The Method to Improve the Luminance Efficiency by Auxiliary Capacitor in AC PDP

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Abstract

The improvement of luminous efficacy is one of the major issues in PDP industry. In this work, we propose the new driving method for high efficiency AC-PDP and analyze its discharge characteristics. The suggested method can control the effective capacitance of panel by external auxiliary capacitor. External capacitor induces reduction of gap voltage proportional to the panel current, this in turn modifies the transient behaviour of discharge. The peak current level is reduced and the discharge duration is increased. As a result of these modifications, the luminous efficacy is enhanced by about 200 % compared with the conventional driving method

1. Introduction

AC-PDPs have recently achieved good performances and their image quality can now compete with that of cathode ray tubes (CRTs). However, improvement of luminous efficiency, image quality and cost-reduction is still necessary to compete with other candidates (LCD, OLED, and Projection TV, etc.) [1]. There have been many efforts for developing high efficiency PDP by optimization of cell structure, working gas mixing [2,3]. Recently, the sustaining driving method using two or multi steps have been introduced and many researchers have been conducted to increase luminous efficiency by improving the method of sustaining driving. Basic concept of these studies is to control the transient state of ac discharge. [4] However, this method make a circuit of PDP complicated, further problem can happen.

2. Background and the method of new sustain driving

The effective capacitance between the plasma and electrode provided by dielectric layers plays very important role in ac- PDP such as current limiting and wall charge set up. Therefore, optimization or controlling the capacitance is required for efficiency improvement.

Although some experiments show that the efficacy increases with the thickness of dielectric layer increases [5], relationships between the effective capacitance of PDP cell and the discharge characteristics are not well known.

In this study, we introduce the simple driving method to improve luminance efficiency by using external auxiliary capacitor.

The effect of auxiliary capacitance on the PDP performances is measured and analyzed in terms of I-V characteristics, IR light waveforms, luminance and luminous efficacy.

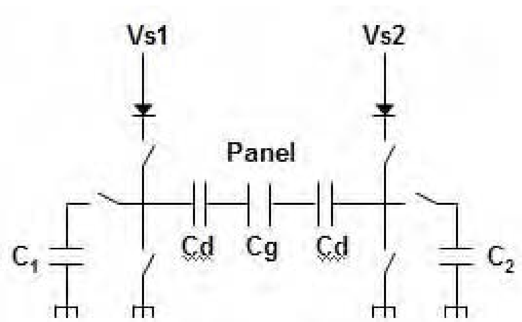
Fig.2 is a schematic diagram of driving method using auxiliary capacitor. Fig.2(a) is an equivalent circuit of the suggested sustain driving method. Generally the conventional driving method in sustain period occurs an excessive discharge, which increases power loss on ac-PDP.

So the suggested method is that adjust this excessive condition by auxiliary capacitance.

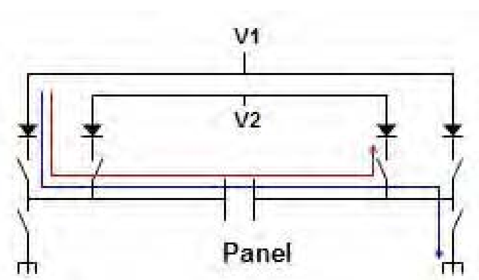
Cd corresponds to effective capacitance between electrode and dielectric surface. Cg is gap capacitance. When the discharge is ignited, voltage-dependent current source is connected between Cg. For normal mode of operation, the current path is established as Vs1 (or Vs2)-Cd-current source-Cd – Ground. When external capacitance is serially connected, plasma sees lower effective capacitance. Therefore gap voltage increases much faster and current grow is limited.

The role of C2 (or C1) is same as Cd except that the voltage drop in C2 is proportional to the whole panel current, not to individual cell current. This can maintain the power consumption in constant level according to an image load of panel.

Fig.2(b) shows the driving method used in actual experiment. Here, the switching FET itself plays a role of the auxiliary capacitor.



(a) Suggested method



(b) Experiment method

Fig.2 Schematic diagram of equivalent circuit by external auxiliary capacitor

3. Luminance, Luminous Efficacy and IV waveforms

The test panel used in these experiments is monochrome green 4 inch with XGA resolution. The width of ITO electrode 270um and the gap distance is 65um. The width of bus electrode is 80um, the thickness of dielectric is 35um and the height of barrier rib is 125um. And Xenon partial pressure is 8%-400Torr.

Fig.3 shows the change of luminance and luminous efficacy and Fig.3 shows the change of energy consumption per pulse according to the blocking voltage. Sustain voltage of sustain electrode was fixed to 240V at 10kHz frequency in this case. we can find remarkable improvement in luminous efficiency in suggested method as compared to the conventional method in fig.4 There is trade-off between efficacy and luminance.

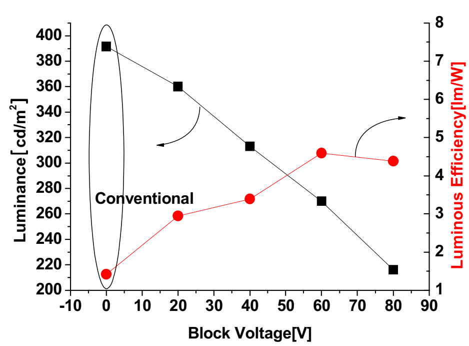


Fig.3 The change of luminance and luminous efficiency according to blocking voltage

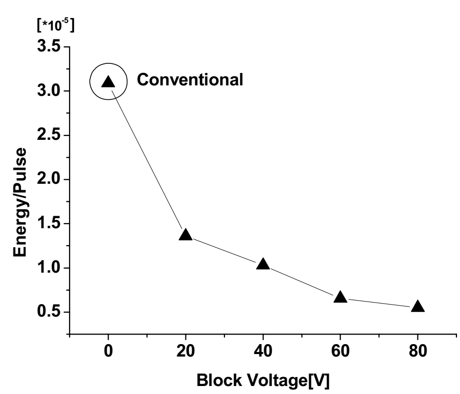


Fig.4 The change of energy consumption per pulse according to auxiliary capacitance

Fig.5 shows the luminous efficiency as a parameter of sustaining voltage and frequency. Fig.6 shows the energy consumption per pulse as a parameter of sustaining voltage and frequency. For the conventional method, efficiency decreases with sustain voltage and frequency. The suggested method shows similar voltage and frequency dependencies. However, as shown Fig 6, energy input per pulse in the driving with external capacitor is less sensitive to sustain voltage compared with the conventional driving method. More important point is that the energy per pulse is dramatically reduced. Comparing two modes at the same frequency, luminous efficiency is improved greatly. The degree of improvement is higher at lower frequency.

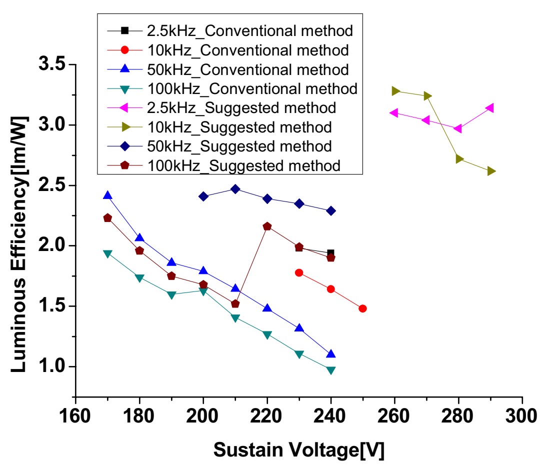


Fig.5 Luminous efficiency for sustain voltage and frequency

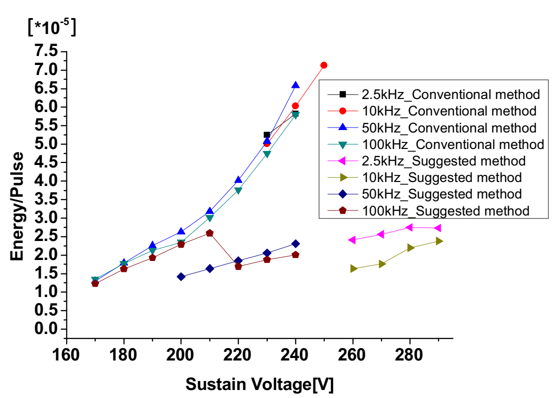


Fig.6 Energy consumption per pulse for sustain voltage and frequency

Fig.7 shows the change of luminance and energy consumption for different image loads.. In driving commercial PDP, the number of sustain pulses is controlled in order to increase the maximum peak white luminance with stable power consumption, which is called as APL (Average Power Level) control.

Since the effects of external capacitance depend on the whole panel current, luminance decreases with increasing panel load as shown in Fig.7. This characteristic is similar with APL controlled driving. Therefore the suggested method can be adapted as hardware APL control. [6]

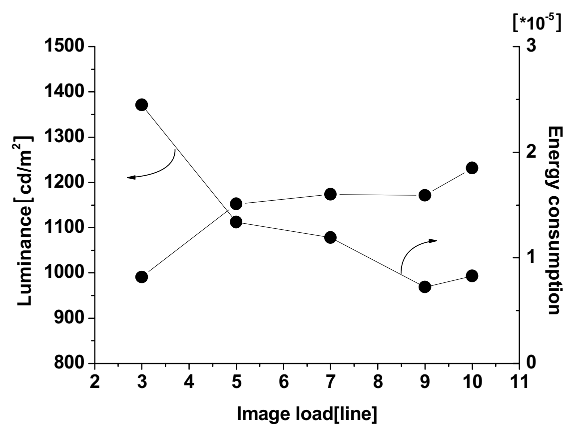
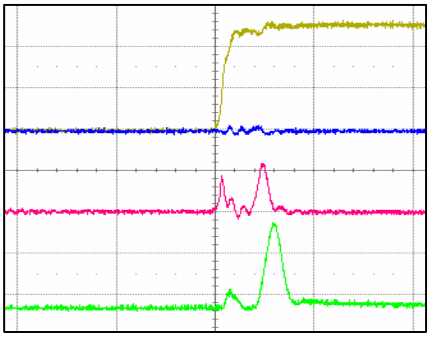
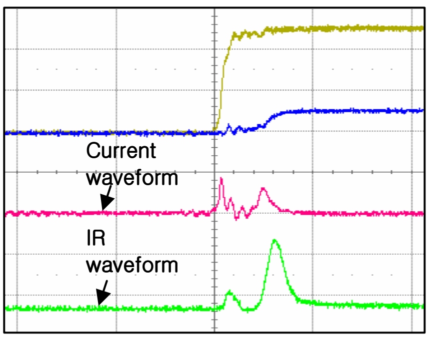


Fig.7 Energy consumption for image load

Fig.8 shows I-V and IR characteristics of two methods. As shown Fig.8(a), we see the excessive current when discharge, whereas the suggested method restrict the excessive current due to the potential increment of the opposite electrode. Fig.8(b) shows that the suggested method produces a lower peak discharge current and longer discharge duration. These characteristics results in high luminous efficiency. [7]



(a) Conventional method



(b) Suggested method

Fig.8 I-V and IR Characteristics

4. Conclusion

The effects of external capacitance on the discharge characteristics of ac-PDP have been investigated. External capacitor induces reduction of gap voltage proportional to the panel current, this in turn modifies the transient behaviour of discharge. The peak current level is reduced and the discharge duration is increased. As a result of these modifications, the luminous efficacy is enhanced by about 200 % compared with the conventional driving method.

5. Acknowledgements

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