which is the same as conventional ones. The number of the tips is determined in consideration of align free between front and rear panels. For comparison purpose, the four kinds of cell structures in Fig. 5 are fabricated in a 4-inch model PDP. In this case, one of the kinds of cell structure includes 300 cells.

3. Results and Discussion

Fig. 6 shows the waveform of displacement current I_0 and addressing discharge current I_a in addressing period between scan and address electrodes of K-0 and K-1 in Fig. 5. For the conventional type K-0, the addressing time was 1.21 μs. The 1.21 μs is the sum of the discharge time lag (0.53 μs) and the duration of discharge current (0.68 μs). For the modified bus electrode type K-1, the addressing time, the discharge time lag and the duration of discharge current were 1.04 μs, 0.41 μs, and 0.63 μs, respectively. From these results, it can be observed that the addressing time of K-1 is reduced by about 15 % than that of K-0. In this case, the luminance was almost the same with the K-0.

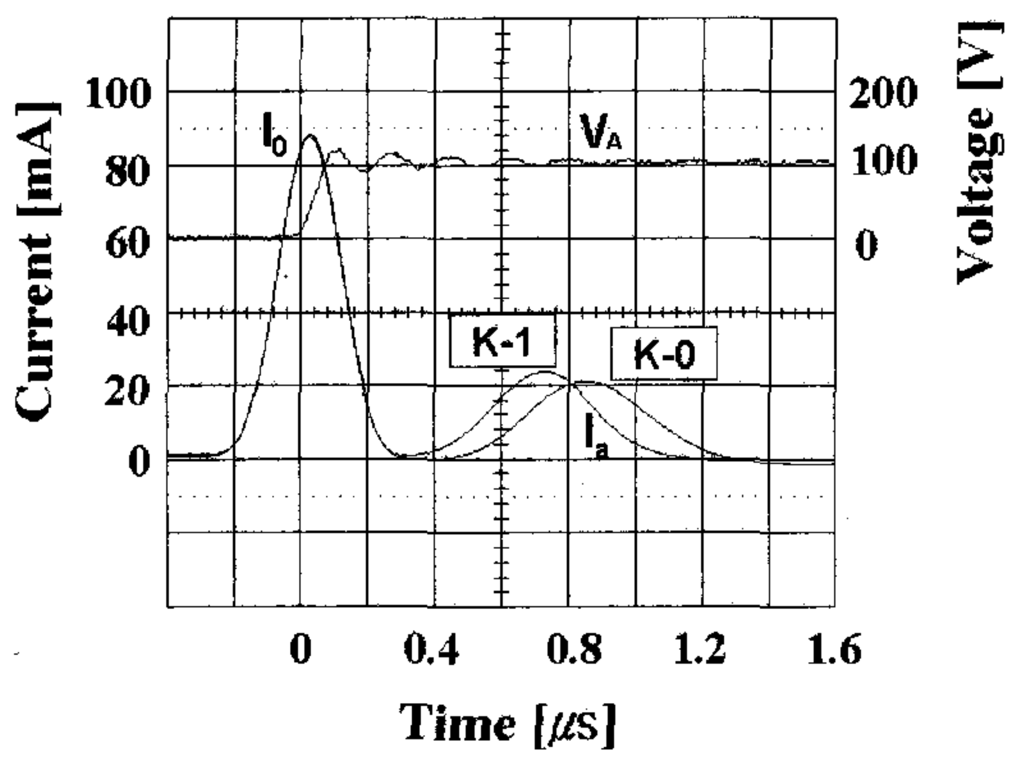


Fig. 6. The discharge current waveforms as a parameter of bus electrode.

The decrease in the addressing time of K-1 may be due to the decrease in the discharge time lag. The discharge time lag arises due to the following two conditions which must be simultaneously satisfied in order that an address discharge can occur in a gas[8]. First, there should be at least one suitably located free electron in a gas. Secondly, the electric field must be of sufficient strength and duration to ensure that this electron produces a sequence of avalanches that lead to addressing discharge.

In the absence of an initiatory electron, addressing discharge will not develop immediately even through the electric field greatly exceeds the breakdown field[8-10]. Under these circumstances, it is necessary to wait for the arrival of an electron liberated by some means. Free electrons can be produced easily in the case of modified bus electrode of K-1 by the concentration of electric field at the tip of the protrusion parts. Therefore, the addressing time of K-1 is reduced compared with K-0.

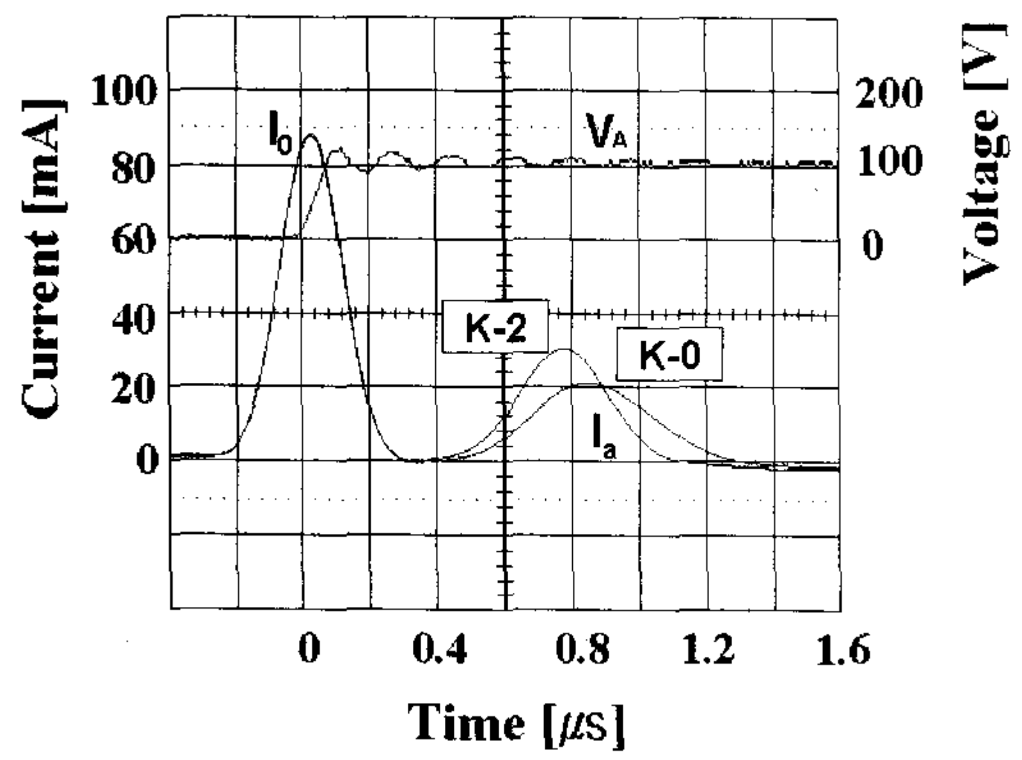


Fig. 7. The discharge current waveforms as a parameter of address electrode.

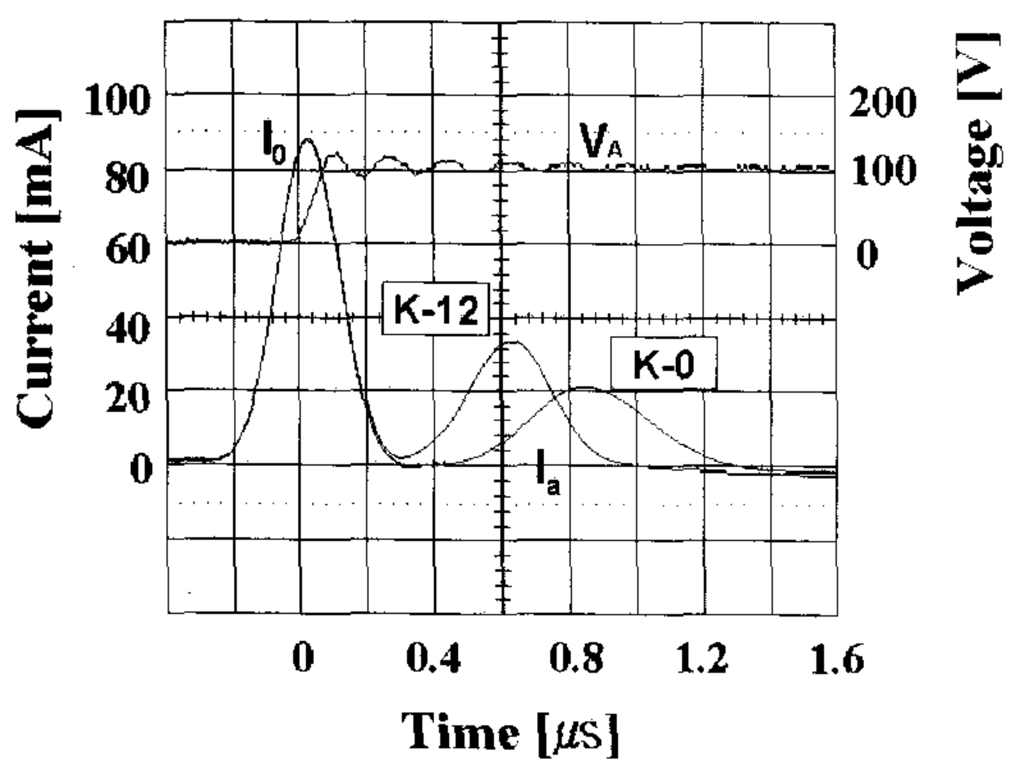


Fig. 8. The discharge current waveforms as a parameter of conventional and modified new bus and address electrodes.

Fig. 7 shows the waveforms of displacement current, discharge current and applied voltage, when modified address electrode K-2 is used. For comparison purpose, the current waveform for the conventional address electrode was also added. For the discharge current waveform of K-2, the addressing time, the discharge time lag and the duration of discharge current were 1.04 μs, 0.5 μs and 0.54 μs, respectively, whereas 1.21 μs, 0.53 μs and 0.68 μs for the conventional address electrode of K-0. From these result, the addressing time of K-2 is reduced also by about 14~15 %, as compared with K-0.

Fig. 8 shows the addressing discharge current and voltage waveforms when both the bus electrode and the address electrode are modified as shown in K-12 type of Fig. 5. From the discharge current waveform of K-12, the addressing time, the discharge time lag and the discharge sustain time were 0.86 μs, 0.35 μs and 0.51 μs, respectively. From these results, the addressing time of K-12 is reduced by about 30 % than that of K-0.

4. Conclusion

In this study, a new method for reducing the addressing time has been suggested. By introducing free alignment triangular protruding bus electrode, the addressing time was reduced by about 15 %, and by introducing free alignment triangular protruding address electrodes, the addressing time was also reduced by about 15 %. Consequently, total addressing time could be reduced by about 30 %. Almost the same luminance and luminous efficiency as conventional types are obtained by introducing the new modified electrodes.

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