A New Driving Method for Vertical Discharge PDP

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Abstract

Even though the surface discharge PDP (SD PDP) has become a standard form of PDP, there is no doubt that we need another breakthrough to achieve less cost and more efficiency. The historical approach of a vertical discharge PDP (VD PDP) has some advantages comparing with a SD PDP , but its life problem caused by ion bombardment to the phosphor layer seems to be a fatal problem for a VD PDP.

A new driving method described here will make it possible to solve this issue and give a bright view for the second generation PDP based on a VD PDP.

1. Introduction

A VD PDP has less number of electrodes, which can provide a simpler panel structure, and a higher yield of production. A capacitance between sustain electrodes of a VD PDP is much smaller than that of a SD PDP. This is another advantage for designing a high resolution panel. The advantage of a SD PDP is that the sustain electrodes are separated from a phosphor layer. The comparisons in structures between SD PDP and VD PDP are shown in Fig.1. Since the sustain discharges for a SD PDP are done between the parallel electrodes on the front glass, the phosphor layer is completely protected from ion bombardment. But the phosphor layer in a VD PDP is impacted by ions, because phosphor covers the electrodes on the rear substrate. Even if a small window is opened in the phosphor layer, ion bombardment gives severe damage to the phosphor within a short time. Extend of the damage to the phosphor layers and electrodes, depends on the acceleration voltage of ions and the discharge currents.

For conventional sustaining operation of AC PDP, the voltage between the electrodes wall should be higher than the breakdown voltage, because the discharge space between the electrodes is already conductive, in other words the space is filled with plasma as well as metastables, high voltage is not necessary to initiate discharge between the electrodes. Then the damage to the electrodes or phosphor layers will be minimized.

A new driving method, named as SPM (Self Priming Method) has been developed to utilize these advantages.

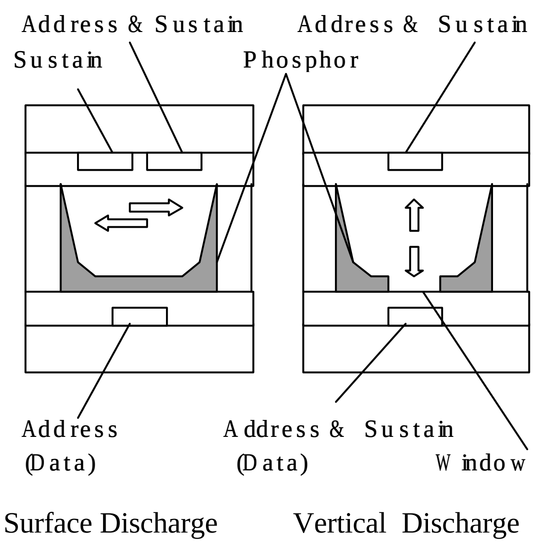


Fig. 1

2. Self Priming Method (SPM)

The fundamental idea of SPM may be understood by a narrow pulse erasing method for AC PDP and a pulse memory method for DC PDP. Fig.2 shows the difference in operations between a conventional method and SPM.

A conventional sustain voltage waveform supplied by drivers and a wall voltage waveform generated by discharges is shown in Fig.2(a). A discharge current waveform is shown in Fig.2(b). Fig.2(c) shows the plasma and the metastable density in the discharge space. The waveforms of

SPM are shown in the Fig.2(d)(e) and(f) in the same manner .

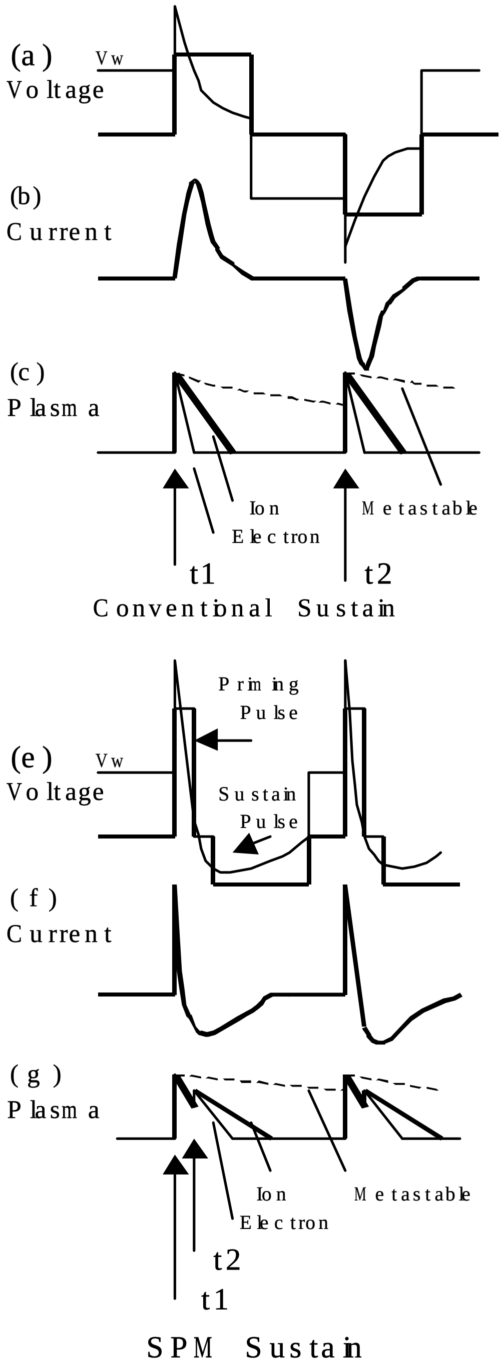


Fig.2

Comparing those waveforms in Fig.2 ;

1) In SPM, the sustain pulse is made by a combination of a narrow pulse named as a priming pulse and a wide pulse named as a sustain pulse. The sustain pulse is supplied in a short interval after the priming pulse. { Fig. 2 (e) }

2) In SPM, the discharge current which flows at the priming discharge period is continuously reversed at the sustain period, since the discharge space keeps conductive during these periods. {Fig.2(e)}

3) In SPM, even the voltage between the electrodes is low at the sustain period and the current can flow reversibly, since the plasma and metastables are existing at the discharge space. {Fig.2(e)} {Fig2(g)}

4) In SPM, the peak discharge current of the sustain discharge is much lower than that of the priming discharge. { Fig.2(f)}

3 Actual Operations of SPM

More detailed explanations for SPM are given by the following data which were tested by Fujitsu 21" SD structure panel.

3-1 Lower sustain voltage in SPM

The priming pulse lowers the voltage of the sustain pulse. The actual waveform shown in Fig.3 is tested to measure the effect of the priming pulse.

The voltage of M1 (180v: constant) is supplied to the data electrode of the panel which is covered by a phosphor layer and a dielectric layer. No MgO covers it. T1 is the pulse width as the priming pulse.

The voltage of M2 (Vs) which is a sustain pulse is supplied to one of the pair display electrodes on the front glass.

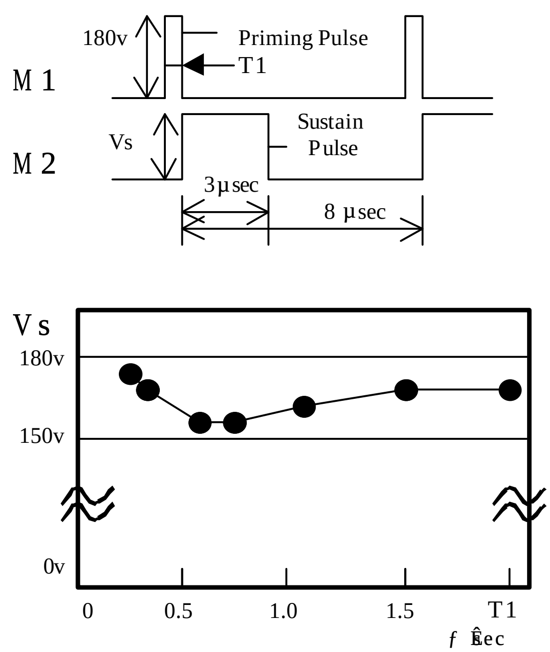


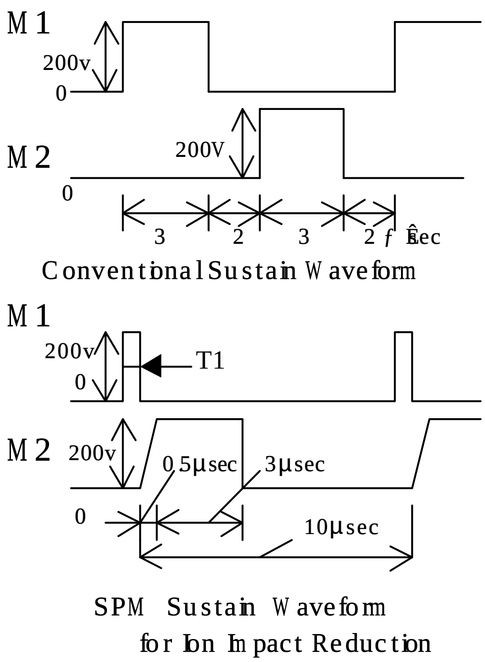
Fig. 3

Fig.3 shows, if T1 is wider than 1.5ìsec , the priming does not affect to the sustain voltage.

If T1 is narrower than 0.5ìsec, the priming is not enough to the sustain voltage down.

Between 0.6 - 0.8ìsec, T1 is optimized.

3-2 Less ion impact to the electrodes in SPM



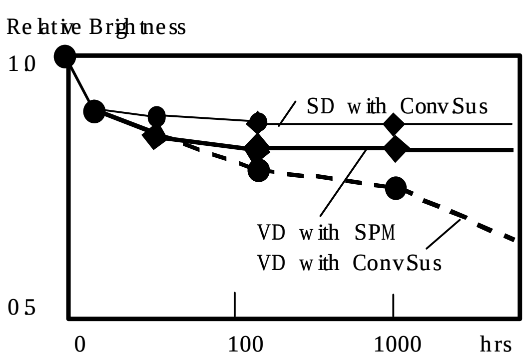


Fig. 4

If the conventional sustain pulse were applied between X and Y electrodes, the discharge characteristic would be changed in a short time. To test the ion impact reduction to the electrodes and phosphor layers by SPM, brightness was measured as a life test. The actual waveform which was used for this test is shown in Fig.4.

The pulse shape is modified to reduce the ion impact more by a sloped shape of sustain pulse.

The impact is adjusted by the inclination of the slope. If the slope is steep, the impact becomes stronger. T1 was fixed at 0.6ìsec for this test.

Fig.4 shows that the brightness dimmed much faster with a conventional sustain than with SPM. The initial fast dim was observed even with the surface discharge as well as the vertical discharge. The dim rate of VD with SPM is almost the same level with SD with conventional sustain method.

3-3 Higher efficiency in SPM

A discharge efficiency is improved by SPM. Since at the sustaining period after the priming period in SPM, a gamma process is not necessary to flow a current reversibly and build up reversed wall charges. This means an alpha process without a cathode fall is possible. The power is consumed at the cathode fall to get secondary emissions from a cathode. If the discharge occurs without a cathode fall, the panel efficiency will become much higher. SPM is promising such kind of high efficient operation.

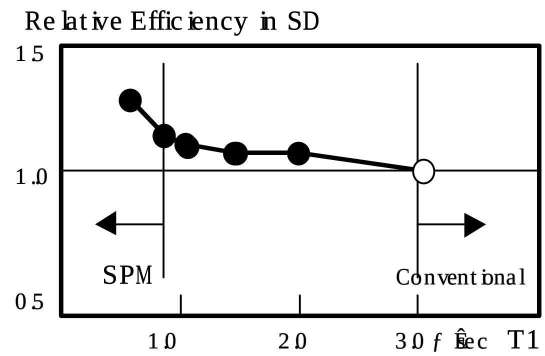


Fig. 5

Fig. 5 shows the relative efficiency of SPM compared with a conventional operation.

This comparison was made with a surface discharge (SD) mode. The waveforms are the same with those in Fig.4. Those two different waveforms of SPM and conventional sustain were applied to the pair electrodes of SD instead of VD electrodes in this test, because comparing the efficiency is rather difficult with different structure. The white circle is the point of the conventional sustain operation by the waveform of Fig.4. The efficiency goes up in the SPM region of under 0.8ìsec of T1.

The results of this test indicates SPM can improve 15~20% of the efficiency for a conventional 3 electrodes surface discharge PDP.

4. Discussion

4-1 Possible panel structures

A simple VD structure which is better for high resolution panels than a SD structure becomes possible by using SPM. However, even though the ion impact to the phosphor layer can be reduced by using SPM, the discharging characteristics are still unstable, because the phosphor layer of the panel which we tested covers the electrodes.

SPM will provide new panel structures for the second generation PDP.

AC/DC structure, for instance, will be possible. A wire electrode can be used for DC electrodes instead of screen printed electrodes in this structure. Then the heating processes for panel fabrication will be drastically reduced. And a wide variety of DC cathode materials will give a lot of alternatives for breakthrough to improve the panel efficiency as well.

5. Summary

A new driving method, named as Self Priming Method, has been discussed. This new driving method is applicable not only for the new VD PDP structure, but also for all of the conventional structures.

If SPM were applied to the pulse memory DC PDP of NHK, the sputtering problem will be removed with just covering the cathode by dielectrics and MgO. No current limit resistors are necessary. 2)

If SPM were applied to the VDPDP, like Photonics' or Thomson's AC PDP, the life problem will be improved without covering phosphors with MgO. 3)

If SPM were applied to the PALC of Technical Vision, SONY and Sharp, the life problem which is caused by the UV of 254nm radiation from mercury influencing on LCD will be solved. Mercury is not necessary, if one of the addressing electrode is covered by dielectrics and MgO, and SPM were used. 4)

SPM is also suggesting the ways to improve the panel efficiency of standard 3 electrodes SD PDPs of Fujitsu, NEC, Pioneer, etc., because the power losses at the cathode fall could be minimized. 5)

New structures using SPM will be discussed in the near future.

6. Acknowledgement

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