A study on the temporal bright image sticking problem in AC PDP

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Abstract

In this study, the causes of temporal bright image sticking problem in an AC PDP were investigated. The temporal bright image sticking problem in an ac PDP is observed to be a relatively lower luminance following several minutes on-time at a high gray level compared to that of the ordinary turned-on image area. We focused on the detailed causes of image sticking, which are directly related with the visible emission such as the changes in the characteristics of phosphor, MgO surface and gas dynamics. The experimental results show that the thermal quenching of phosphor and temperature-dependent discharge characteristics change cause the image sticking problem.

1. Introduction

One of the issues related with the image quality of an ac PDP is the temporal bright image sticking that arises during the bright background display, which results in unexpected gray pattern that produces a stain on the same gray level of the image.[1, 2] This lowered luminance image pattern compared to the adjacent area occurs as a results of the long-time display at high gray level. This phenomenon can be explained by the observation of luminance variation of test panel which is driven by different number of sustain pulses during a fixed time. Fig. 1 shows the relative luminance of full white (Red, Green, Blue) and glass temperature of test panel for each driving sustain frequency (10 kHz, 30 kHz, and 50 kHz). Whereas the luminance of 10 kHz driving was maintained at an almost constant level, that of 50 kHz decreased by about 5% after 10 minutes turn-on. This result shows that the luminance decrease with time is related to the driving frequency, which results in change of the panel temperature by the heat emitted from the discharges.

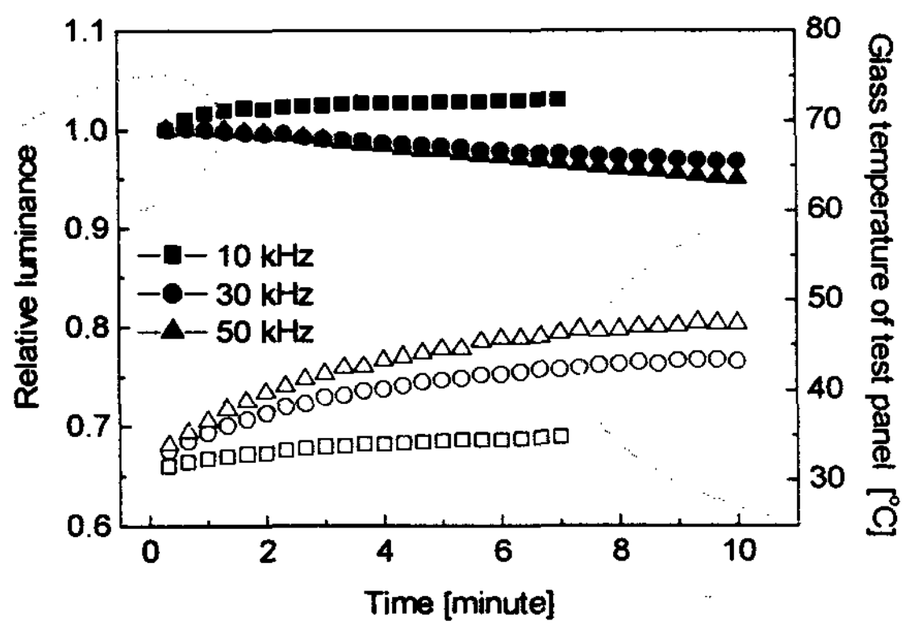


Fig. 1 Relative luminance and glass temperature of test panel vs sustain frequency.

Accordingly, we suspected the heat from the plasma discharges to be the primary cause of bright image sticking problem and thus studied the factors that could be directly affected by the heat such as the phosphor, and discharge characteristics.

2. Experiment and Results.

2-1. Temperature-dependent phosphor characteristics

Generally, most phosphors show the temperature-dependent thermal quenching of luminance, which can be explained qualitatively by one-dimensional configurational coordinate model as shown in Fig. 2 [3,4]. In this figure, the relaxed-excited-state may reach the crossing of the two parabolas if the

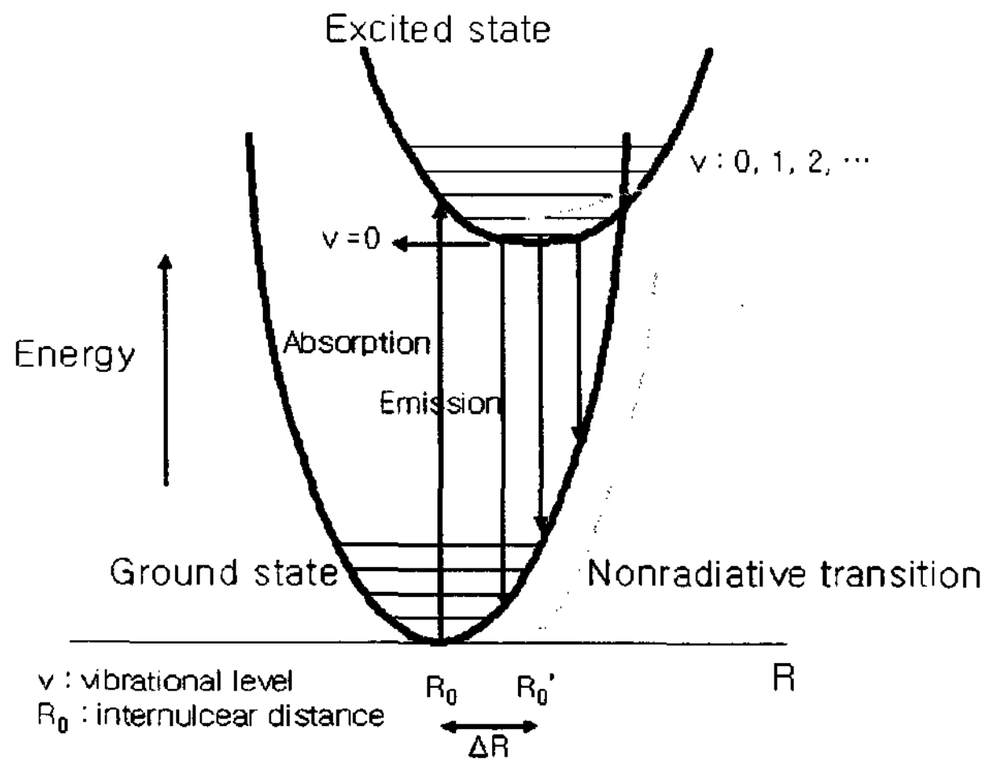


Fig. 2 Schematic illustration of a configurational coordinate model.

temperature is high enough. Via the crossing, it is possible to return to the ground state in a nonradiative manner.

Figure 3. shows the schematic diagram for the thermal dependency measurement of phosphors that are used in PDP. In this experiment, the compositions of employed phosphors are commercially used ones; RED: (Y, Gd)BO_3:Eu, GREEN: Zn_2SiO_4:Mn+YBO_3:Tb + (Ba,Sr,Mg)OAl_2O_3:Mn, BLUE:$BaMgAl_{10}O_{17}$:Eu, and to ensure the conditions of light emission in an ac PDP, D2 lamp (Hamamatsu Co., Ltd., Japan) and VUV band pass filter which has the center at 150nm were used.

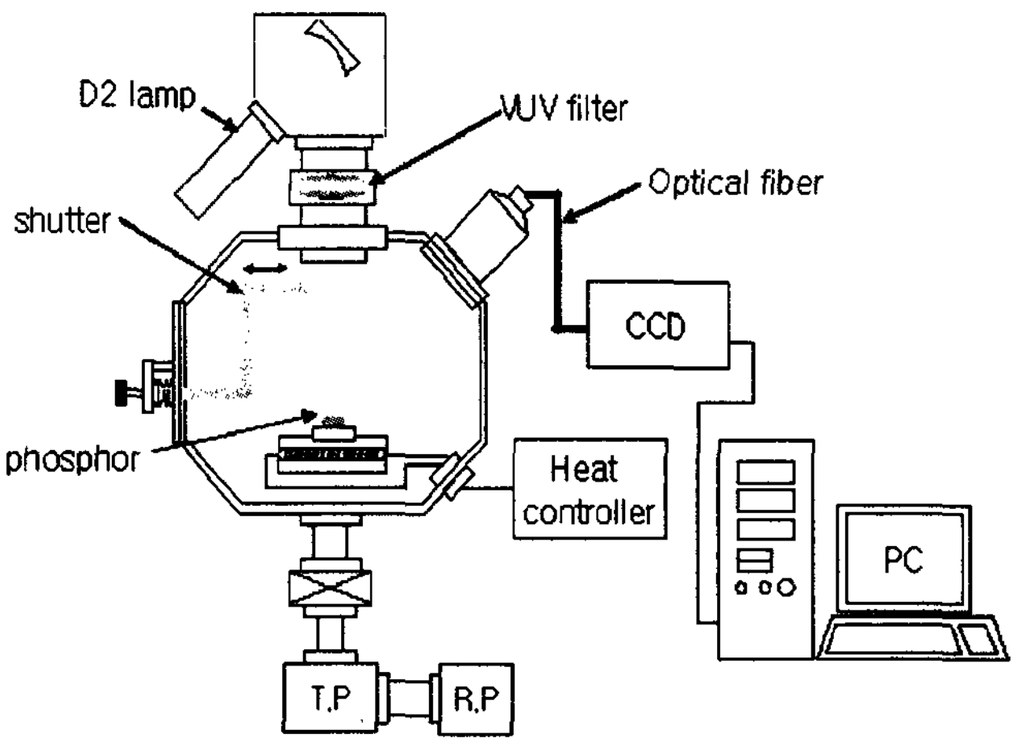
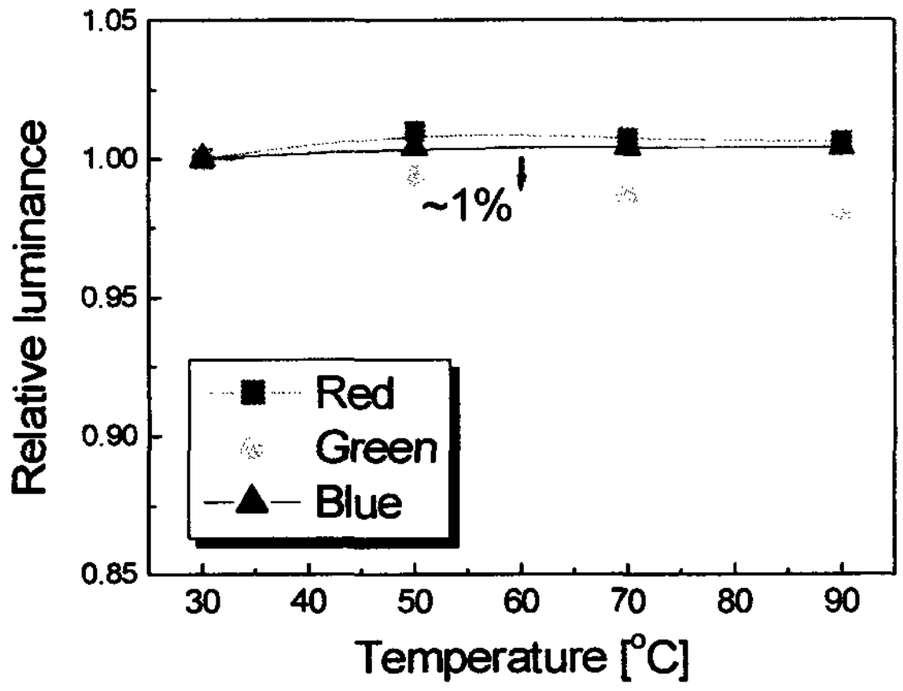
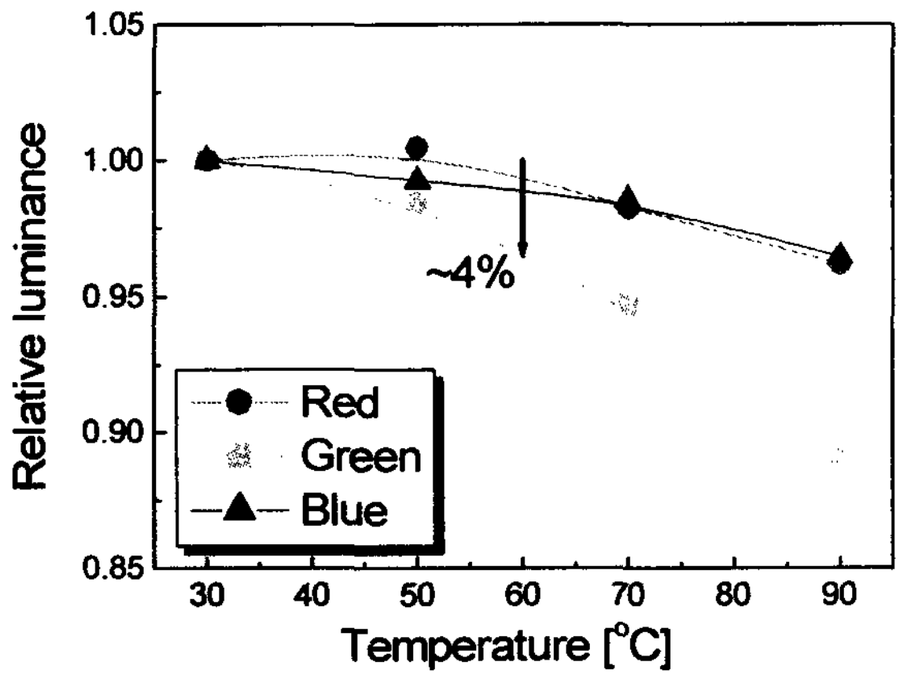


Fig. 3 Schematic diagram of the thermal dependency measurement system for phosphors.



(a)



(b)

Fig. 4 Relative luminance of each color vs panel temperature.
(a) phosphor itself, (b) luminance of test panel

Fig. 4 (a) shows the relative emission intensity of each phosphor as the temperature changes. The experimental result shows that the relative emission intensities of red and blue phosphor are nearly same for the temperature range of 30~100°C, whereas, that of green phosphor decreased by about 1% at 60°C and more at higher temperature.

2-2. Panel experiment as to an ambient temperature

To investigate the portion of each factor that contributes to bright image sticking problem in an ac PDP, we investigated the

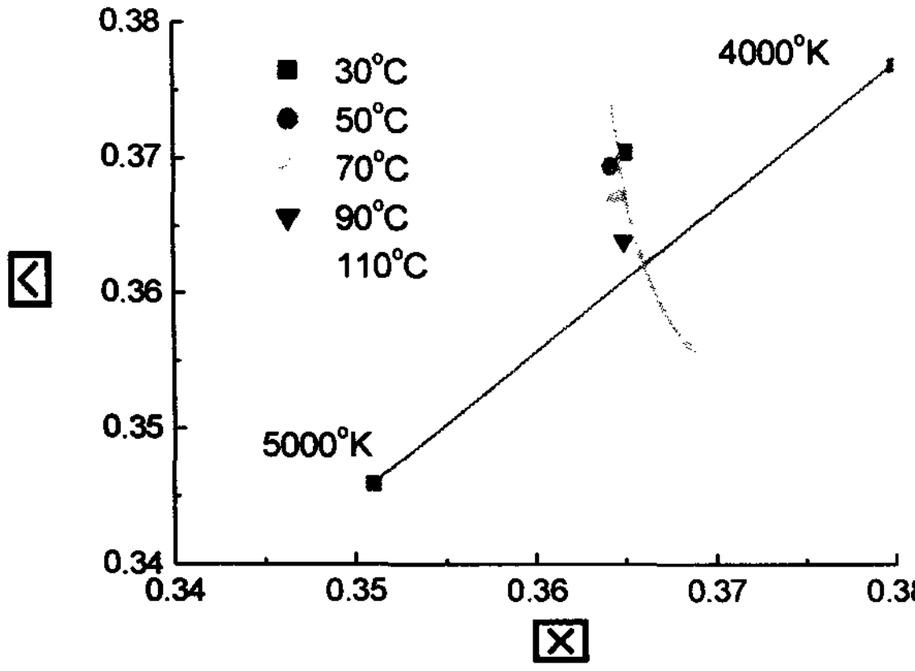
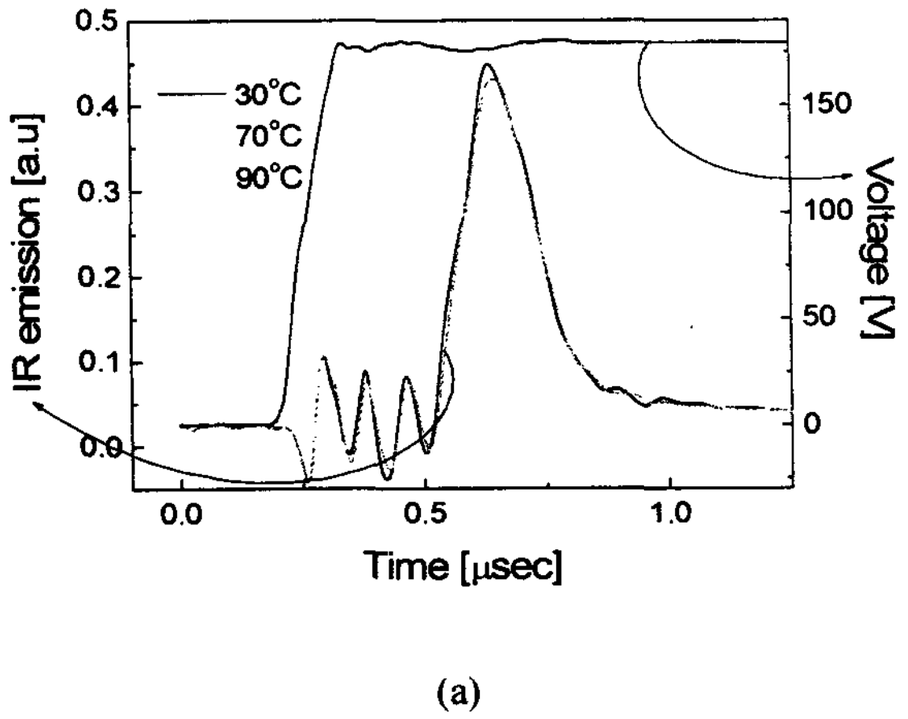


Fig. 5 White color coordinate vs panel temperature.

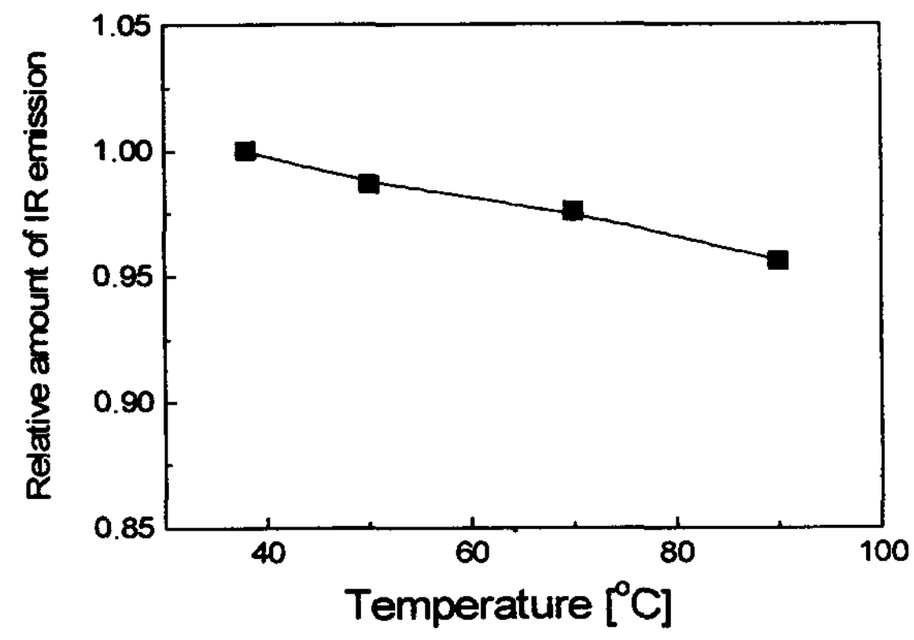
effect of panel temperature variation which affects on the discharge characteristics. The panel used in this research was a coplanar type 4-in diagonal ac PDP with a 1080㎛ cell pitch, of which electrode widths were 340㎛ with 80㎛ separation. The barrier ribs were 150㎛ high. The panel was filled with Ne-Xe(4%) mixture gas to a pressure of 400 torr.

By controlling the temperature of test panel by placing in the temperature controlled annealing chamber, we measured the luminance and IR emission. Fig. 4 (b) shows the relative luminance of each color as to the panel temperature. The luminance of all these colors decreased with the increase of temperature where that of green color showed the largest decrement. From the calculation of luminance and color coordinate of each measurement, we found that temporal image sticking is the result of the localized luminance degradation rather than the color shift as shown in Fig. 5. Fig. 6 shows the infra red (IR) emission from the 3■5 pixels of full color test panel averaged over 256 times by changing the ambient temperature. As the temperature increased, the peaks of IR waveforms decreased and the delays from the sustain pulse increased. Furthermore, the totals of IR emission were reduced.

On the basis of panel results, we conducted the wall charge measurement experiment as to the number of sustain pulses by the longitudinal electro-optic amplitude modulation technique using a cubic structural Pockels crystal as the dielectric material[5-7].The principle and method of wall charge



(a)



(b)

Fig. 6 IR emission characteristics of a full color test panel vs panel temperature. (a) averaged IR emission waveform. (b) relative amount of IR emission.

measurement were reported in ref[5-7]. To check the temperature dependence of wall charge distribution. we applied different number of sustain pulse train (10, 50, 100, 150) for a given interval of time(10msec) and repeated, which results in different panel temperature. The period of sustain pulse is 20μsec, which swings from -130V to 130V with 10μsec width. Fig 7 shows the wall charge distribution change as to the number of sustain pulses. In this result, the amount of wall charges decrease and the slope of wall charge distribution between sustain electrodes gap are less steep as to the increase of sustain pulse number, which is correlated with the temperature change of test panel as to sustain frequency in Fig. 1.

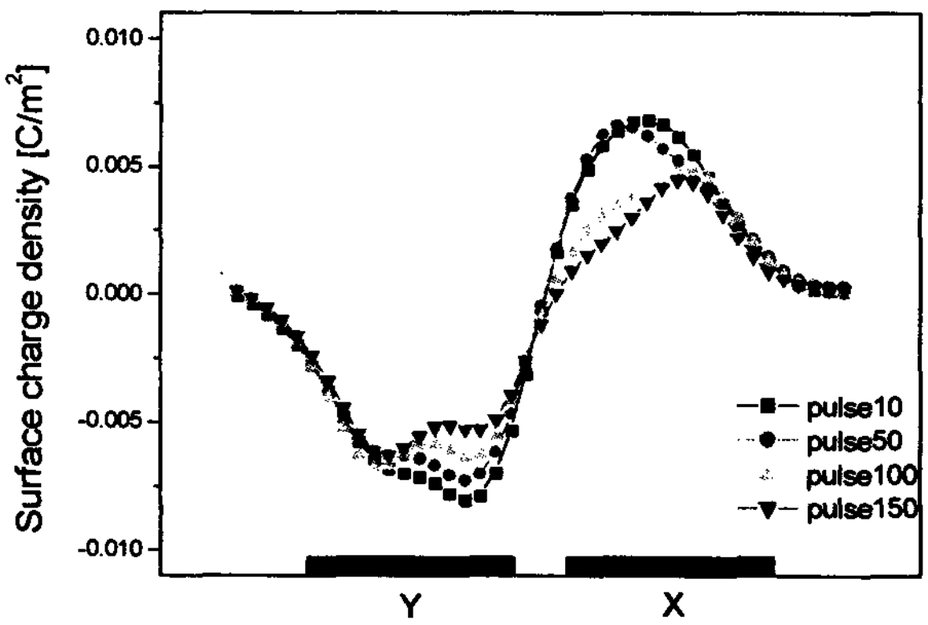


Fig. 7 Wall charge distribution vs applied sustain pulse number.

3. Summary

In this research, we examined the cause of the bright image sticking problem and found that it results from the localized luminance degradation rather than the color shift due to the increase of phosphor temperature as far as the phosphor characteristics are concerned. Through the measurement of IR emission during sustain period and wall charge measurements as to number of sustain pulse, the discharge characteristics were also found to be influenced by the heat emitted from sustain discharges. Further study is planned to clarify if the MgO surface characteristics change as for the possible cause for the temporal bright image sticking problem.

Reference.

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