Dual Address Electrodes for Fast Addressing Method of ac-PDP with High Xe% Working Gas

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Abstract
In this paper, new address electrode having separated dual electrodes is suggested to reduce addressing time in ac PDP. It had been found that both the formative and jitter width of the suggested electrode are improved by 10~20 % compared with the conventional one on IMID 04'. So we experiment other several kinds of the separated electrodes, and the change in discharge characteristics is analyzed by using a two-dimensional fluid simulation. The key feature of the suggested structure is that the distribution of Xe and Ne ion is controllable during the address periods without significant increases in the capacitive load of the address electrodes.

1. Introduction
As a driving method for an ac PDP, address-display separated (ADS) scheme has been used widely [1],[2]. However, one of the most important problems in ADS scheme is that the address time is too long. The addressing time is defined as the sum of the discharge time lag and the duration of discharge current [3]. If the addressing time increases, the sustaining period for image display should be decreased. As a result, the luminance of the PDP decreases. Moreover, gas mixture with a high partial pressure of Xe has recently been introduced in PDP industry to increase luminous efficiency and luminance [4],[5]. However, the addressing time and the duration of discharge current increase with Xe concentration due to the decrease of the effective ion mobility [6],[7].

In this paper, various modifications of the address electrode shape are suggested in order to reduce the addressing time and its jitter. Also, the experimental results are analyzed with a two-dimensional fluid simulation [8]-[10]. Each case of the suggested structure and experimental method are described in Sec. 2. Experimental and simulation results are presented for the comparison of the modified address electrode with a conventional electrode in Sec. 3, followed by conclusions summarized in Sec. 4

2. Experimental method
Figure 1 shows a typical structure of a discharge cell in an ac PDP, and Table 1 shows the specifications of 4-inch test panels used in this study. The cell dimensions of test panel are equal to that of 42" VGA grade commercial panels.

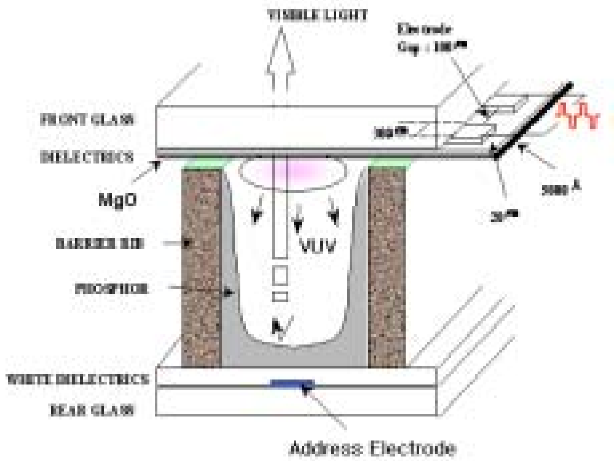


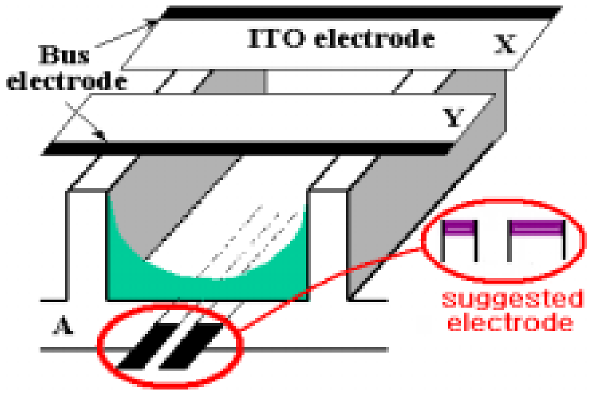
Figure 1. Principle structure of a discharge cell

Table 1. The specification of 4-in ac PDP.

Front panel		Rear panel	
Dielectric thickness	30 μm	White Back thickness	15 μm
ITO width	310 μm	Rib height	130 μm
ITO gap	60 μm	Rib pitch	360 μm
Bus width	100 μm	Rib width	70 μm
MgO thickness	5000 Å	Working gas	Ne + Xe (8%)

Figure 2 shows the schematic of suggested addressing electrodes within a conventional ac PDP cell, and table 2 shows the specification of each case according to the shape variation of the address electrode. The total electrode width of 100㎛ used in this work is the same as that of the reference design (Case1) of the conventional address electrode, but case 8 uses a wider gap size of 140㎛ without separation. The structures of case 2~7 separate the electrode. The structures of case 1 and case 8 have one electrode such like 100㎛, 140㎛ in order to compare to play a role in separate with non-separate. The structures of case 2~5 have the difference of gap distance on same electrode, and the structures of case 3, 6 and 7 have the difference of electrode on same gap distance. The structures of case1, 2, 3 and 6 directly make an experiment on our laboratory.

Moreover, a two-dimensional fluid simulation [8]-[10] is adopted for the investigation of the discharge characteristics with the modified electrodes (case1~8), and its results compare well with the experimental results.



X : Discharge sustain electrode

Y : Scan / discharge sustain electrode

A : Address electrode

Figure 2. the schematic of suggested addressing electrodes within a conventional ac PDP cell

The characteristics of the suggested electrodes have been compared with the conventional one under the circumstances of Xe contents of 8%, in terms of dynamic margin, discharge time lag and jitter width in address discharge.

In order to detect the discharge current waveform of a cell during the address period, we used a high sensitive light detector, APD (avalanche photo-diode). It is well known that the light waveform shows similar tendency to the discharge current waveform at the peak time and for its dispersion [11].

Table 2. The specification of each case according to the variation of the address electrode and the case of experiment and simulation

	The structure of electrode	The distance of gap	experiment	simulation
Case1	100㎛	0 ㎛	◎	◎
Case2	50㎛ 50㎛	20 ㎛	◎	◎
Case3	50㎛ 50㎛	40 ㎛	◎	◎
Case4	50㎛ 50㎛	60 ㎛		◎
Case5	50㎛ 50㎛	80 ㎛		◎
Case6	60㎛ 40㎛	40 ㎛	◎	◎
Case7	70㎛ 30㎛	40 ㎛		◎
Case8	140㎛	0 ㎛		◎

3. Results and Discussion

Figures 3(a) and 3(b) show the outline of the formative time lag and the jitter width of Cases 1, 2, 3 and 6, when they are driven by the ADS drive waveform. The delay time is measured by APD during address period while the address voltage is increased from 50V to 80V with an increment of 10V. From these figures, it was observed that the addressing time and its dispersion increase as voltage increases, and the formative time lag and the jitter width of case 3 and 6 are reduced approximately by 20 - 30 % compared with that of case 1, and the gap distance of 40㎛ has shorter delay time than 20㎛. Moreover, we reported that the dynamic margin of the modified structure is broader than that of the conventional structure on IMID 04'. As its broadened margin domain is more stable in discharge, the discharge delay time and the jitter width are reduced. The separated gap of each electrode plays an important role in broadening electrode width and activates discharge in address period.

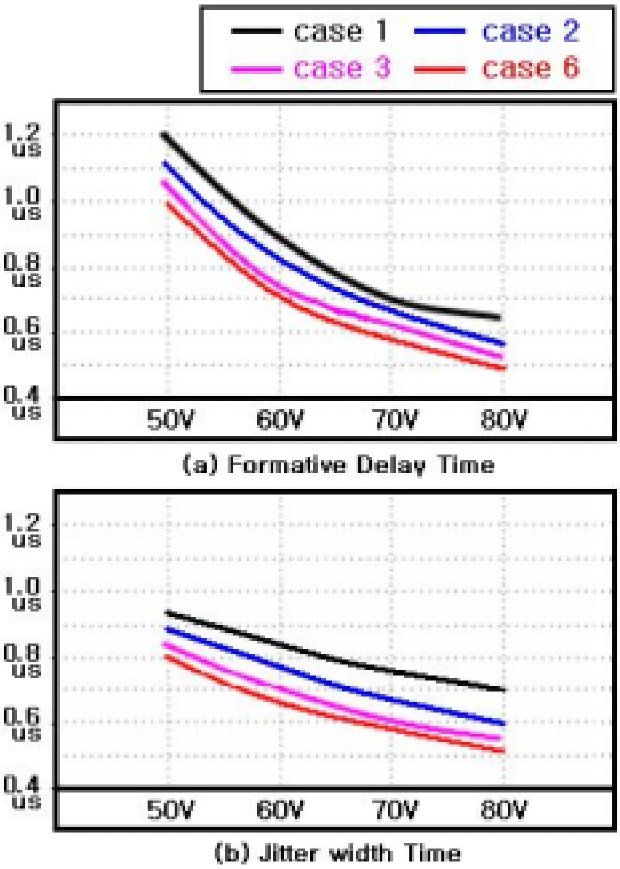


Figure 3. The outline of the formative time lag (a) and jitter width (b) of Cases 1, 2, 3 and 6

In order to analyze the experimental results of modified electrodes, we simulated facing discharges for each case by a two-dimensional fluid simulation. The simulation code is supported by POSTEC. Table 3 shows that the time of peak current, the particle number of Xe+ and electron and the power according to the structure of the address electrodes during address period. The time of peak current is detected the peak point of current after supplied square pulse. The change of Ne+ particle number is similar to the change of electron number.

In Figures 6(a)-6(d), the contour plots show the density distribution of Xe ions at the peak time of each addressing discharge. Figures 6(a) - 6(d) present to cases 1, 3, 7 and 8, respectively, and other cases can't show cause of paper space.

Table 3. Time of peak current, the particle number of Xe+ and electron and the power according to the each case during address period.

Electrode Structure	Time of peak current	Number of Xe+	Number of electron	Power
Case 1	1.767μs	4.61e6	3.27e5	2.07mW
Case 2	1.700μs	5.48e6	5.84e5	2.83mW
Case 3	1.677μs	5.92e6	6.84e5	3.08mW
Case 4	1.680μs	6.19e6	6.6e5	2.97mW
Case 5	1.702μs	6.46e6	5.62e5	2.76mW
Case 6	1.676μs	5.92e6	6.87e5	3.09mW
Case 7	1.674μs	5.92e6	6.95e5	3.11mW
Case 8	1.634μs	6.51e6	9.69e5	3.93mW

Because the speed of a discharge is related to the ion motion, the numbers of Xe+ and Ne+ play a dominant role in the jitter width. Especially, the number of Xe+ is 50 times larger than the number of Ne+ as the ionization threshold energy is smaller for the Xe gas, and thus Xe+ is the most important particle acting on the jitter width.

In case of the gap distance between two electrode (case 2~5), the 40μm gap (case 3) has the fast discharge time and the most Ne ion, electron and power. The longer gap distance has the more Xe+, but Xe+ is distributed very broadly in this case. So, we confirm that concentrated Xe+ is smaller rather than in center of 40μm gap.

In case of the asymmetric rate between two electrode (case 3,6,7), the structure of 70μm+30μm (case 7) has the fast discharge time and the most particles. From the figure 6, the Xe ions accumulated on the dielectric surface starts to move to the address electrode when the pulse is applied on the address electrode and Xe ions are distributed on each edge of address electrode at the peak time of discharge. The 70μm electrode of the asymmetric address (case 4) has similar Xe+ quantity with the 50μm electrode of case 2 and the edge side of case 5. The 30μm electrode of the asymmetric address (case 4) has a little Xe+ quantity comparing with the 50μm electrode of case 2 and the edge side of case 5. Therefore, the 70μm electrode triggers fast discharge during address period and the 30μm electrode spends less power. Considers that the jitter width of case 3 is almost similar to case 6 in the experiment, we can conclude that the structure of separated electrode is more useful than case 1.

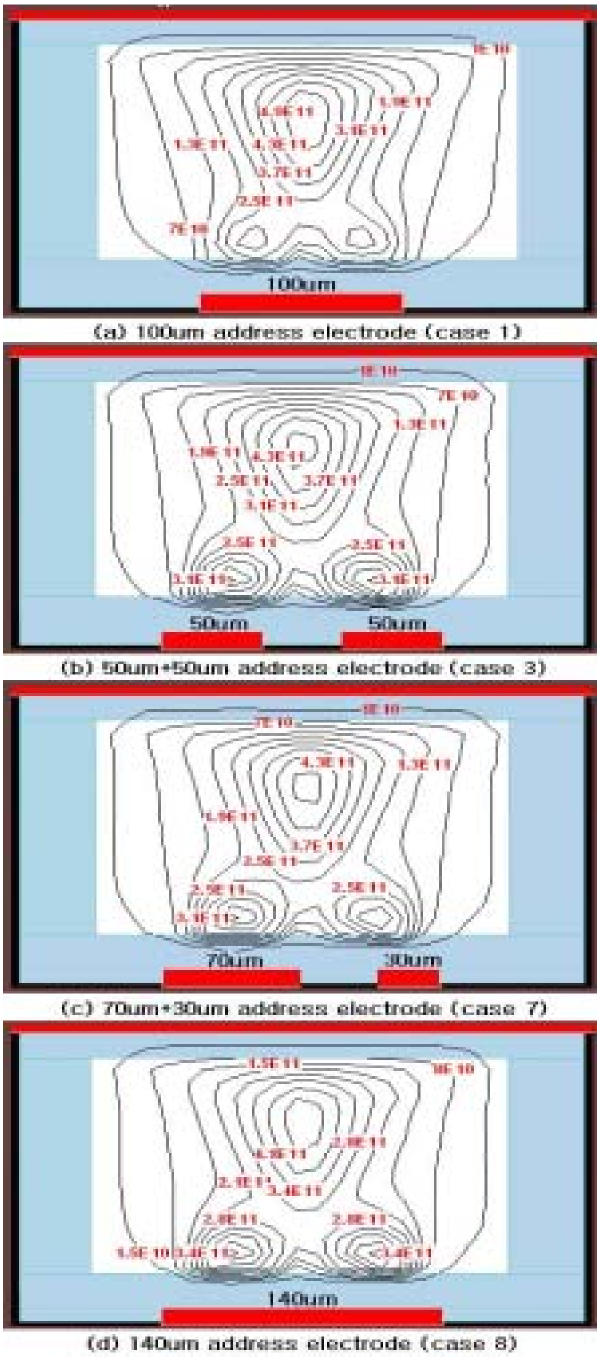


Figure 7. The contour plots of the density of Xe ions at the peak time of each addressing discharge

4. Conclusion

In this paper, we suggest new addressing electrode shapes to reduce the jitter width even with a high Xe concentration to acquire high luminance efficiency. The suggested address electrodes maintain the dynamic margin and reduce the jitter width by 20%~30%. Also, we investigate that case 7 has the fast discharge time and the most particles by using a experiment and a 2-dimansional simulation. Because the dielectric and phosphor covering address electrode assist the electric field on empty space between the separated electrodes, the modified electrode can control the distribution of particles during the address periods without significant increase in the capacitive load of the address electrodes and other driving circuit.

5. References

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