Luminous efficacy of 12 lm/W in an AC PDP in terms of measurement of the discharge in Ne+20%Xe and green cells

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Abstract

Dual auxiliary pulses are adopted in an AC PDP with an auxiliary electrode. The secondary auxiliary pulse of dual auxiliary pulses efficiently utilizes priming particles and contributes to improved luminous efficacy. A shorter time interval between the two auxiliary pulses resulted in better efficacy. The maximum luminous efficacy was approximately 12 lm/W according to measurement of the discharge in a Ne+20%Xe gas-mixture and green cells.

1. Introduction

Flat panel displays (FPDs) lead current information display technology. In particular, AC-Plasma Display Panels (PDPs) are widely used for large-size digital television screens owing to their excellent features such as thin panel, light weight, wide viewing angle, good image quality, long lifetime, and low cost. However, the relative low luminous efficacy of AC-PDPs is a drawback in terms of competition with other FPDs [1]. In order to resolve this problem, many approaches have been considered, including increasing the portion of Xe atoms in Ne atoms [2], implementing a long coplanar-gap between the common and scan electrodes [3], and the use of various display cell shapes [4]. In our previous work, an AC PDP with a FEEL (Fourth Electrode for Enhancing the Excitation rate in a Long coplanar gap) structure was proposed to improve luminous efficacy [5]. A single pulse applied to an auxiliary electrode during afterglow within the sustain period improved the excitation efficiency of Xe atoms and reduced the discharge current and minimum sustain voltage, resulting in luminous efficacy of more than 10 lm/W in 42-inch VGA resolution and green cells [6, 7]. The mechanism underlying the improved efficacy in the AC PDP with a FEEL structure was also studied [7]. In this work, based on previous results, dual pulses are applied to an auxiliary electrode to improve the luminous efficacy of an AC PDPS with a FEEL structure.

2. Experimental

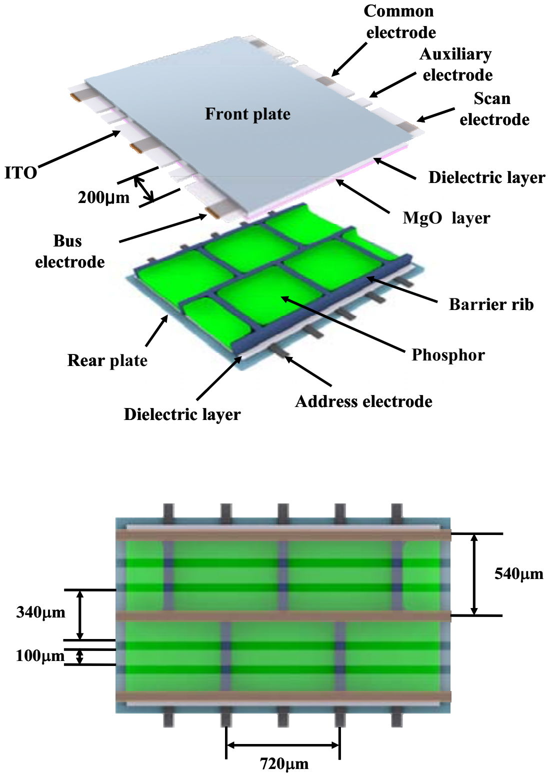


Fig.1 Schematic diagram of FEEL PDP with closed barrier ribs

Fig.1 shows a schematic diagram of a FEEL PDP with closed barrier ribs, which has a sub-pixel size of 0.54 mm×0.72 mm, as designed for a 42-inch VGA resolution. Common, scan, and auxiliary electrodes are made of an ITO layer and located on the front plate. The distance between the common and scan electrodes and the width of the auxiliary electrode is 200 μm and

100μm, respectively. The ITO layer is coated with a transparent dielectric layer and an MgO thin film layer. On the rear plate, an address electrode, a dielectric layer, barrier ribs, and a green phosphor layer are formed. The height of the barrier ribs is 200 μm. A Ne+20%Xe gas-mixture is used as a discharge gas and the total gas pressure is 450 Torr.

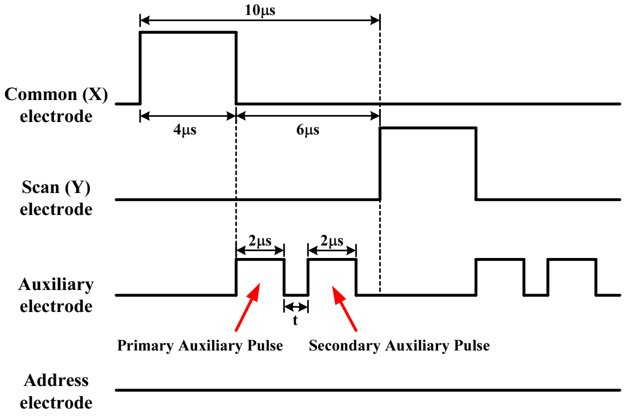


Fig.2 Pulses waveforms applied to the common, scan, auxiliary, and address electrodes during the sustain period

Fig.2 shows pulse waveforms applied to the common, scan, and auxiliary electrodes during the sustain period. The dual pulses applied to the auxiliary electrode are distinguished from our previous work. After the primary auxiliary pulse, a secondary auxiliary pulse is applied to the auxiliary electrode during afterglow. There is a time interval, t, between the two auxiliary pulses. Here, the frequency of the sustain pulses and the auxiliary pulses is 50 kHz and 100 kHz, respectively. The time interval t was also varied.

3. Results and discussion

In order to verify the effect of applying a secondary auxiliary pulse in terms of improvement in discharge characteristics, the priming effect, luminance, dissipation power, discharge current, and luminous efficacy were measured. First, the firing voltage of the test pulse followed by the secondary auxiliary pulse was measured to investigate the priming effect. Fig.3 shows the firing voltage of the test pulse followed by the secondary auxiliary pulse and the firing voltage 300 μsec after the secondary auxiliary pulse. The priming effect was defined as the net difference between the two firing voltages of the test pulse, denoted as a black rectangle and red circle, respectively, in Fig.3. Here, the voltage of the sustain pulse was fixed at 260 V for measuring the firing voltage of the test pulse. At 300 μs after the secondary auxiliary pulse, the firing voltage of the test pulse increased with an increase in the voltage of the secondary auxiliary pulse due to a decrease in the wall charges between the common and scan electrodes. At 0 μs from the secondary auxiliary pulse, the firing voltage of the test pulse remarkably decreased. This illustrates that priming particles are held or created by the secondary auxiliary pulse and used for the reduction of the firing voltage of the test pulse. From this result, it is concluded that the secondary auxiliary pulse can control or create priming particles, and is expected to contribute to improvement of the characteristics of the display cell.

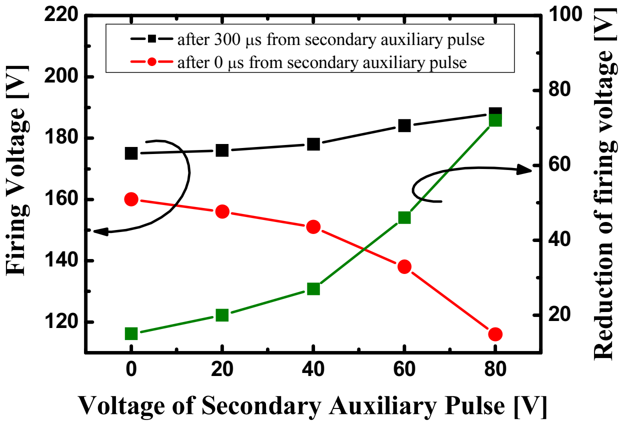
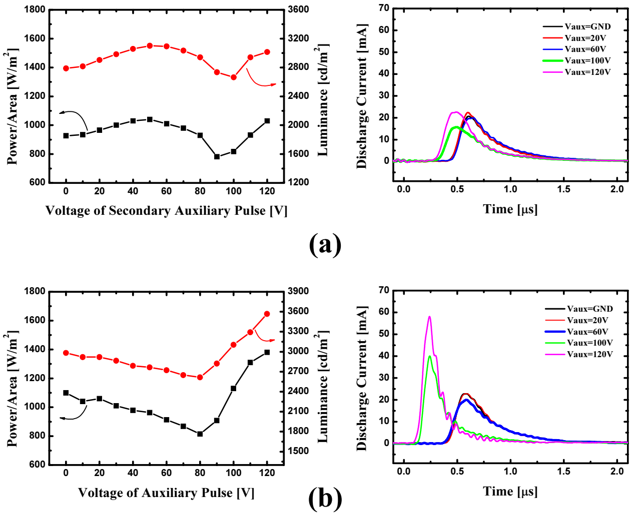


Fig. 3 Firing voltage and reduction of firing voltage of test pulse due to priming effect of secondary auxiliary pulse

Fig.4 (a) shows the power density, luminance, and discharge current of the test panel at a sustain voltage of 260 V, a primary auxiliary pulse voltage of 60 V, and a time interval (t) of 1μs. The power density and the luminance increased until a secondary auxiliary voltage of 50 V, and decreased in a secondary auxiliary pulse voltage range of 50 V to 90 V, and thereafter increased again. The observed decreases in power and luminance in the voltage range of 50 to 90 V are attributed to weak discharges. Also, the rate of decrease of the power density was higher than that of the luminance in this range. However, the rate of increase of the power density was higher than that of the luminance over a secondary auxiliary voltage of 90 V, because of discharges generated by the secondary auxiliary pulse. Therefore, the luminous efficacy reached a maximum value at a secondary auxiliary pulse voltage of 90 V, as shown in Fig. 5. Power density, luminance, and discharge current obtained from the case of a time interval of 2 µs are shown in Fig.4 (b). Note that different behaviors are observed from those obtained at a time interval of 1 µs. The power density and luminance decreased until 80 V with an increase in the secondary auxiliary pulse voltage. It is thought that secondary auxiliary pulse cannot efficiently utilize priming particles generated by the primary auxiliary pulse due to the increase in the interval between two auxiliary pulses. Over a secondary auxiliary pulse voltage of 80 V, the power density and luminance increased due to discharges generated by the secondary auxiliary pulse. The luminous efficacy for the case of an interval of 2 µs showed a maximum value at a secondary auxiliary pulse voltage of 80 V, which was lower than that for the case of a 1 µs interval as shown in Fig.5.



(a)

(b)

Fig.4 Power density and luminance as a function of voltage of secondary auxiliary pulse and discharge current; (a) Time intervals of 1 µs and (b) 2 µs

Fig.6 shows the minimum sustain voltage as a function of the secondary auxiliary pulse voltage in accordance with time intervals of 1 µs and 2 µs. In the case of a time interval of 1 µs, the minimum sustain voltage decreased due to the priming particles, which are controlled by the secondary auxiliary pulse in a secondary auxiliary pulse voltage range of 20 to 80V. The minimum sustain voltage increased in a secondary auxiliary pulse voltage range of 90 V to 110 V, because the reduction of wall charges was more dominant than the priming effect. The minimum sustain voltage rapidly decreased due to a strong discharge over a secondary auxiliary pulse voltage of 110 V. However, the discharge current also increased at this level, and thus the luminous efficacy decreased. In the case of a time interval of 2 µs, the minimum sustain voltage increased in the voltage range of the secondary auxiliary pulse until 90 V, as delineated in Fig. 4 (b). Over a secondary auxiliary pulse voltage of 90 V, the minimum sustain voltage rapidly decreased because of discharge.

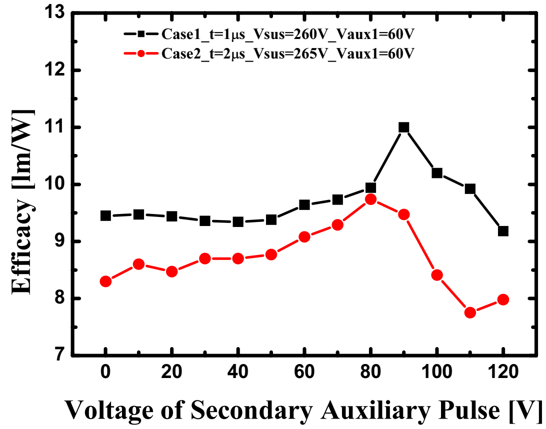


Fig.5 Luminous efficacy as a function of voltage of secondary auxiliary pulse

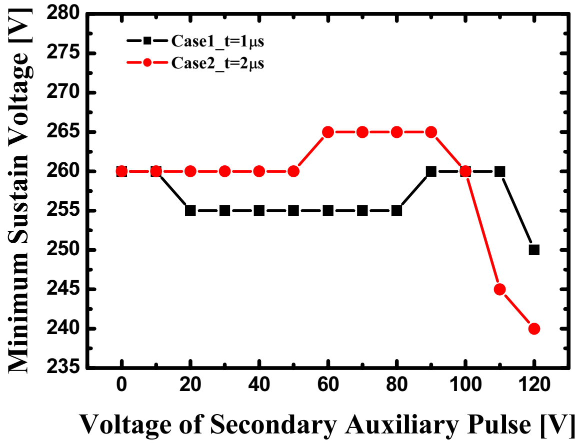


Fig.6 Minimum sustain voltage as a function of voltage of secondary auxiliary pulse

Fig.7 shows the luminous efficacy as a function of the sustain voltage in accordance with the secondary auxiliary pulse voltage and the time interval of 1 µs.

The luminous efficacy was considerably improved by applying the dual auxiliary pulses compared to that obtained by applying a single auxiliary pulse and a non-auxiliary pulse. The improvement in luminous efficacy is attributed to a reduction in the discharge current and enhancement of the excitation rate of microplasma due to the dual auxiliary pulses. When the voltage of the primary and secondary auxiliary pulse was 60 V and 80 V, respectively, and the time interval between the two auxiliary electrodes was 1 μs, the maximum luminous efficacy obtained from the test plasma display panel with FEEL structure was approximately 12 lm/W in terms of measurement of the discharges in Ne+20%Xe and green cells.

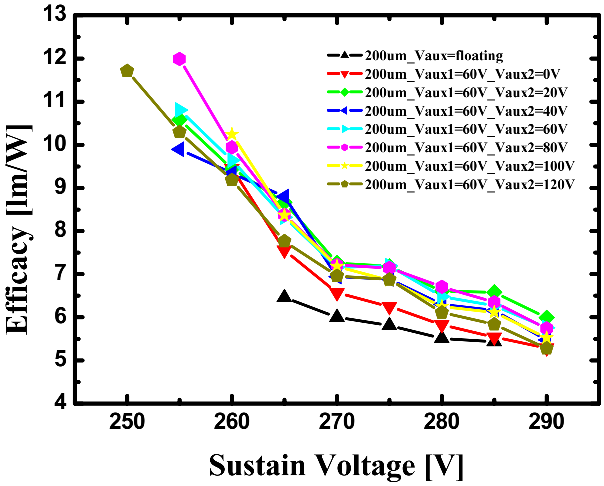


Fig.7 Luminous efficacy as a function of sustain voltage in accordance with various secondary auxiliary voltages

4. Conclusion

The application of dual auxiliary pulses to an AC PDP with an auxiliary electrode improved luminous efficacy. The dual auxiliary pulse scheme is as follows: A primary auxiliary pulse is applied to an auxiliary electrode during afterglow within the sustain period. The distribution of wall charges are then changed; in particular, some wall charges accumulated on the sustain and auxiliary electrodes are erased, and consequently the discharge current is reduced. Also, priming particles are held or created by the primary auxiliary pulse. A secondary auxiliary pulse is subsequently applied to the auxiliary electrode. The secondary auxiliary pulse can utilize priming particles to enhance the excitation rate of microplasma and reduce extra wall charges, consequently contributing to improved luminous efficacy. In this work, it is found that a shorter time interval between the two auxiliary pulses resulted in better efficacy. There exists a certain voltage range for the primary and secondary auxiliary pulses within which high luminous efficacy can be obtained. The optimal voltage of the primary auxiliary pulse is in a range of 40 to 60 V, as obtained in our previous work [6], and the optimal voltage of the secondary auxiliary pulse is in a range of 20 to 90 V. Using this dual auxiliary pulse scheme, a maximum luminous efficacy of 12 lm/W was obtained in terms of measurement of the discharge in Ne+20%Xe and green cells. From the results, it is concluded that the dual auxiliary pulse scheme is useful for obtaining high luminous efficacy in a AC-PDP with a FEEL structure.

5. References

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