Sustain Discharge Mode Assisted by Various Auxiliary Pulses in AC PDP

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Abstract

The sustain discharge mode using various auxiliary pulses was proposed to improve both the luminance and luminous efficiency of ac-plasma display panel (ac-PDP). It was found that the various auxiliary pulses, which were applied at the rising and falling time of the sustain pulse, played a role in strengthening both the main and self-erasing discharges. As a result, the sustain waveforms with auxiliary pulse improved both the luminance of 23 % and the luminous efficiency of 36 %, when compared with the conventional sustain waveform without auxiliary pulse.

1. Introduction

In the current PDP technology, the luminance and luminous efficiency need to be further improved for the successful commercialization of the full color digital PDP-HDTVs [1]. Lots of technology for improving the luminance and luminous efficiency focused on the reduction of an address time, a new cell structure, a new materials, various driving schemes, and so on [2] [3]. In particular, some research results have been reported for improving the luminous efficiency using the various sustain waveforms [4]. However, the luminance improvement was relatively small, when compared with the high luminous efficiency improvement.

In this work, various auxiliary pulses were proposed to improve both the luminance and luminous efficiency during a sustain-period. The sustain discharge characteristics of the main and self-erasing discharge were examined when the auxiliary pulses are applied at the rising and falling time of the sustain pulses. In addition, the corresponding luminance and luminous efficiency were also examined.

2. Experiment

Fig. 1 shows the conventional and new driving schemes in which the auxiliary short pulse are applied with a simultaneous application of the sustain pulse. The reset and address waveforms were modified to prevent the misfiring discharge between the scan/ sustain electrode and address electrode during a sustain-period. In the conventional driving scheme, no address pulse is applied, whereas in the new driving scheme, the various auxiliary pulses are applied at the rising and falling edge of the sustain pulse (Case 1, Case 2, Case 3). Note that the positive auxiliary pulses are applied at the rising time of the sustain pulses, whereas the negative auxiliary pulses are applied at the falling time of the sustain pulses.

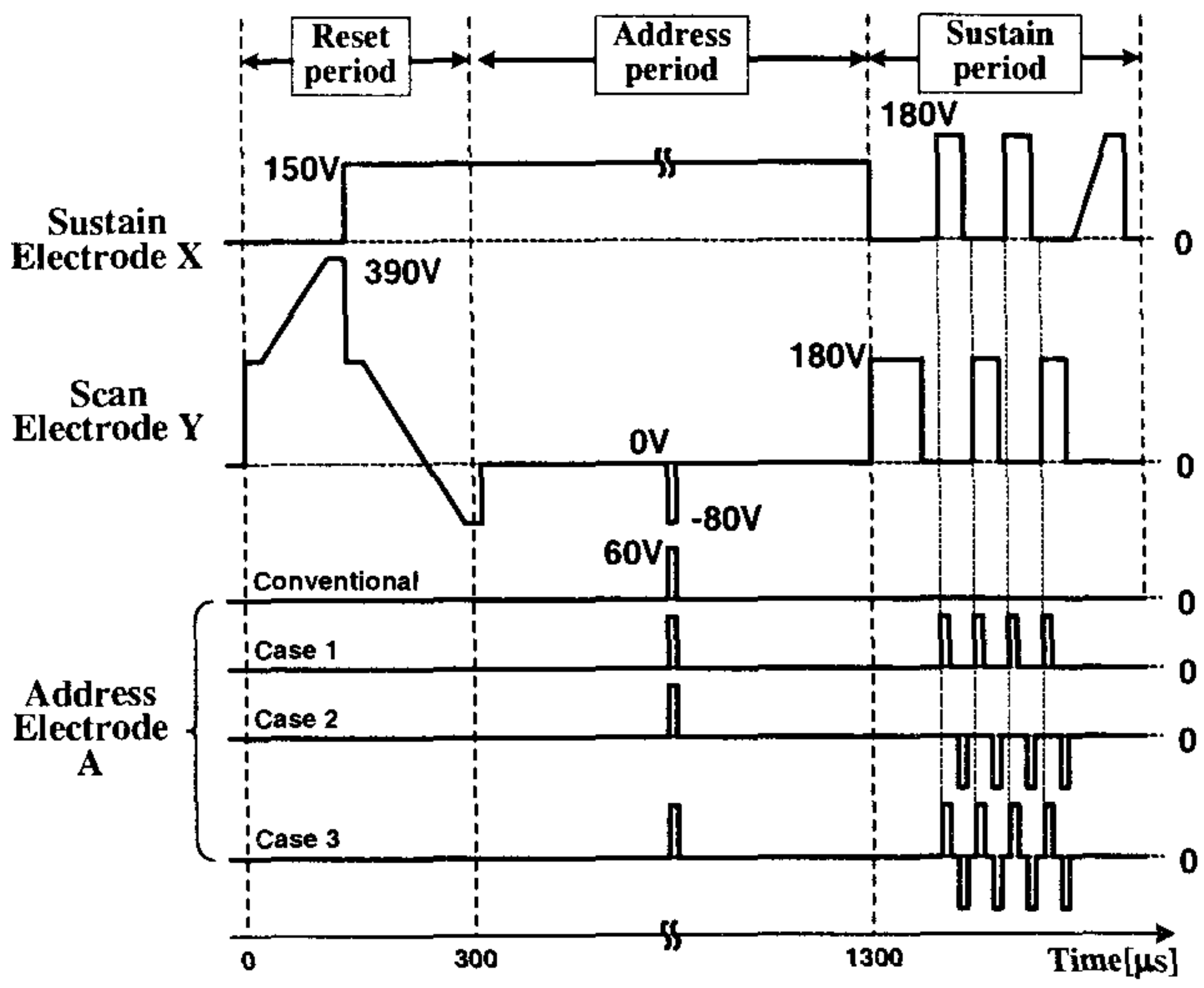


Fig. 1. Comparison of new driving scheme with conventional driving scheme.

The 4-inch test panel was used in the current study. The driving conditions are as follows: an address pulse width of 2 μs during an address-period, a sustain frequency of 100 kHz, sustain pulse width of 3 μs, a short auxiliary pulse width of 600 ns. The other conditions were illustrated in Fig. 1. The amplitudes of the auxiliary address pulses were varied to investigate how they influence the sustain discharge characteristics.

It is well known that the main discharge can be enhanced and produced fast by applying the short auxiliary address pulse at the rising time of the sustain pulse compared with conventional sustain waveform. It was reported that the luminance and luminous efficiency were improved by the sustain waveform with the short auxiliary address pulse [3]. In this paper, the variation of the width in the positive and negative auxiliary address pulses were not considered because the application of the auxiliary pulses at the rising and falling edges of the sustain pulse can more affect the main and self-erasing discharges. Accordingly, the width of the two types of the auxiliary pulse proposed in this paper was fixed for 600 ns.

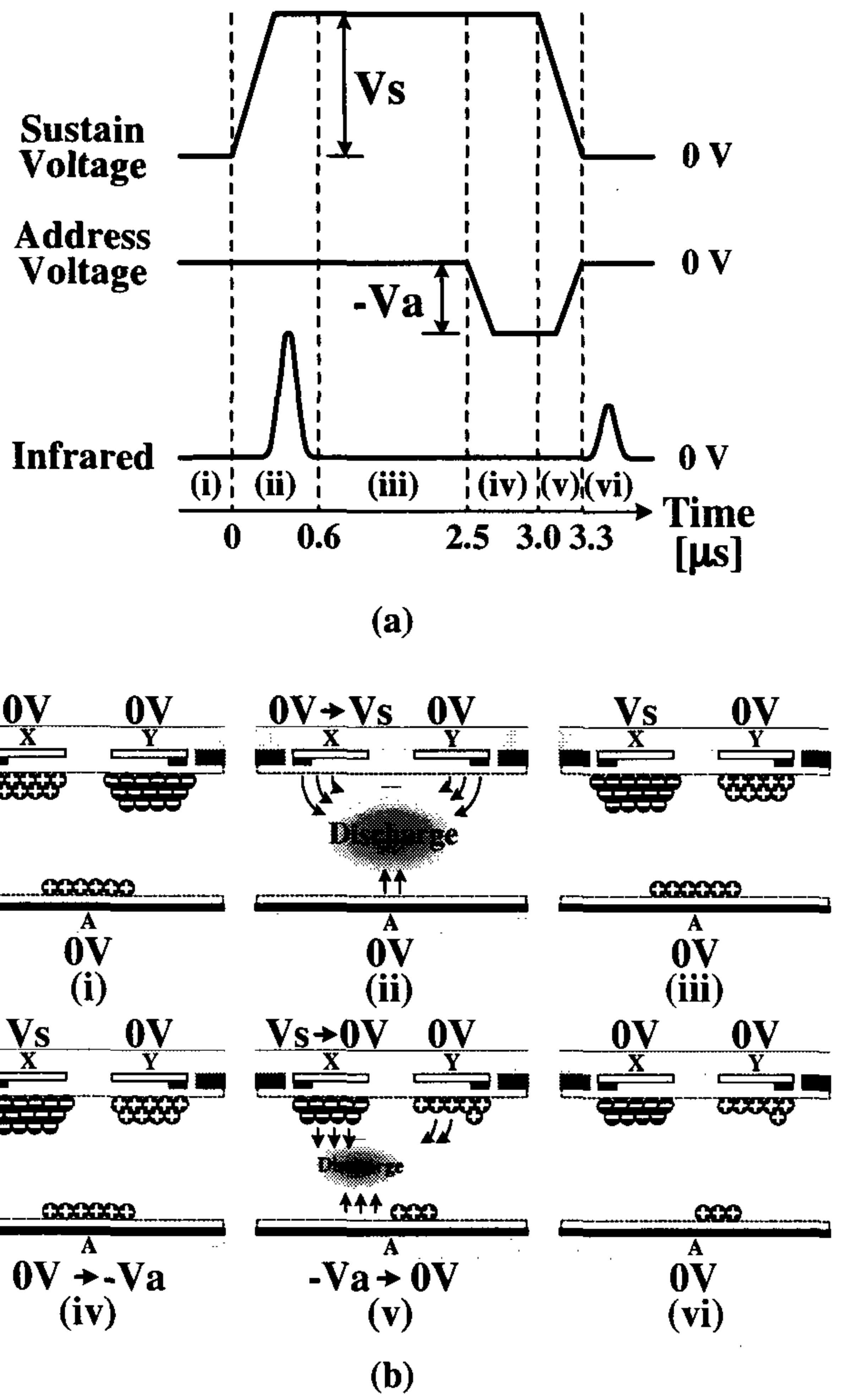


Fig. 2. Voltage and IR (823 nm) waveforms (a) and schematic model for temporal behavior of wall charges (b) in 4-inch AC PDP with proposed driving scheme for self-erasing discharge.

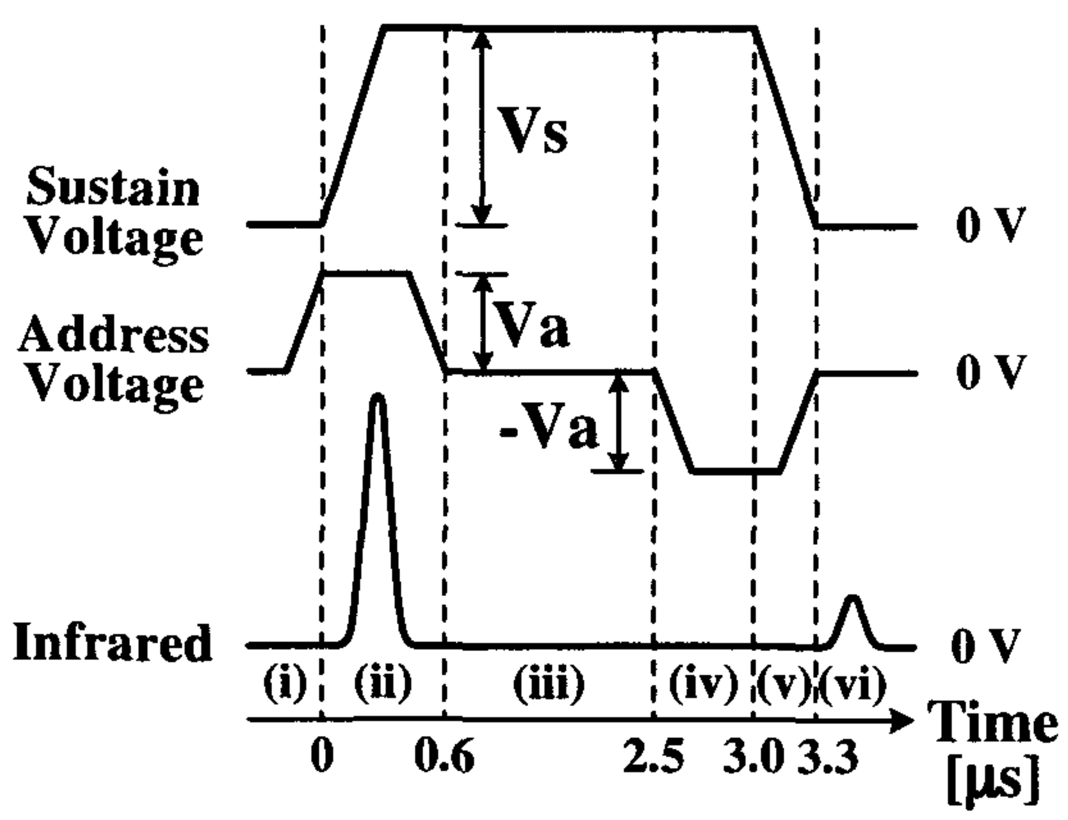
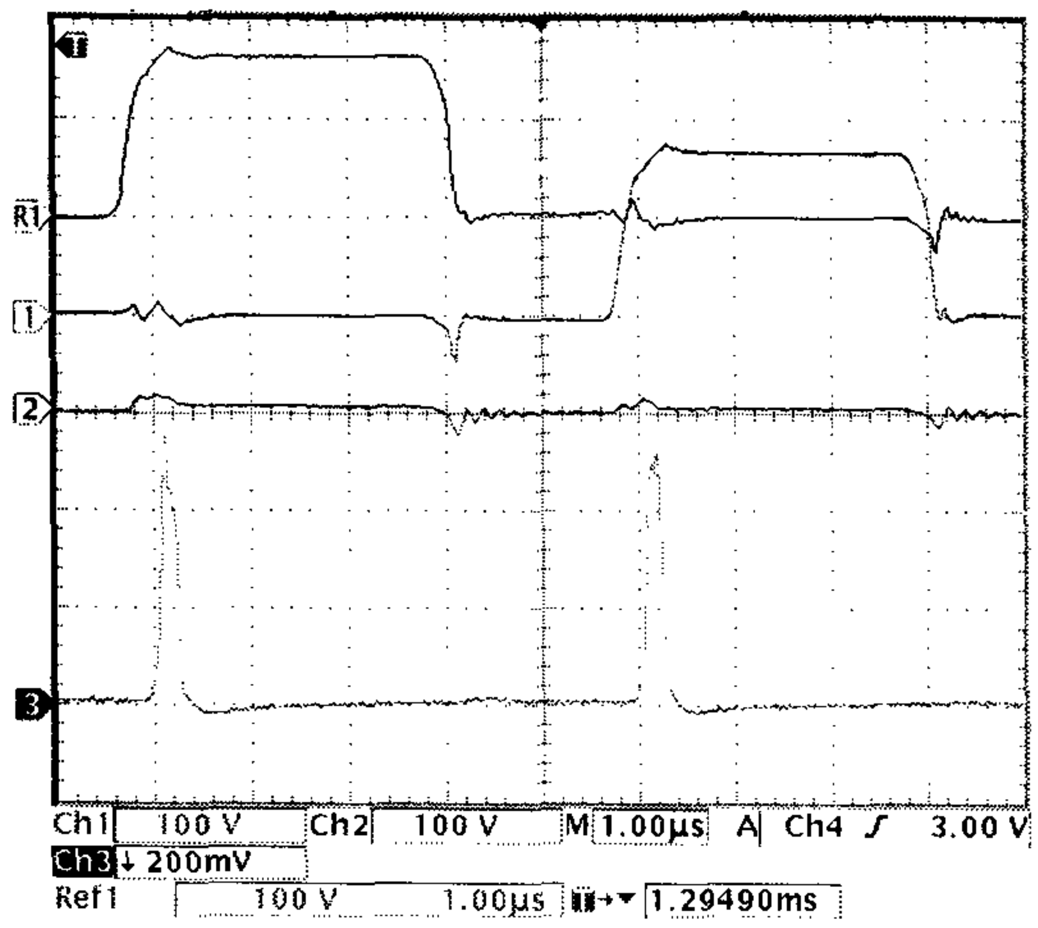


Fig. 3. Driving waveform for enhancing the main discharge using positive auxiliary address pulse.

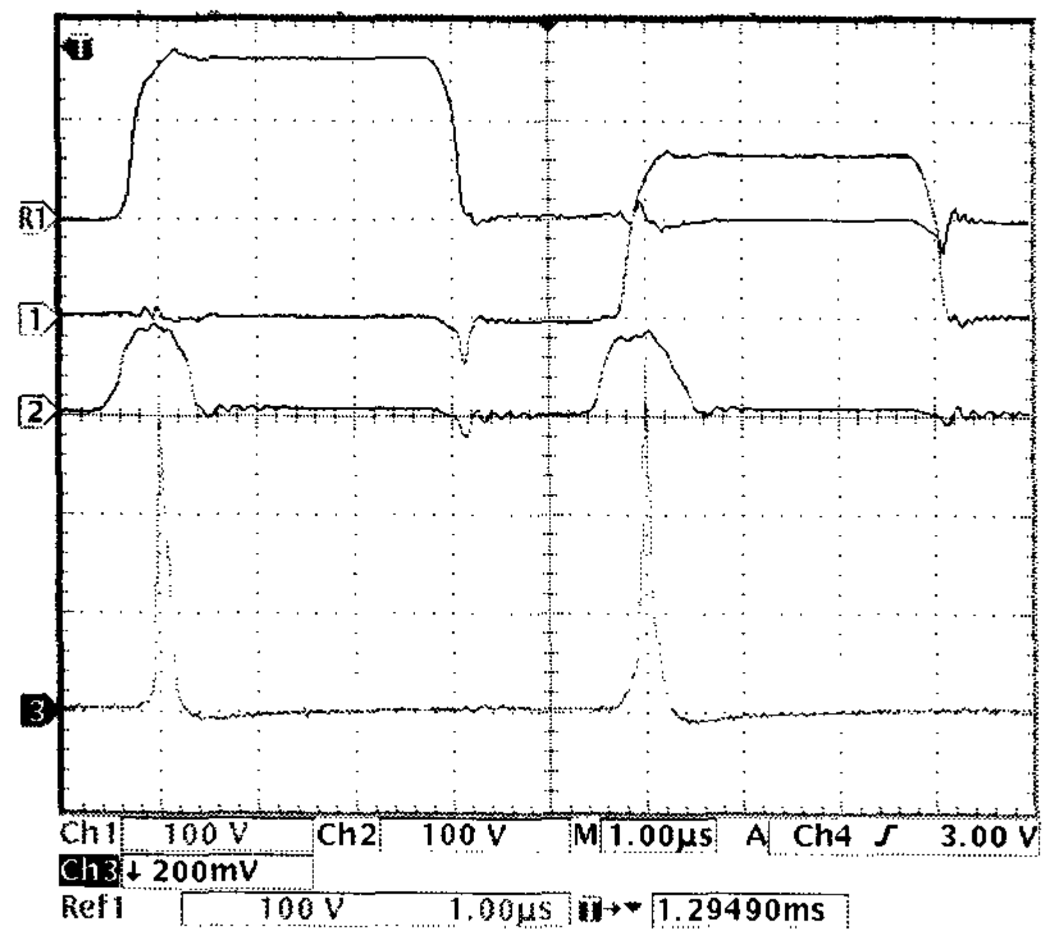
Fig. 2 (a) shows the driving waveforms of the sustain and auxiliary pulses (Case 2) applied to the three electrodes and the corresponding IR (823 nm) waveform based on the actual waveforms measured from the 4-inch test panel during a sustain-period. The corresponding temporal behavior model of the wall and space charges within the PDP cell relative to the varied voltage of the three electrodes are also shown in Fig. 2(b). When the sustain pulse is applied to the sustain electrode X, the plasma is produced due to the wall charges accumulated by the previous sustain pulse [Fig. 2(b)-(ii)]. This is the main discharge that emits the IR. After the main discharge is produced, the electrons and ions are accumulated on the electrodes X, Y, and A with the opposite polarity, respectively [Fig. 2(b)-(iii)]. At the point of 2.5 μs, the negative auxiliary address pulse is applied to the address electrode A [Fig. 2(b)-(iv)]. When the sustain voltage and address voltage fall to zero simultaneously, the self-erasing discharge using the accumulated wall charges is induced between the sustain X and address A electrodes [Fig. 2(b)-(v)]. As the self-erasing discharge is produced by the wall charges in the cell, the total wall charges in the cell on each electrode are reduced and the resultant next main discharge becomes weak. Therefore, this driving scheme can contribute to the improvement of the luminance and luminous efficiency without a misfiring discharge due to the modified reset waveform shown in Fig. 1. However, the loss of the wall charges due to the self-erasing discharge would increase the next sustain voltage, implying that the sustain voltage margin is reduced. To enhance the next main discharge intensity, *i.e.*, to increase the sustain voltage margin, the positive address pulse was applied on the address electrode when the sustain voltage are raised, as shown in Fig. 3.

3. Results and discussion

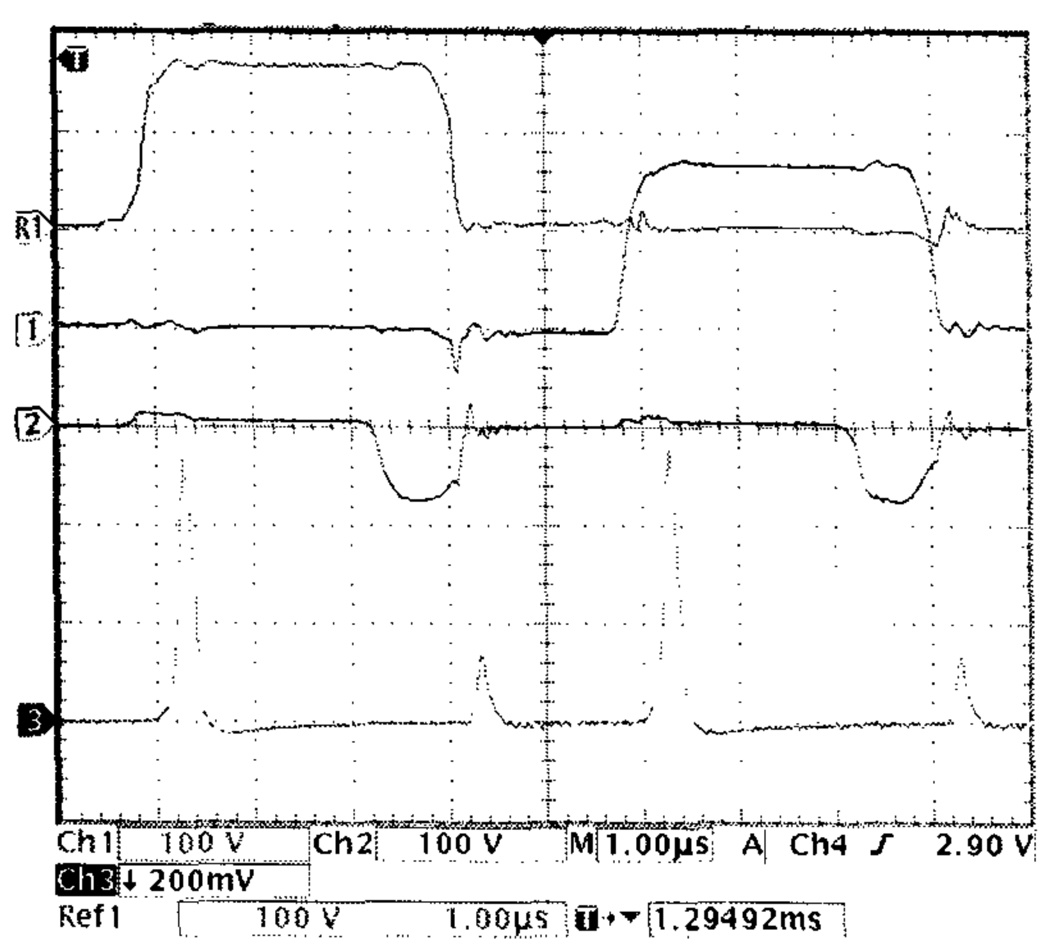
Fig. 4 illustrates the sustain, address voltage, and IR (823 nm) waveforms measured from the 4-in. test panel in the case of the conventional (a), case 1 (b), case 2 (c), and case 3 (d), respectively. The driving conditions in the conventional and new driving cases are a sustain voltage of 170 V, a driving frequency of 100 kHz, a sustain pulse width of 3 μs, an address pulse width of 600 ns, and address voltage of 80 V. In the conventional sustain driving scheme of Fig. 3(a), IR is emitted only once during the main discharge produced by the sustain pulse. On the other hand, in the case 1 of applying the positive auxiliary pulse at the rising time of the sustain pulse, the IR intensity of the main discharge was higher and the discharge initiation point was faster than conventional driving scheme, as shown in Fig. 4(b). In Fig. 4(c), after the negative auxiliary pulse was applied near the falling edge of the sustain pulse and fell to zero at the falling edge of the sustain pulse, the self-erasing discharge was produced and the resultant next main discharge become weak. Finally, when the positive and negative address pulses were applied to the address electrode at the rising and falling edge of the sustain pulse, the main discharge intensity was enhanced whereas the self-erasing discharge intensity decreased slightly.



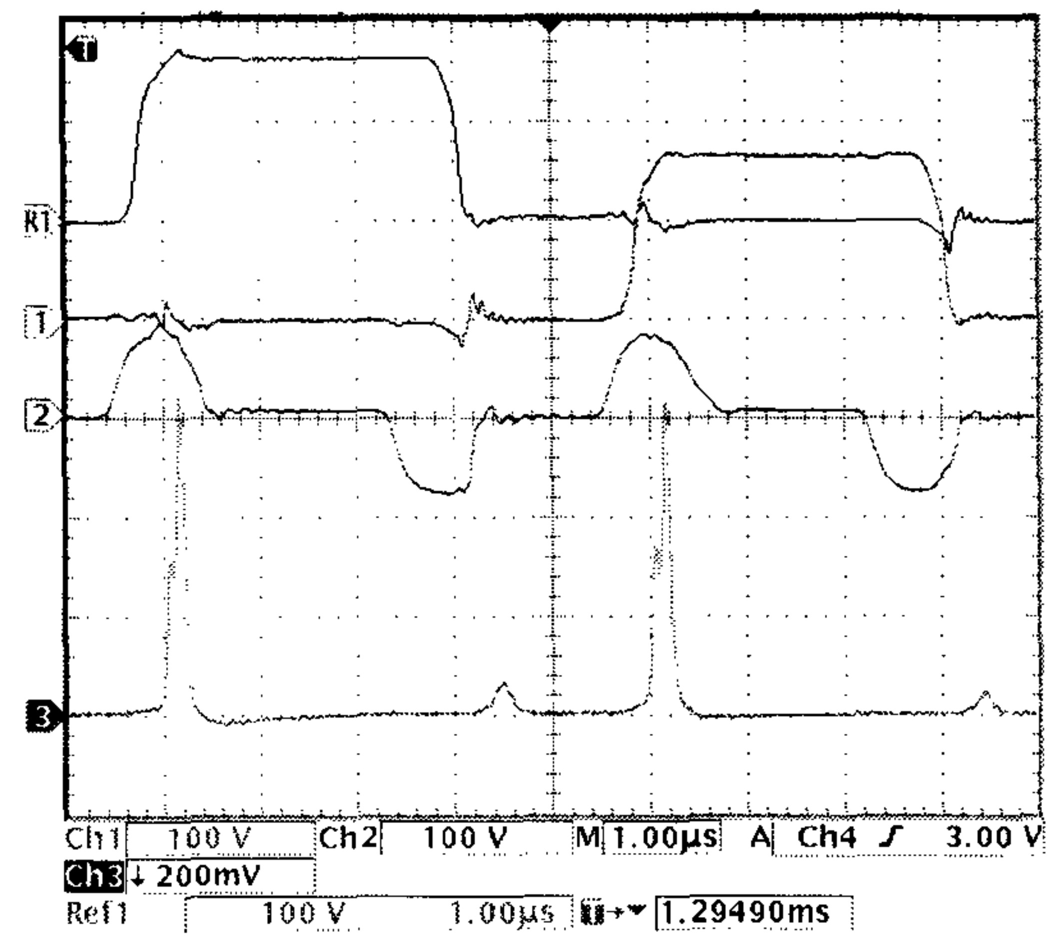
(a) Conventional driving scheme



(b) Case 1



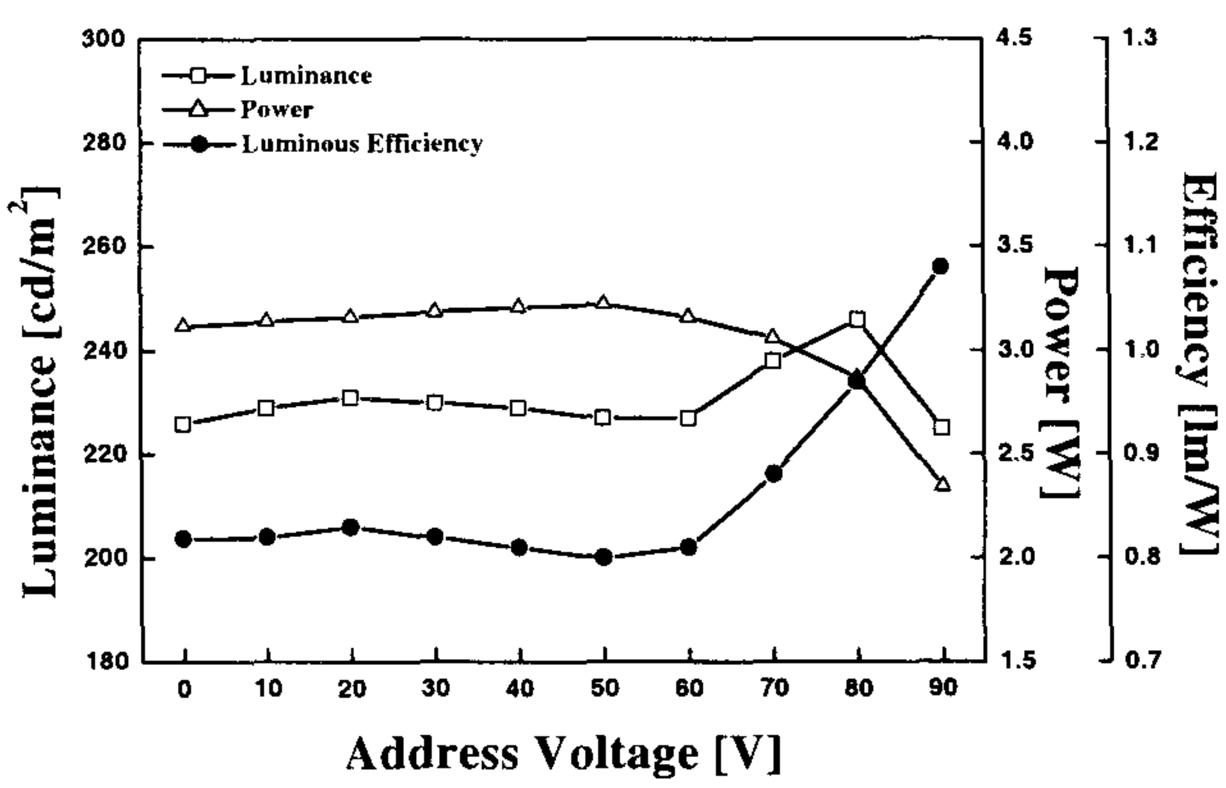
(c) Case 2



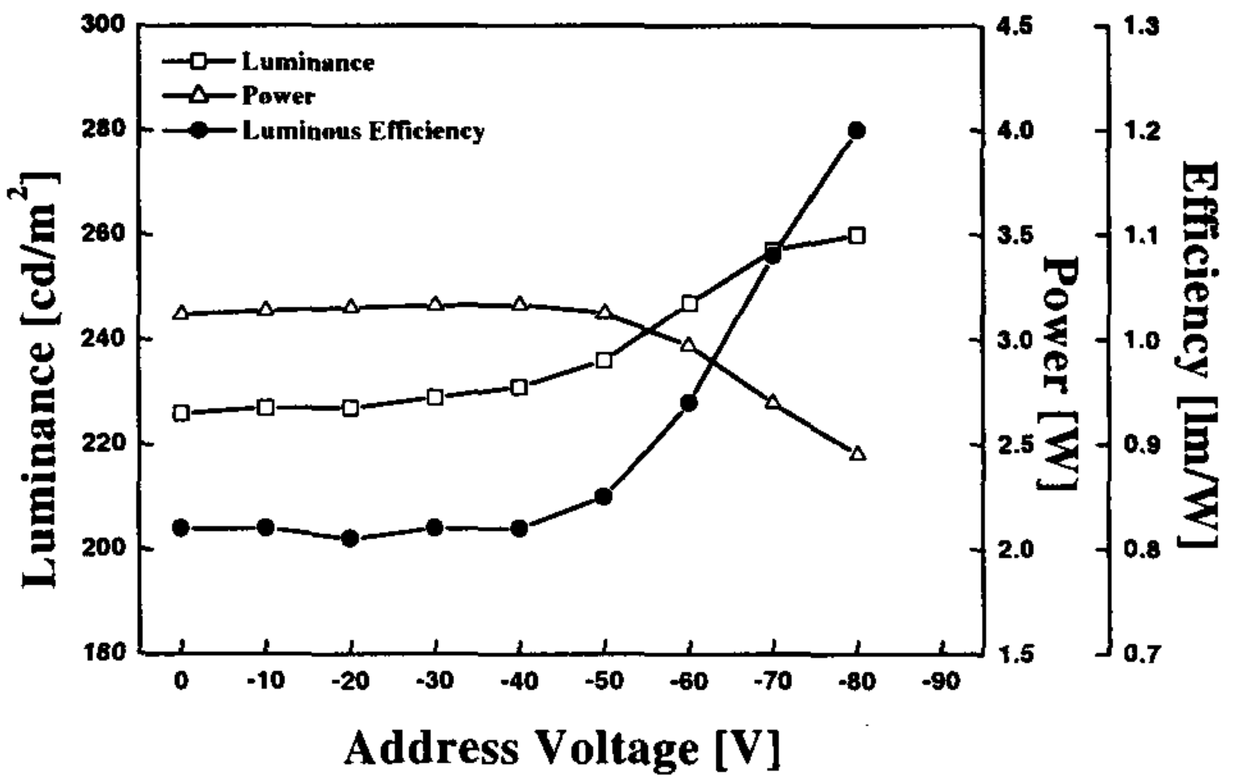
(d) Case 3

Fig. 4. Voltage and IR waveforms measured from 4-inch AC PDP test panel in the case of conventional (a) and three cases (b), (c), (d) waveform.

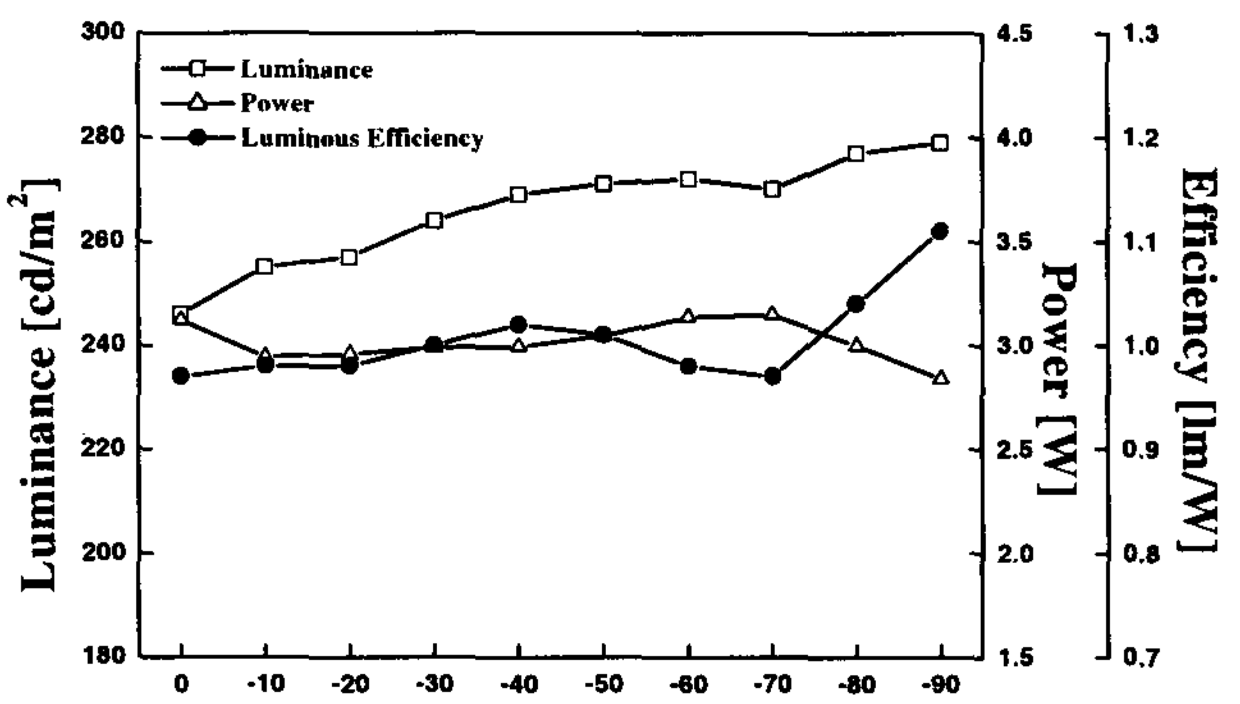
Fig. 5 illustrates the changes in the luminance, power consumption and luminous efficiency with an increase in the amplitudes of the auxiliary short pulse under the various driving modes: (a) Case 1, (b) Case 2, (c) Case 3. The widths in the positive and negative auxiliary pulses were fixed for 600 ns. In Fig. 5 (a), as the amplitude of auxiliary pulse increases, the main discharge intensity increases so that the luminance and luminous efficiency increases up to 9 % and 18 %, respectively. In the address voltage below –40 V, the luminous efficiency does not change because the address voltage below –40 V does not induce the self-erasing discharge. In the address voltage condition ranging from –50 V to –80 V, the self-erasing discharge intensity increases so that the luminance and luminous efficiency increases up to 15 % and 46 % compared with conventional driving scheme. However, in the case of applying the address voltage of –90 V, the main sustain discharge becomes too unstable due to the previous strong self-erasing discharge.



(a) Case 1



(b) Case 2



(c) Case 3

Fig. 5 Changes in luminance, power consumption, and luminous efficiency with an increase in the amplitude of various auxiliary address voltages: (a) case 1, (b) case 2, (c) case 3.

In Fig. 5(c), as the amplitude of auxiliary pulse increases, the main and self-erasing discharge intensities increase simultaneously so that the luminance and luminous efficiency increase up to 23 % and 36 %, respectively. It is expected that the proper control of the various auxiliary pulses can contribute to the high improvement of both the luminance and luminous efficiency of an ac-PDP.

4. Conclusion

This work focuses on the various auxiliary pulses, which can enhance both the main and self-erasing discharge. When compared with conventional sustain waveform with no auxiliary address pulse, the new waveform shown in Case of Fig.1 can improved both the luminance of 23 % and luminous efficiency of 36 % without a misfiring discharge.

5. References

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