

Effect of Working Gas Pressure on Misfirng of ac PDP at High Ambient Temperature

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Abstract

One of the important problems in ac PDP in recent years is the misfiring of ac PDP at high ambient temperatures which consequently degrades the image quality of the ac PDP. This may be due to the change of working gas pressure and/or MgO surface characteristics at high ambient temperatures. This paper deals with the effect of working gas pressure on the misfiring of ac PDP at high ambient temperature. From this study, we found that the main cause of the misfiring at high ambient temperature is the increase in discharge firing voltage induced by increased working gas pressure

Keywords : misfiring, gas pressure, high temperature, plasma display panel

1. Introduction

The ac plasma display panel (PDP) which is the leading candidates for large area wall-hanging TVs [4, 12] is a flat panel display which utilizes gas discharge in realizing images. Fig. 1 shows the fundamental structure of a discharge cell in ac PDP. The size of a discharge cell is about 0.3 ㎜ × 1 ㎜ × 0.15 ㎜ (height). The tri-primary colors (RGB) are obtained from RGB phosphors excited by vacuum ultraviolet photons emitted from gas discharge [1-3], [13].

As a driving method of ac PDPs address, display separated(ADS) scheme has been widely used [5-7]. In the ADS scheme, a picture of one frame is divided into eight sub-fields and each sub-field is composed of a reset, address and sustaining periods as shown in Fig. 2.

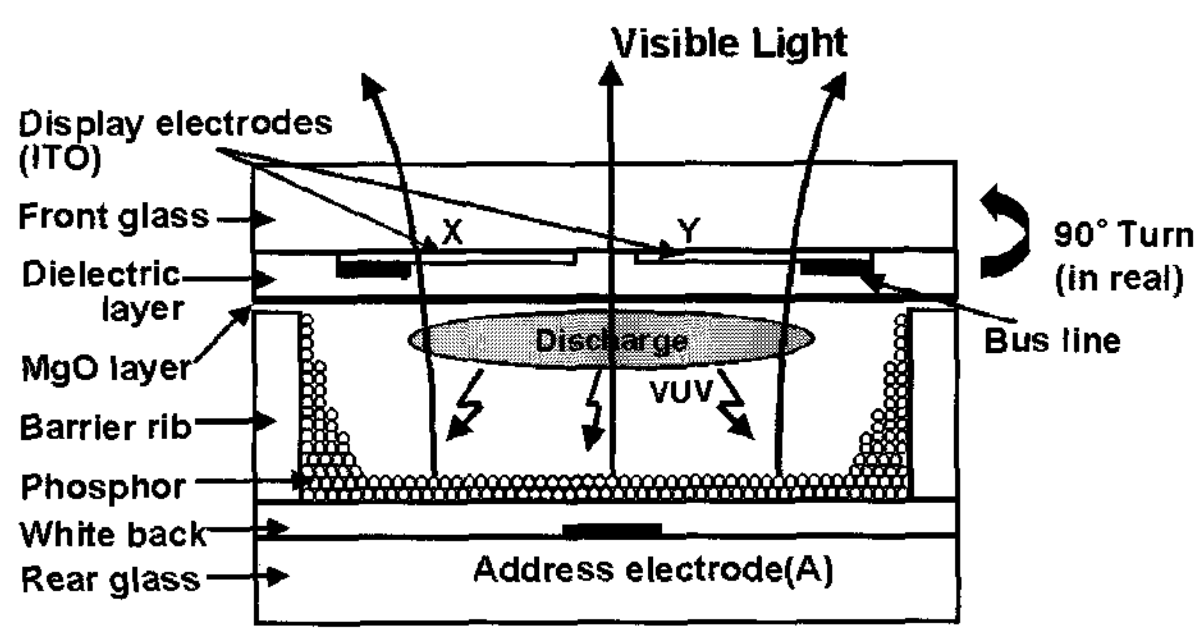

Fig. 1. Principle structure of a discharge cell in ac PDP.

One of the main problems in ac PDP is the misfiring of ac PDP during address and sustain periods at high ambient temperature. This misfiring degrades the image quality. The high ambient temperature indicates the maximum temperature of the panel during operation. The temperature falls within a range of 50 and 80℃. The causes of this problem are not yet known. The variations in operating conditions include working gas pressure, 2nd electron coefficient of MgO thin film, and wall charge or priming particle at high ambient temperature.

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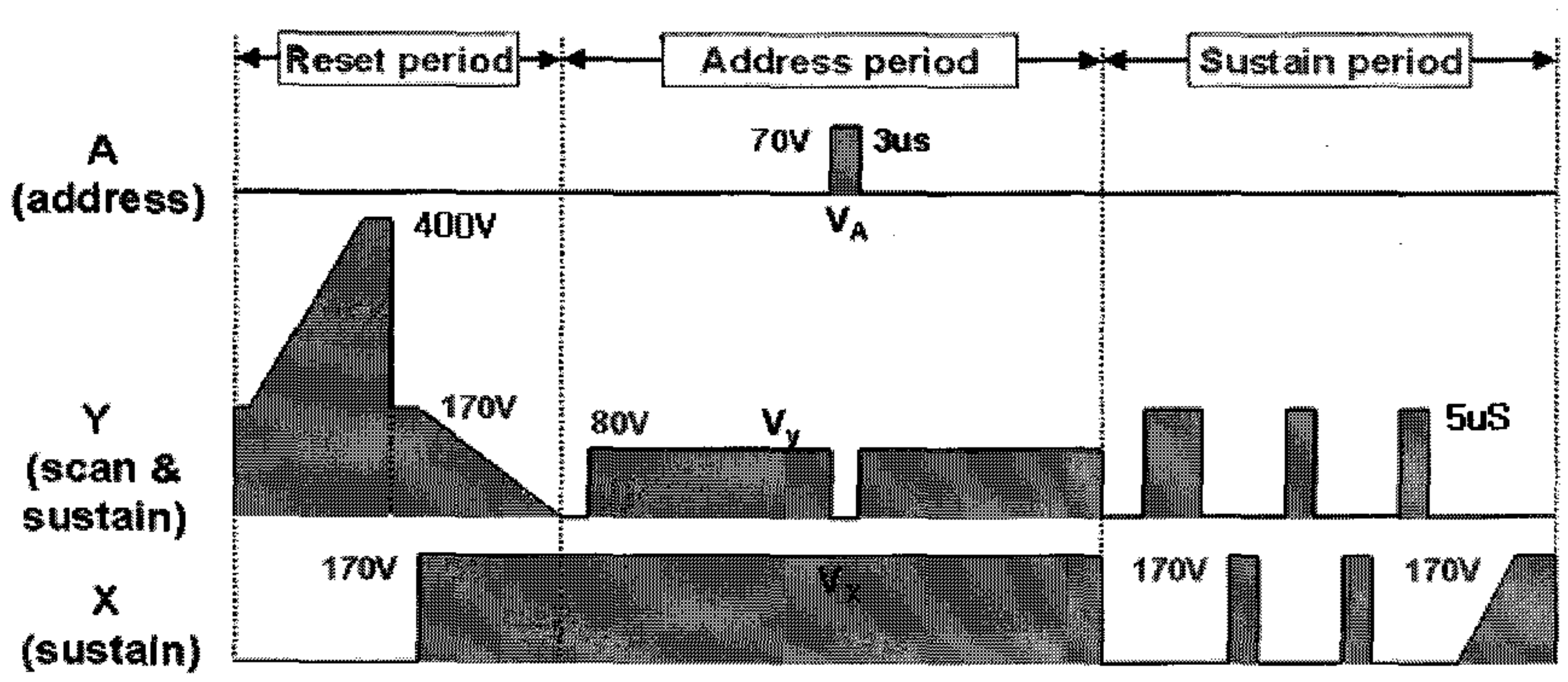


Fig. 2. Schematic diagram of driving waveform.

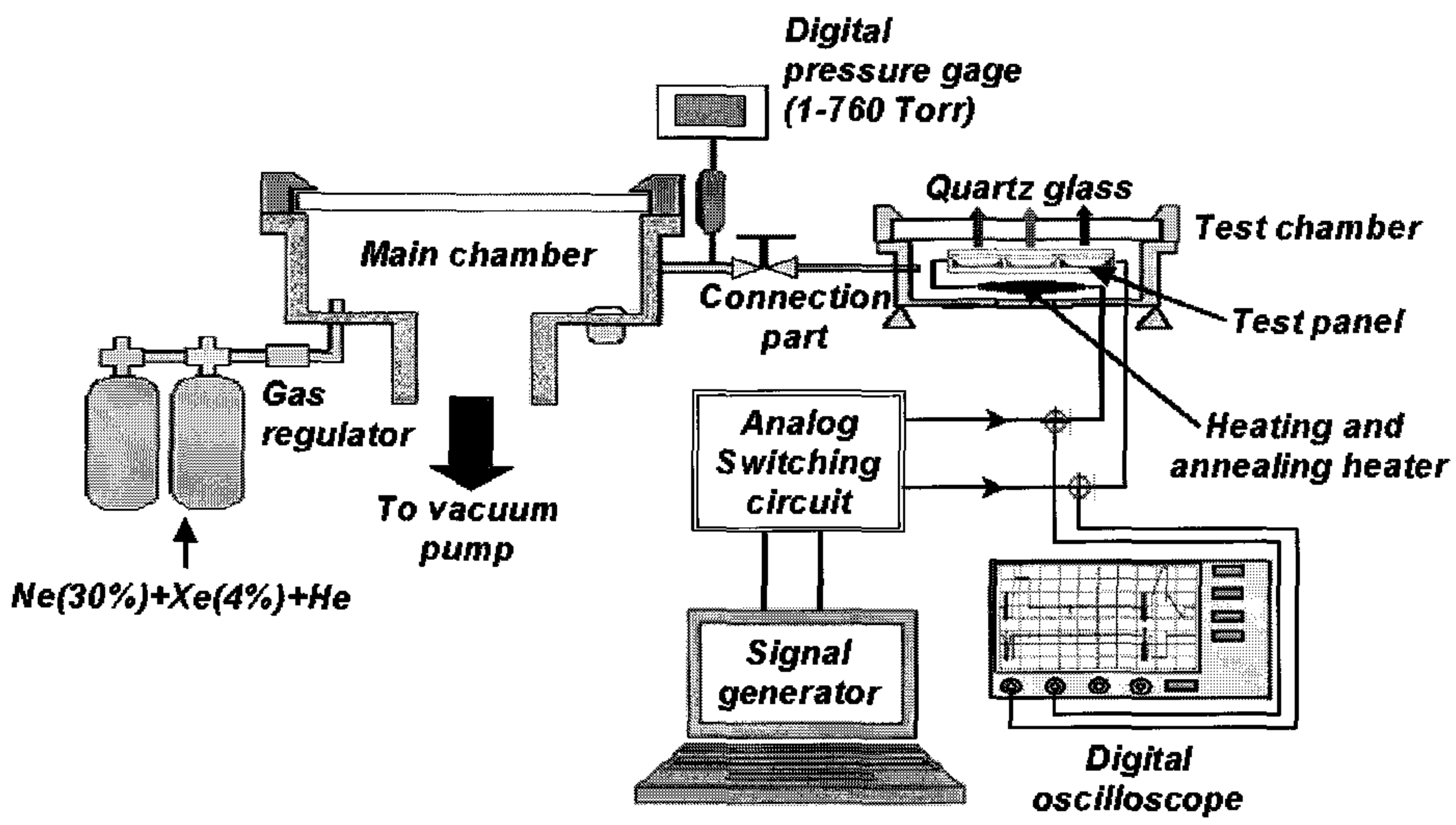


Fig. 3. Experimental set-up.

It is assumed that such varying of the operational conditions could change the firing and sustain voltage, that could cause misfiring ac PDP.

In this paper, we investigated the effects of working gas pressure at high temperature on the misfiring of ac PDP.

2. Experimental

Table 1 shows the specification of 4-inch stripe-type test model PDP of VGA resolution prepared for this study. The total number of scan lines was 30. In the test of static firing and sustain voltage of the test panel, ac square pulse voltage with 50 % duty ratio was applied. The working gas in the panel was Ne(30 %) + Xe(4 %) + He and the gas pressure was 400 torr at room temperature.

In order to find out the effect of working gas pressure on the misfiring of the test panel in the ADS driving scheme, the driving waveform as shown in Fig. 2, was applied. In this case, tha total time of a sub-field was 1.63 ms. In the reset period, the ramp rising and falling time were 100 μs and 150 μs, respectively. The width of scan pulse was 3 μs which is the same pulse width as the conventional 40-inch PDP and total address period was as about 1 ms [1-3].

Fig. 3 shows the schematic diagram of the experimental set-up equipped with molecular vacuum pump system, main and test chambers, digital pressure gauge, test panel heating and annealing systems, driving circuit and measuring systems.

Fig. 4 shows the discharge current detect circuit of surface discharge between X and Y electrodes and facing discharge between A and Y electrodes at the reset-up

Table 1. The specification of 4-inch test model PDP

Front panel		Rear panel	
ITO width	310 μm	Address electrode width	100 μm
ITO gap	60 μm	White back thickness	20 μm
Bus width	100 μm	Rib height	130 μm
Dielectric thickness	30 μm	Rib width	60 μm
MgO thickness	5000 Å	Rib pitch	360 μm
Working gas : He+Ne(30 %)+Xe(4 %)		Phosphor thickness	30 μm

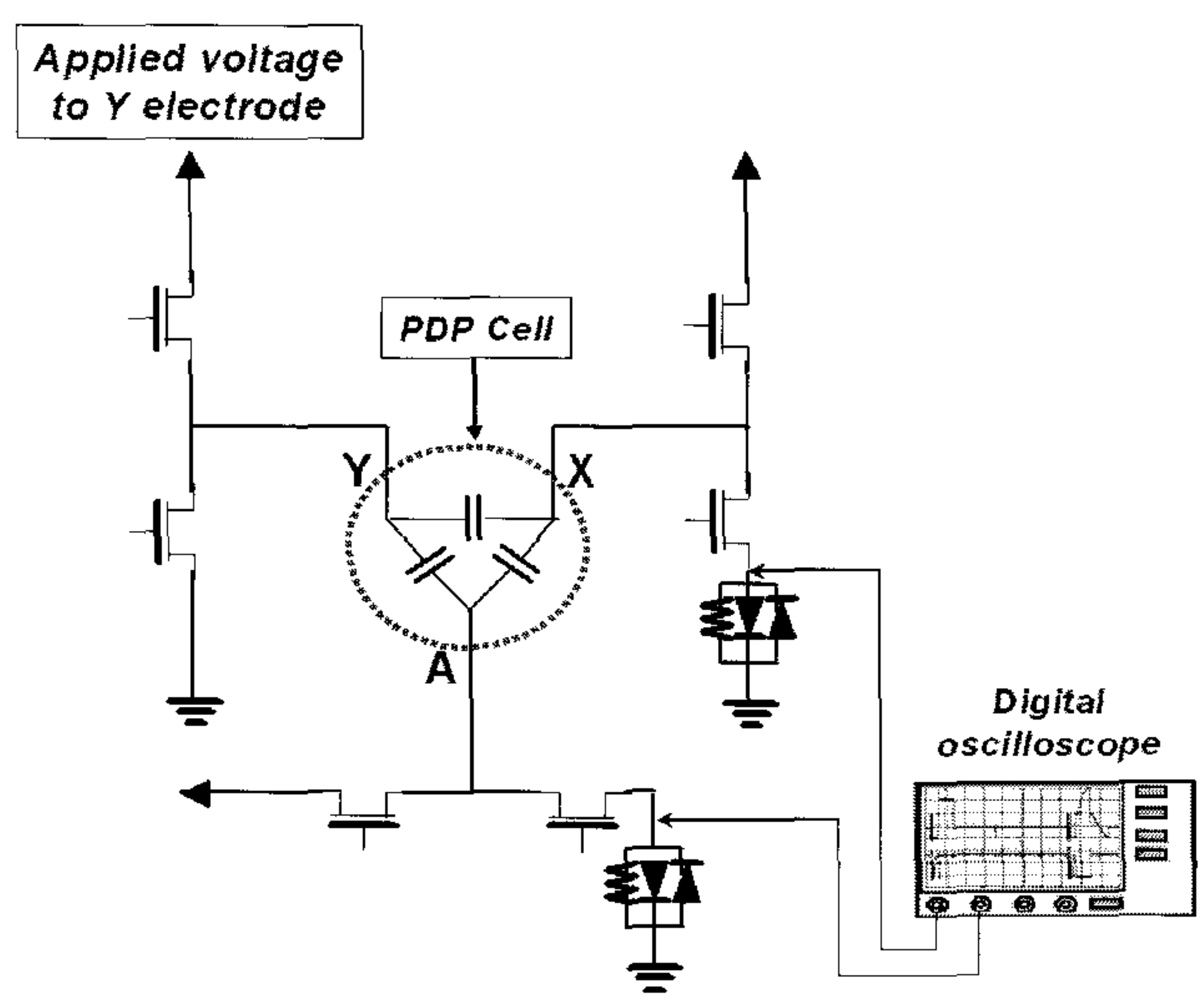


Fig. 4. The discharge current detect circuit of sustain and address electrodes.

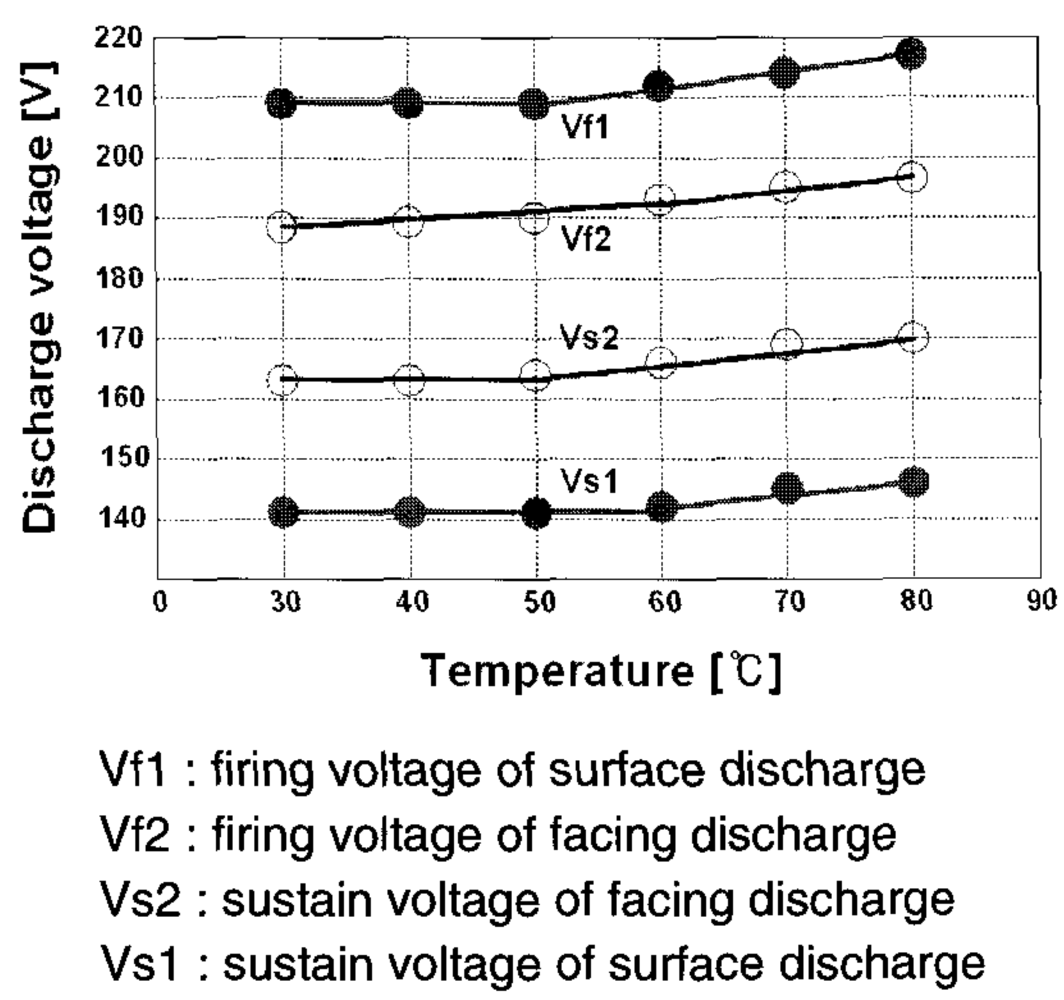
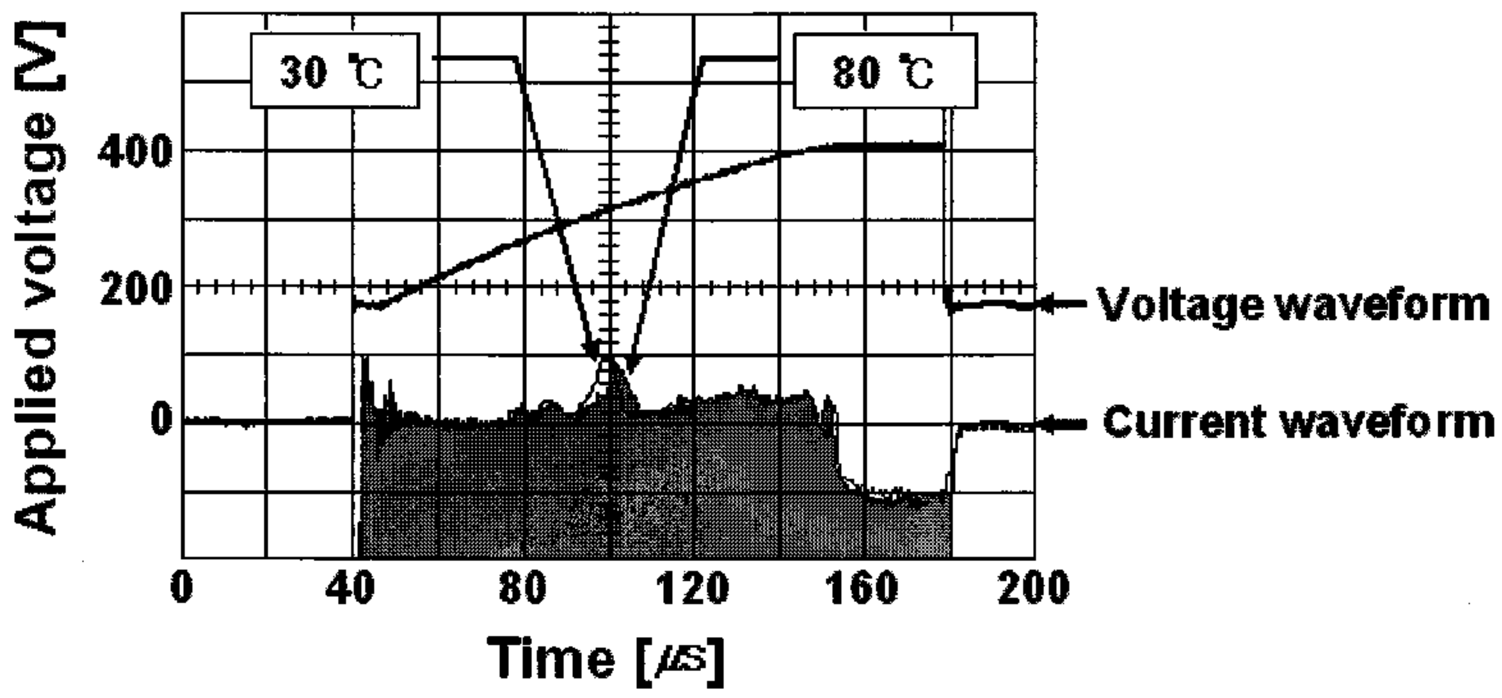


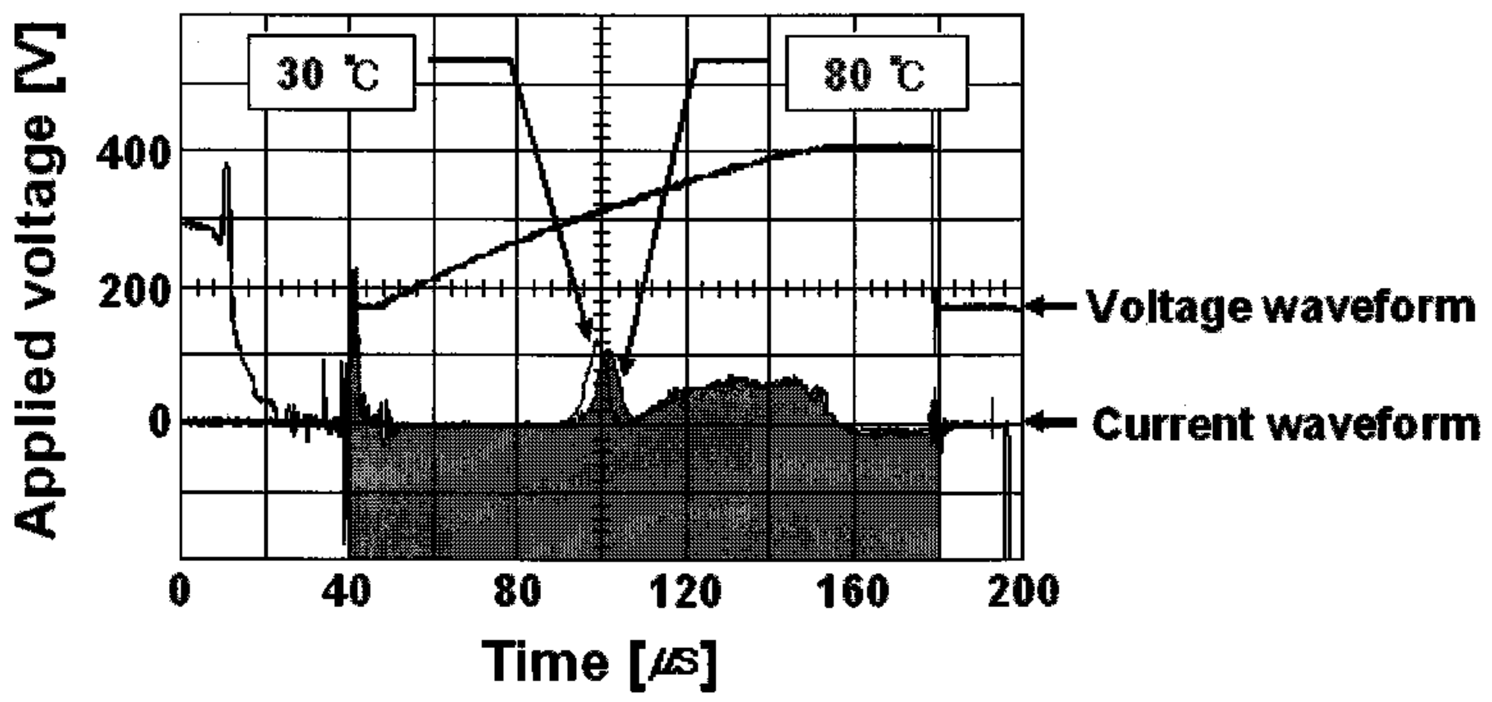
Fig. 5. Surface and facing discharge voltage characteristics as a parameter of ambient temperature.

period of ADS driving scheme [11].

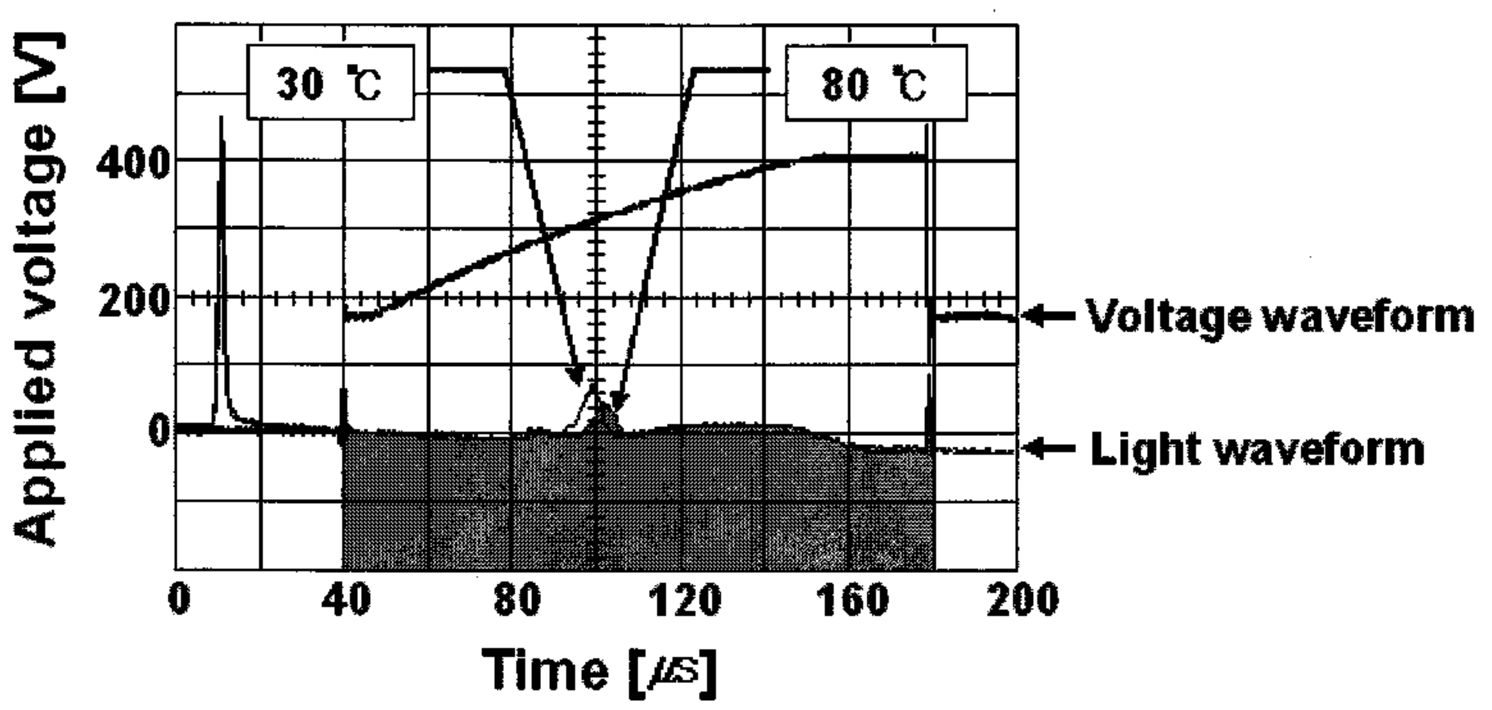
In order to detect the emitted light accurately, a highly sensitive light detector was used. The detector consistsed of avalanche photodiode (APD), temperature compensating bias circuit, and low noise current-voltage (I-V) amplifier circuit (C5460, Hamamatsu.) [2].



(a) surface discharge current waveforms



(b) facing discharge current waveforms



(c) Corresponding light waveforms

Fig. 6. Discharge current waveforms for the surface(a) and facing(b) discharge and corresponding discharge light(c) waveforms.

3. Results and Discussion

Fig. 5 shows the firing and sustain voltage characteristics for both surface and facing discharge of sealed test panel as a parameter of ambient temperature after aging for 2 hr at 350 ℃. From Fig. 5, we can see that the discharge voltage remains almost constant until about 50 ℃, and thereafter increases with ambient temperature regardless of the type of discharge. The firing voltage of surface discharge, Vf1, was higher by about 20 V than that of facing discharge, Vf2, whereas the sustain voltage of surface discharge, Vs1, was lower by about 20 V than that of facing discharge, Vs2. The

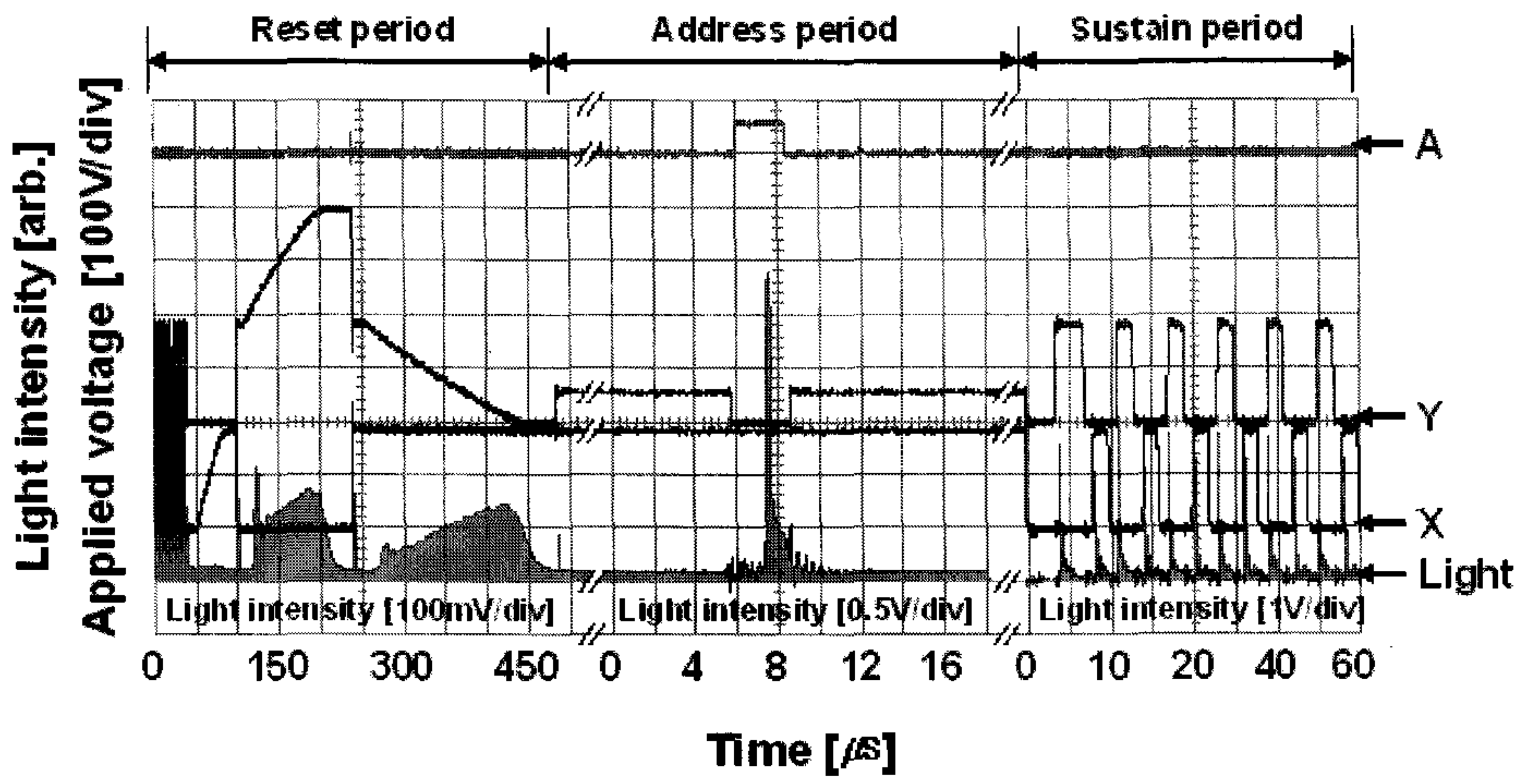


Fig. 7. Typical address and sustain discharge characteristics in ADS driving at room temperature.

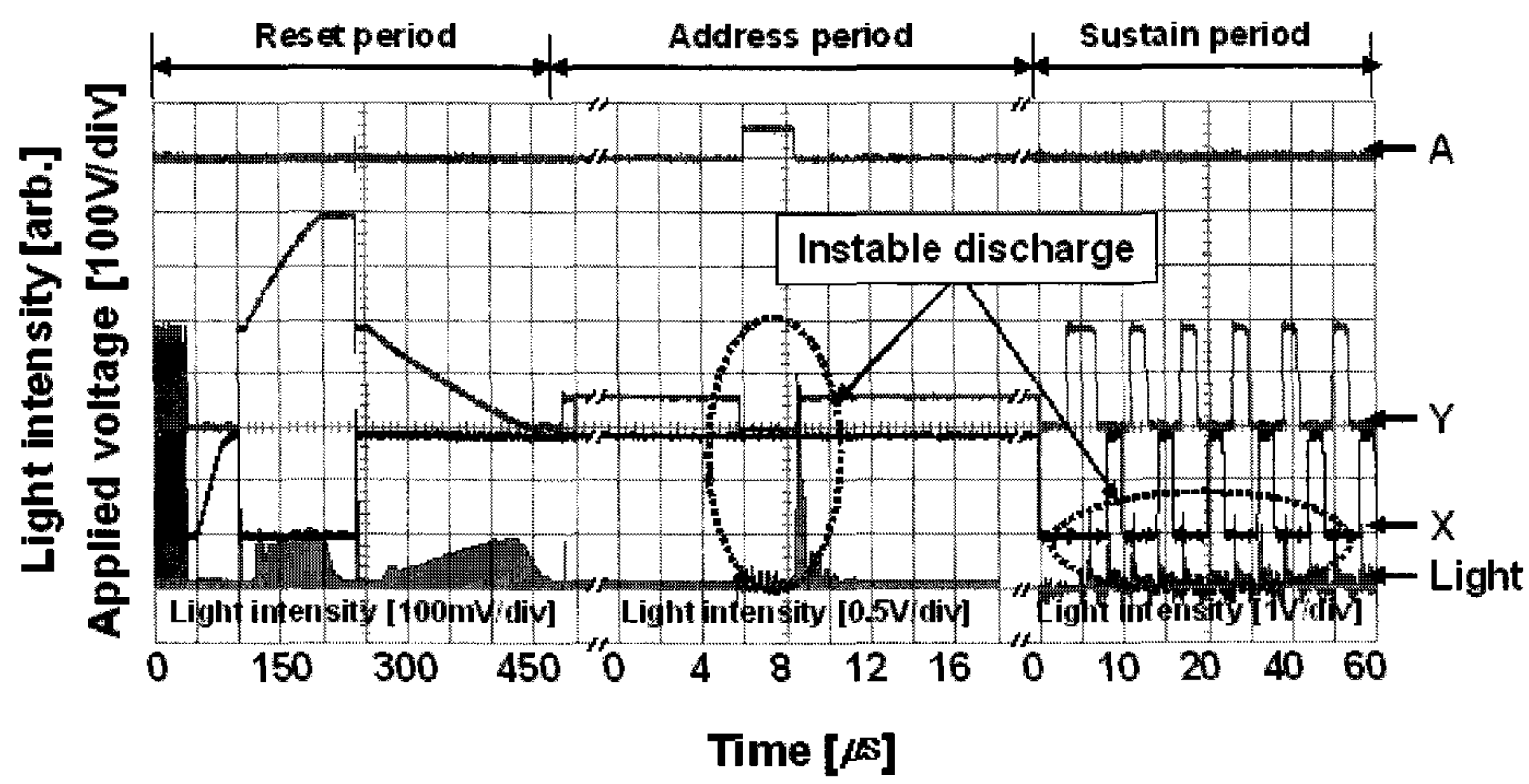


Fig. 8. Typical address and sustain discharge characteristics in ADS driving at 60℃.

voltage margin of surface and facing discharge was about 70 V and 30 V, respectively.

Basically, the discharge voltage should remain constant under constant gas density by Paschen's Law. However, the Paschen's Law is not applicable to the PDP cells for the following reasons.

1. One of the reasons for deviation from the Paschen's Law arises from the non-uniformity of the electric field profile between electrodes of ac PDP. [8]

2. The Paschen's Law is not applicable to the gaseous mixtures, especially with Penning mixture gas which is used as a discharge gas of ac PDP. With the admixture gas, ionization may occur through collisions with metastables of the main gas. [9]

3. In Paschen's Law, γ was assumed to be independent of electric field E and gas pressure P, i.e., E/P is constant. However, γ is not only a function of E/P but also P. [10]

In order to determine the variation of discharge voltages with temperature, the firing voltages must be measured at reset-up period of real ADS driving scheme.

Figs. 6(a) and (b) show the typical discharge voltage and current waveforms for the sustain and address discharge, respectively, during the reset-up period after the erasing sequence. For comparison, the results at room temperature (30 ℃) and at 80 ℃ are shown in the figure. Fig. 6(c) shows the corresponding discharge light intensities. In Fig. 6, the discharge firing voltages for the room and high temperature are 300 V and 320 V, respectively.

This increase in discharge firing voltage may lead to a misfiring. For example, Figs. 7, 8 and 9 show typical

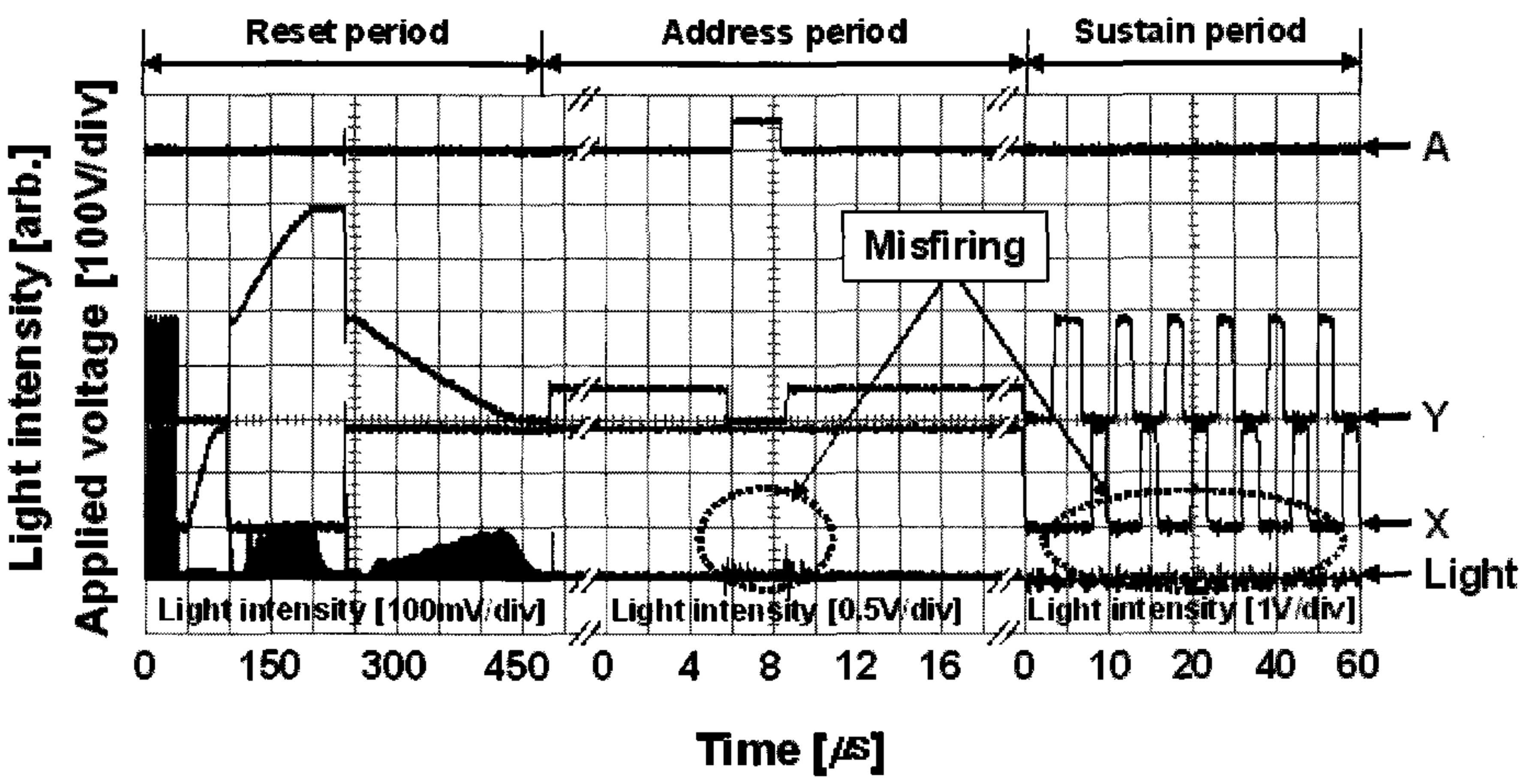


Fig. 9. Typical address and sustain discharge characteristics in ADS driving at 80 ℃.

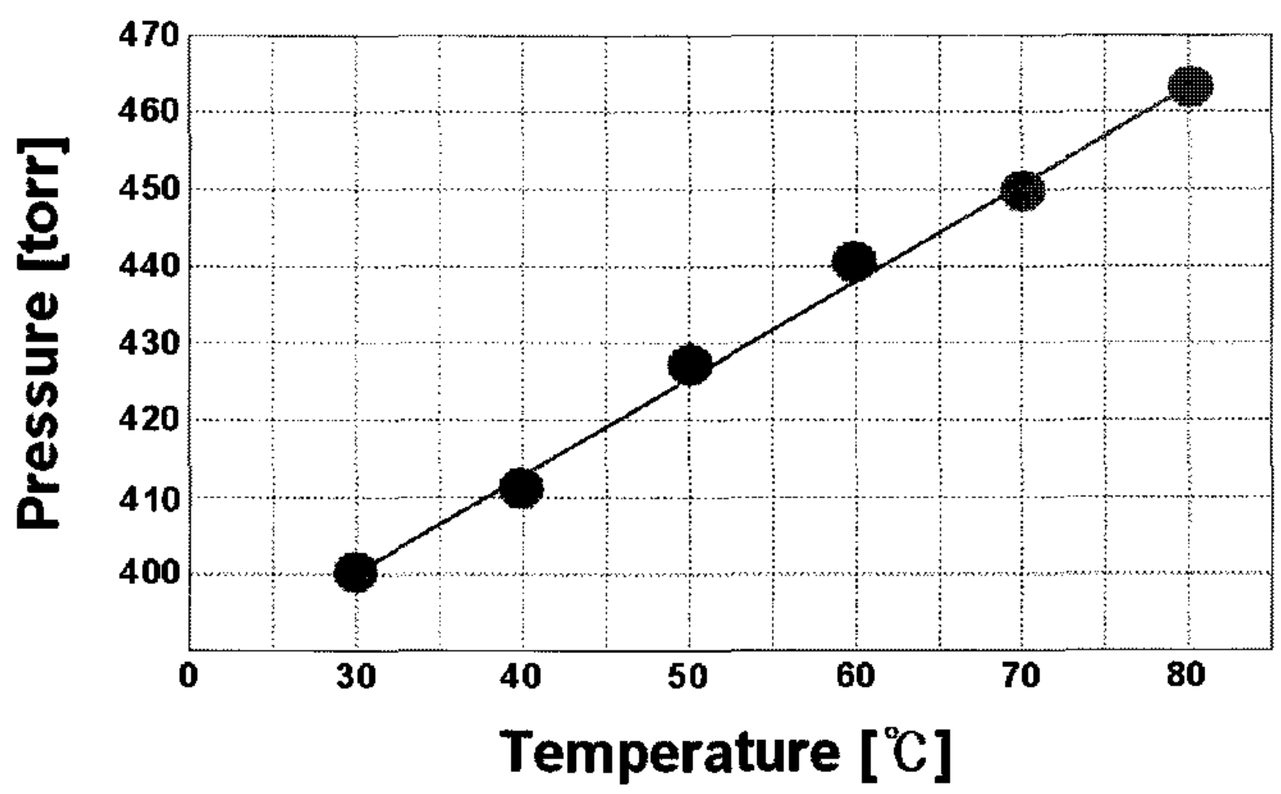


Fig. 10. Relationships between gas pressure and ambient temperature for non-sealed ac PDP.

address and sustain discharge characteristics in ADS driving scheme at room temperature, 60 ℃ and 80 ℃, respectively.

At room temperature (Fig. 7), stable address and sustain discharge was noticed from the discharge light waveform.

However, at 60 ℃ (Fig. 8), instable address and sustain discharges were observed. At 80 ℃ (Fig. 9), misfiring in address and sustain period were noted.

The increase in the discharge voltage with the ambient temperature may be attributed to the increase in discharge gas pressure of the panel and to the variation of the MgO characteristics.

The relationship between gas pressure P [torr], temperature T [K] and volume density n [cm^{-3}] can be expressed as follows [9].

$$P=1.035\times10^{-19}nT \quad (1)$$

When $n=1.29\times10^{-19}$ [cm^{-3}], the relationship between P and T can be expressed as

$$P=1.335T \quad (2)$$

If the panel temperature was increased from room temperature to 80 ℃, the gas pressure could have estimately increased from 400 torr to 471 torr. Therefore, the total variation of gas pressure is about 70 torr.

With the test panel, which is clamped after assembling the front and rear panel in test chamber as shown in Fig. 3, the gas pressure varied from 400 torr to 463 torr when the temperature was increased from room temperature to 80 ℃ (Fig. 10). Therefore, the total variation of gas pressure was about 60 torr. The difference in the theoretical value is assumed to have

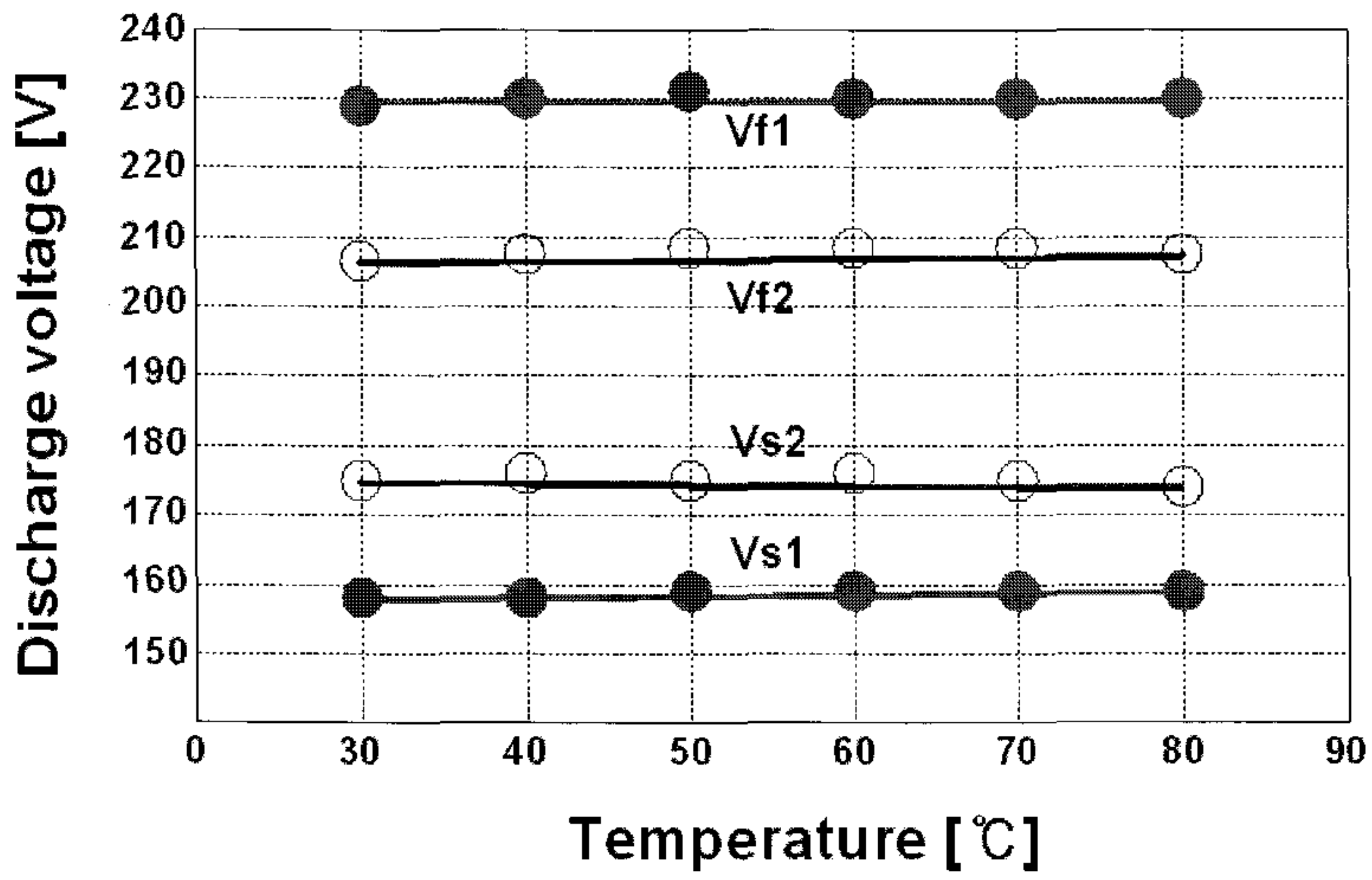


Fig. 11. Discharge voltage characteristics as a parameter of ambient temperature under constant working gas pressure.

been due to the existence of measuring gas pipe line and device.

These increases in the gas pressure may lead to the slight increase in the gap between front and rear panels, which in turn whould decrease the electron mean free path, or the coefficient of collision ionization. These factors could increase the discharge voltage. In order to identify the cause of the increase in the discharge voltage with the temperature, it is important to separate the influence of temperature from that of gas pressure. In addition, in order to decouple these effects, the gas pressure in the test panel is kept constant value of 400 torr regardless of the ambient temperature by the experimental set -up as shown in Fig. 3.

Fig. 11 demonstrate the relationship between discharge voltage and ambient temperature under constant working gas pressure. This figure shows that the discharge voltages remain almost constant regardless of the temperature rangg from room temperature to 80 ℃.

In Fig. 5 the surface and facing discharge firing voltage increased about 8 V in the same temperature range.

These results show that the increase in the discharge voltage with the real panel is due to the increase of working gas pressure inside the panel rather than due to the variation of MgO characteristics or other factors with the temperature increase.

Therefore, we found that the main cause of the misfiring of ac PDP at high ambient temperature is the increase in the working gas pressure and the corresponding discharge firing voltage at high temperature.

4. Conclusion

In this paper, the misfiring phenomena of ac PDP which seriously affects the image quality at high ambient temperature are assumed. The possible cause factors, such as MgO, gas pressure and wall charges are assumed. It is found out that the main factor on the misfiring at high ambient temperature is the increase in the working gas pressure and in the corresponding discharge firing voltage.

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