Characteristic of High Voltage Aging in AC PDPs

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Abstract

A relationship between discharge delay time and the aging method were investigated: A-Y (Address electrode - Scan electrode) aging and conventional X-Y (Common electrode - Scan electrode) aging with the variation of sustain voltage beyond self-erasing discharge. Although A-Y aging decreases discharge delay time, it has several drawbacks like non-uniformity of discharge, degradation of luminous efficiency and a color temperature. In a conventional aging condition which is carried out near the mid-margin voltage, discharge delay time is short in low voltage and high frequency condition. As an alternative to conventional voltage aging, high voltage aging is suggested which is carried out at self-erasing sustain voltage region. High voltage aging shows lower discharge delay time and fast aging speed than conventional voltage aging.

1. Introduction

Plasma display panels (PDPs) are leading display devices in a large sized flat panel display. Among the fabrication process of a PDP, aging plays the role of stabilizing electro-optical properties such as luminance, discharge current, and driving voltage [1].

Aging has two major roles. Firstly, it saturates phosphor efficiency which degrades fast in the early stage of panel operation. Secondly, it cleans up the surface of the MgO protective layer which is contaminated during fabrication process so as to stabilize operating voltage and discharge current [2].

Currently most of PDPs are aged and operated by surface discharge within the marginal voltage range. The aging process focused only on X-Y surface discharge while addressing discharge in driving condition uses A-Y discharge. Furthermore, surface discharge does not spread uniformly across the cell so that it can not perform aging on overall MgO surface.

In this paper, several aging methods were compared and proposed new one which provides uniform aging over the entire cell area and improves discharge delay time.

2. Results

The variations of discharge delay time in AC PDPs by the A-Y aging process were firstly investigated. Aging was performed at 300V with sustain frequency of 10kHz. Panels were X-Y aged for 9 hours at 250V with 10kHz before A-Y aging. A-Y aging was performed for 3 hours to measure discharge delay time and luminous efficiency. Discharge delay time is expressed as Tsc6Z which includes average and standard deviation of discharge delay time. As shown in Figure 1 discharge delay time decreased by 5% to 10% after one hour of initial A-Y aging. And then, it tended to saturate during next periods. But A-Y aging caused several problems. Color temperature during aging process degraded rapidly. And the luminous efficiency decreased. Non-uniform A-Y discharge between R, G, and B cell were also found. So, although A-Y aging improves discharge delay time property of panel, it would be impractical to apply the aging process on PDP panels.

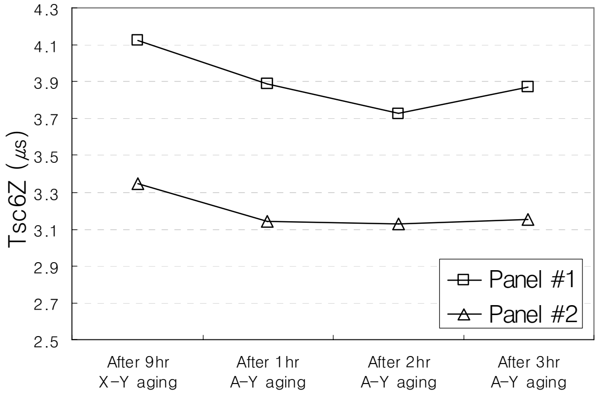

Figure. 1. Discharge delay time variation during A-Y aging at 10kHz 300V (Tsc6Z = average discharge delay time+6*standard deviation of discharge delay time)

Figure 2 shows the variation of discharge delay time during X-Y aging. PDP panels were aged for over one hundred hours at different voltage and frequency. Discharge delay time always increased according to the aging time until it reached at a very high level. It is a very interesting phenomenon for A-Y aging to decrease discharge delay time in spite of additional aging. So, conventional X-Y aging was compared with A-Y aging.

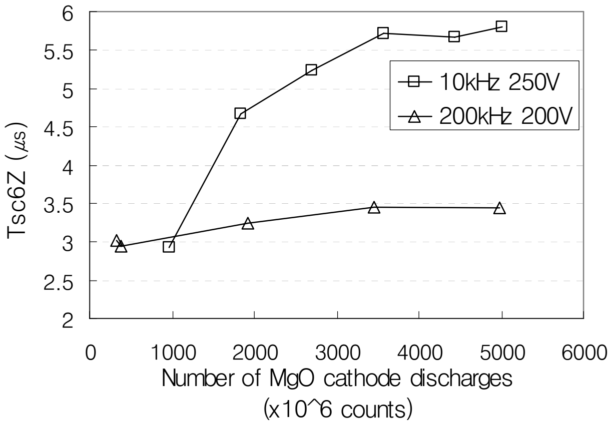

Figure. 2. Discharge delay time variation with lifetime test.

ICCD images were measured for A-Y aging discharge at 10kHz, 300V, and X-Y aging discharge at 10kHz from 200 to 480V using PI-Max 512 by Roper Scientific, Inc. with IR filter. Using gate mode acquirements, IR distributions of discharges in which Y electrode was bombarded with ions were measured. ICCD image results are presented in Figure 3. In X-Y aging, spatial distribution moved from ITO gap area to a horizontal rib area when sustain voltage increased. Above 280V, discharge became weak and non-uniform because of self-erasing discharge. When aging voltage was increased over 400V, IR became strong and uniform again.

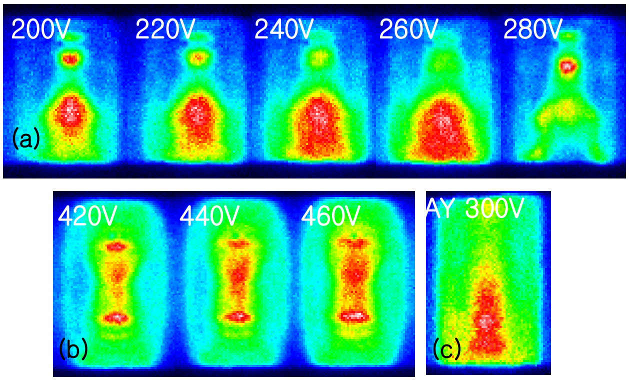

Figure. 3. ICCD image (a) at 10kHz, conventional voltage aging (b) at 10kHz, high voltage aging (c) at 10kHz 300V, A-Y aging.

We analyzed Y electrode part of ICCD data to see the distribution of IR intensity. Histogram data results are shown in Figure 4. In conventional aging voltage of 200 to 260V, IR intensity distribution split into two regions. As aging voltage went up, the split became larger and overall distribution shifts to higher IR intensity. In case of high voltage aging, it showed two peaks of IR profile at first. Above 440V, two peaks merged into one. Finally, distribution of IR intensity of high voltage aging became similar to that of A-Y aging.

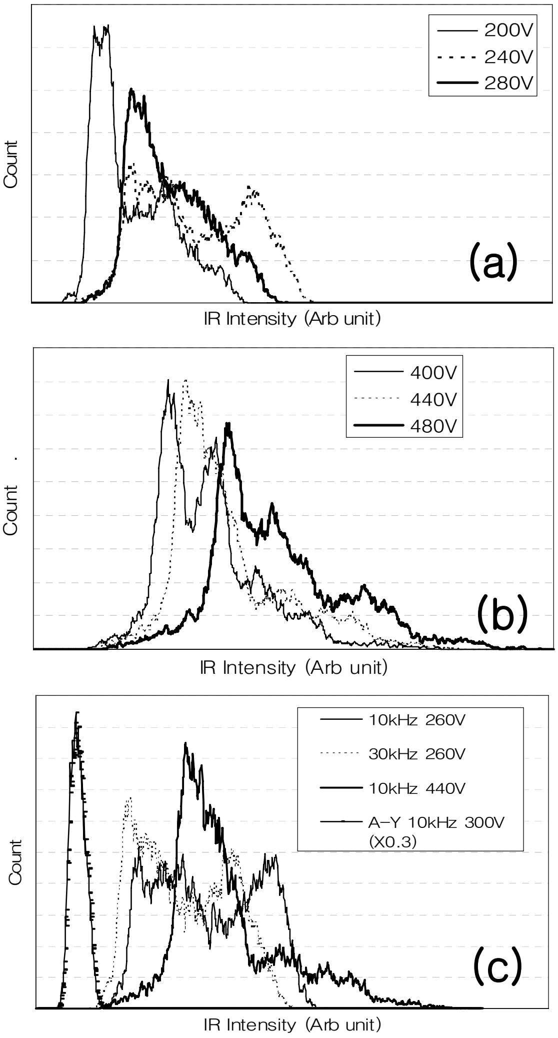

Figure. 4. Histogram of Y electrode area of ICCD (a) at 10kHz, conventional voltage aging (b) at 10kHz, high voltage aging (c) Comparison between aging condition.

In Figure 5, discharge delay time was compared according to aging conditions of panels. Conventional

250V aging at 10kHz showed longest discharge delay time. Discharge delay time was reduced relative to conventional 250V 10kHz aging when aging frequency increased or aging voltage decreased. At high voltage, it showed shortest discharge delay time. According to IR intensity histogram data in Figure 4, discharge delay time reduction by the change of aging voltage from 250V to 230V was mainly caused by reduced IR intensity. Lower ion flux on the MgO surface effected lower degradation. Similar explanation could be applied to the relationship between frequency and discharge delay time. But, it count not explain high voltage aging.

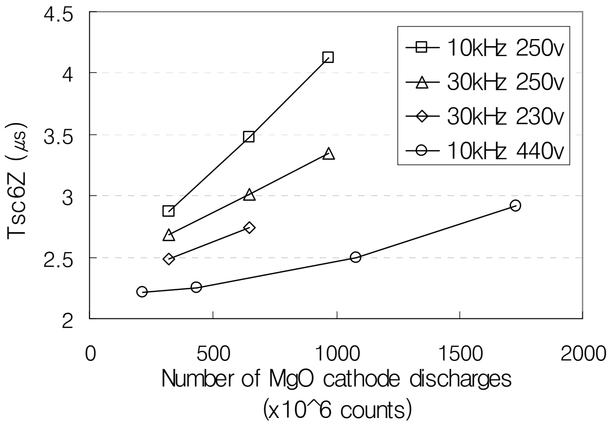

Figure. 5. Discharge delay time according to the aging condition.

440V and 260V aging did not differ in average of IR intensity but in distribution of IR intensity. 260V aging showed two groups of the IR intensity distribution peak. It means that some areas of MgO experienced high amount of ion flux and faster aging speed while other areas experienced low ion flux and low aging speed. This unbalanced aging speed across Y electrode seemed to induce localized damage on MgO which led to large discharge delay time.

On the contrary, high voltage aging has some advantages over conventional voltage aging. Aging speed can be accelerated by applying higher voltage. In conventional voltage range, high power aging is restricted by self-erasing phenomena which reduce discharge current level. So, as far as insulating dielectric layer’s breakdown voltage permits, we can apply higher voltage to accelerate aging processes which will reduce fabrication tact-time. It also gives more uniform MgO surface damage profile.

3. Conclusion

Most of electro-optical characteristics like luminance, driving voltage, current density, IR peak position, and luminous efficiency saturate quickly. But, discharge delay time gets worse with time beyond tolerable level. So, discharge delay time is a very important factor in the aging process. From this point of view, high voltage aging which performs fast and uniform MgO aging is a good candidate for an aging method in AC PDPs.

4. References

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[2] C. Son, J. Choi, and J. W. Park, J. Vac. Sci. Technol. A, Vol. 17, no. 5, pp. 2519-2622, 1999.