Wall Voltage Transfer Characteristics according to Address Bias Voltage

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Abstract

In this paper, we report the wall voltage transfer characteristic between sustain electrodes according to the address bias voltage in a 3-electrodes surface discharge type ac PDP by the VT close curve measurement technique. The result shows the change of wall voltage according to the gap voltage variation depends on the address bias voltage.

1. Introduction

The wall voltage transfer characteristic between sustain electrodes or between address and scan electrode is the most important information for design a driving waveform of ac PDP.[1] The characteristic limits the voltage levels for stable sustain discharge, rising speed of waveform for reliable reset, width of square pulse for erase, and so on.

The VTC(Voltage Transfer Characteristic) curve is the most convenient tool to understand the wall voltage transfer characteristics between 2-electrodes.[2] But, in 3-electrodes ac PDP, which is most popular structure in the market nowadays, the voltage transfer characteristic between 2 electrodes among 3-electrodes could be affected by the condition of remaining electrode.

Some groups proposed the VT (breakdown Voltage Threshold) closed curve for analysis the wall voltage distribution in 3-electrodes structure PDP.[3][4] This idea is very powerful to design a driving waveform of ac PDP, specially ramp type reset waveform. With this excellent analysis tool, we can also estimate the change of wall voltage by comparison the VT closed curves before and after discharge.

Using this technique, we can measure the VTC curve between 2 electrodes in a 3 electrodes type ac PDP. And we also measure the VTC curve between sustain electrodes according to the bias voltage of address electrode. This would be very helpful to design a driving waveform such as erasing or selective reset waveform.

With this idea, we measured the voltage transfer characteristics between sustain electrodes at the various bias voltage conditions of address electrode to study the relation between wall voltage transfer characteristic and address bias condition. The change of wall voltage is calculated from the VT (breakdown Voltage Threshold) closed curve before and after the control pulse which gives an increment of gap voltage between sustain electrodes. Although, VT closed curve cannot tell us the exact wall voltage information at a given time without perfect reset condition, the change of wall voltage can be obtained by measurement of the curves before and after the control pulse.

2. Experimental

We used 4inch diagonal test panel to measure the VTC curves. The specification of the panel is given in table 1.

TABLE 1. Specification of test cell

Specification	value
Cell Dimension	360 ㎛×1080 ㎛
Sustain Electrode gap	80 ㎛
Barrier Rib Height	150 ㎛
Phosphor	Red/Green/Blue
Gas Contents	Ne+4%Xe
Gas Pressure	400 Torr

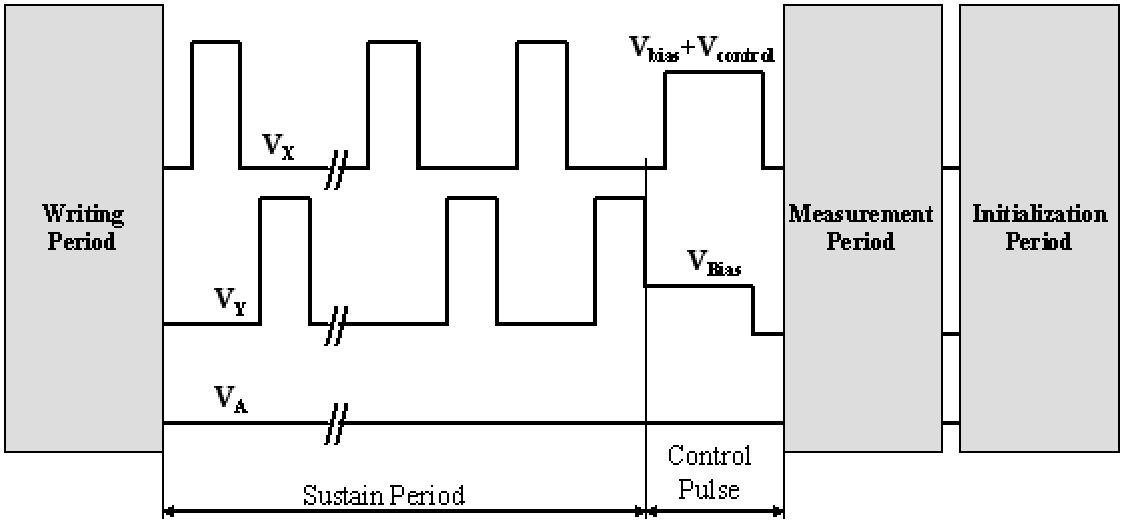

Fig. 1. Measurement Waveform

The measurement waveform is shown in Fig.1. After sustain period, a control pulse is applied. The voltage of control pulse is defined by the voltage difference between X and Y electrode. The bias voltage is the voltage difference between Y and X electrode. After the control pulse, measurement period is introduced. A rectangular type pulse varying the voltage level is applied during the measurement period to find out the breakdown voltage threshold, which is known as "finger print method".[5] To remove the wall voltage fluctuation during measurement period, initialization period also applied. In our experiment, high voltage ramp type reset waveform was used as the initialization pulse. 20 pairs of sustain pulses are applied during sustain period to ensure the same wall voltage state before application of the control pulse.

The measurement sequence is as follows;

(1) Measurement of VT closed curve at the condition of V_{bias}=0V, $V_{control}$=0V to find out the reference wall charge state.
(2) Fix the bias voltage at zero and increase the control voltage
(3) Measurement of VT closed curve at the given condition by (2)
(4) Measurement of VT closed curve according to the voltage level of control pulse
(5) Increasing the bias voltage and repeat the process from (2) to (4).

Occurrence of breakdown was detected by an IR (Infra RED) photo diode, which was focused on a measurement cell by optic lens array. Hence, we could obtain one cell characteristics (green cell was selected).

3. Results and discussion

(a) and (b) in Fig. 2 show the VT closed curves obtained at the conditions of 0V(a) and 105V(b) of control pulse without address bias voltage V_b. We can estimate the change of wall voltages of $\Delta V_{W,XY}$ by measurements of the horizontal displacement of $\vec{A}$ at each condition. From the estimation, we can understand that the wall voltage change between sustain electrodes(X and Y electrode) varies with the address bias voltage condition, hence, the voltage transfer curve changes with the address bias voltage.

Fig. 3. shows the voltage transfer curve obtained at the condition of zero bias voltage. The x-axis is the externally applied control pulse voltage not a gap voltage which is used in VTC curve generally. Because the initial wall voltage is fixed by the stable sustain discharge, the control pulse voltage is the voltage uniformly shifted from the gap voltage. The lines with the slope of 1 and 2 are represented to analyze the characteristics. The curve rises fast in the mid range of control pulse voltage like the characteristic of opposite discharge type ac PDP.

Although another curve obtained at the different bias condition is not shown in this summary, the curve is changed according to the bias voltage as shown in the result of Fig. 2.

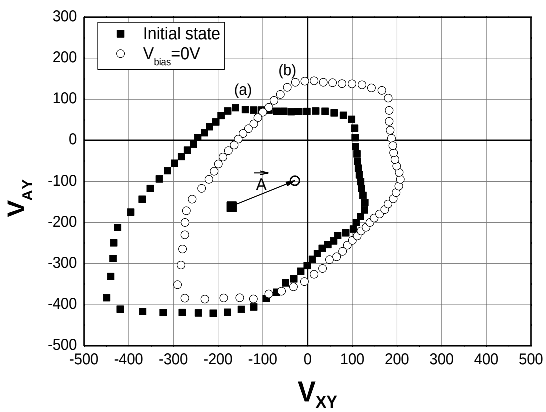

Fig. 2. VT closed curves of initial state, Vbias=0V and Vbias=50V with the control voltage of 105V and Vs=180V

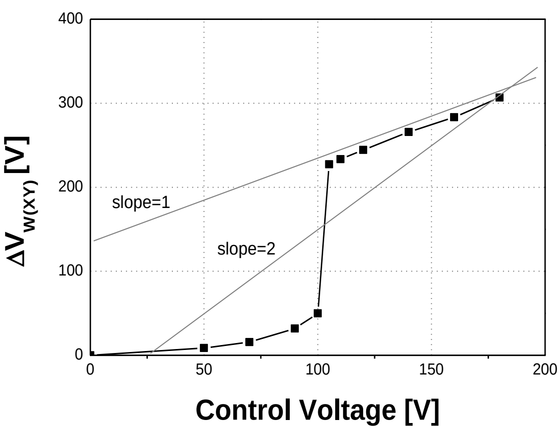

Fig. 3. Voltage Transfer Curve between sustain electrodes with zero bias voltage and Vs=160V(the x-axis is externally applied control voltage)

Fig. 4. show the VTC curves according to the address bias voltage. When the bias voltage increases, the change of wall voltage between X and Y electrode at the high control voltage decreases. And the slope of the also becomes lower.

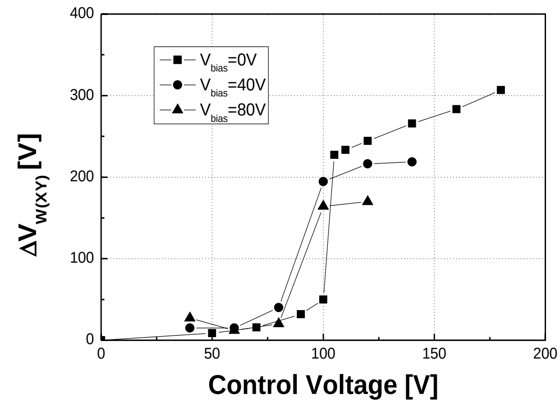

Fig. 4. Voltage Transfer Curves between sustain electrodes with the address bias voltage of 0, 40, and 80V and Vs=160V

The different voltage transfer characteristic according to the bias voltage is explained as follows.

During the discharge by the control pulse, positive ions move to the cathode(Y electrode) and address electrode due to the negatively biased voltage. The higher the bias voltage is applied at a given control voltage, the more ions accumulate on the address electrode, hence, the less ions on the cathode(Y-electrode). Therefore, the wall voltage change between X and Y electrode decreases at the higher bias voltage.

Because of the same reason, the slope of the transfer curve at the high control voltage region becomes small. (Higher bias voltage gives small ratio of ions generated by discharge to the cathode.)

From the result, we can understand that the wall voltage between sustain electrodes can be controlled by the address bias voltage at the high control voltage. The decrement of change of wall voltage according to the bias voltage from 0 to 80V is about 80V at the control voltage of 120V. And increment of wall voltage change is not so significant according to the control voltage when the bias voltage is applied. This means that we can control the wall voltage with the bias voltage of address electrode.

4. Summary

The voltage transfer characteristic is very important information for design a driving waveform of ac PDP. But, in 3-electrodes type ac PDP, the voltage transfer characteristic between 2 electrodes according to the condition of remaining electrode is not understood enough. In this paper, we explain the measurement method of VTC from VT close curve in a 3-electrodes type ac PDP. And, we also show the voltage transfer characteristic between sustain electrodes according to the address bias voltage.

The application of bias voltage to the address electrode gives the change of VTC curve between X and Y electrode. The higher the bias voltage is applied the smaller the change of wall voltage was observed. Moreover, the slope of VTC curve also decreases.

By understanding the relation between VTC curve and bias voltage, it is thought that a new driving waveform such as erase or selective reset could be designed.

5. Acknowledgements

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6. References

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