Characteristics of Xe content in Shadow Mask PDP based on macro-cell studies

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Abstract: *Three macro-cells with different Xe content are made to study the characteristics of Xe content in shadow mask PDPs. The light emission, the work voltage, the sustain discharge delay and the discharge efficiency are investigated in this paper. The results help us to understand the discharge characteristic of SM-PDPs and suggest that using high Xe content is a practical way to obtain high discharge efficiency in SM-PDPs.*

Keywords: Xe content; light emission; work voltage; discharge delay; discharge efficiency

1. Introduction

Plasma display panels (PDPs) are one of the most promising technologies for large size high-definition television applications. However there is still a need for improving the luminous efficiency and lowering the power consumption. Recently many studies on way of improving luminous efficiency have been published. These results show that besides the commonly used cell designs, a marked increased efficiency can be realized by using high Xe content and high sustain voltage [1-3].

A novel AC PDP with shadow mask(SM-PDP) has been presented for its effective structures with lower cost and lower driving voltage [4]. The biggest difference between the SM-PDP and a conventional ACC PDP is that a shadow mask is used for the barrier ribs instead of a dielectric material. The discharge characteristic is improved by the metal barrier rib.

The small dimensions of a PDP cell and the very short duration of the micro-discharge make it difficult to study discharge characteristic for the micro-cell. Numerical simulation and measurement on a macro-cell have become useful tools for optimizing the performance of PDPs. The macro-cell experiment is based on the similarity of the discharge principle in a scaled up version. It has been proven to be extremely efficient in improving our understanding of the physical properties of the plasma and of the parameters controlling the cell performance [5].

In this paper, the discharge characteristic of Xe content in SM-PDP is studied based on macro experiment. The results help us to understand the discharge characteristic of SM-PDP and optimize the performance of SM-PDPs.

2. Experimental conditions

Fig. 1 shows the panel structure of the novel AC PDP with Shadow Mask (SM-PDP) .The front and rear plates are almost same with that of the normal coplanar PDP. The cheap shadow mask is used instead of complex dielectric barrier ribs.

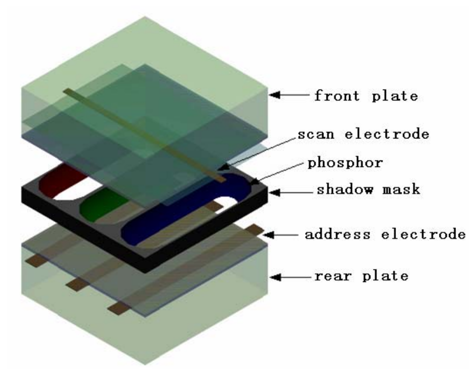

Figure 1. Structure of SM-PDP discharge cell

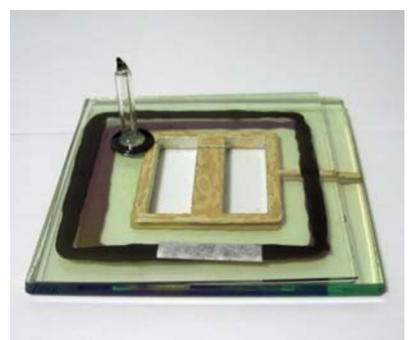

Figure 2. Macroscopic discharge cell of SM-PDP

Fig. 2 is the macroscopic discharge cell of 34inch SM-PDP. The dimensions of the macro cell are 40 times larger than those of the real SM-PDP cells and the pressure of Ne-Xe gas mixture is 40 times smaller than in a real SM-PDP cell. There is no phosphor in the macro cell for measurement of spectrum emission. Three macro cells with the same structure were made and the Xe content is 4%, 10%, and 20%, respectively. The following experiments are based on the three macro cells.

The emission spectrum is measured by the Spectral Scan PR715. The wavelength range of PR715 is 380nm to 1068nm and the important Ne visible emission and Xe infrared emission are within this range. The spatial distribution of the infrared 828nm emission is observed by ICCD with filters. The work voltage and sustain discharge delay were investigated. The discharge efficiency for different sustain voltage is also studied in this paper.

3. Result and discussion

3.1 The light emission

The spectrum of discharge emission in both macro-cell and real panel are studied. As shown in fig. 3, the emission strong lines are the same in both cells. The infrared peak positions are 828nm, 880nm, and 980nm, which are typical for Xe emission spectrum. The visible peak positions are 588nm, 616nm, and 640nm, which are typical for Ne emission spectrum. The emission spectrum in macro cell is quite similar to that in real panel. Fig. 4 shows the spectrum measured with macro cells of different Xe content under the same driving waveform. As Xe content increases, the infrared emission increases while the visible emission decreases. It is also found that the Ne emission is greatly reduced when the Xe content exceed 10%.

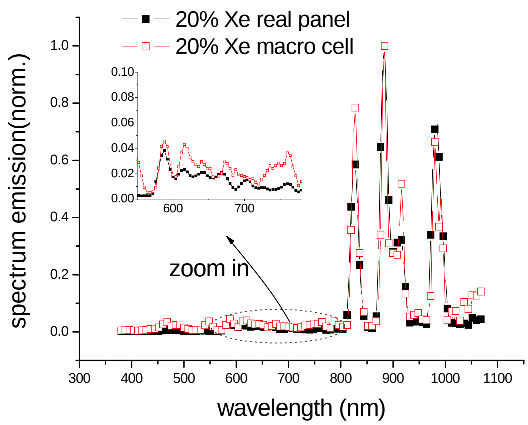

Figure 3. Spectrum in real panel and macro-cell

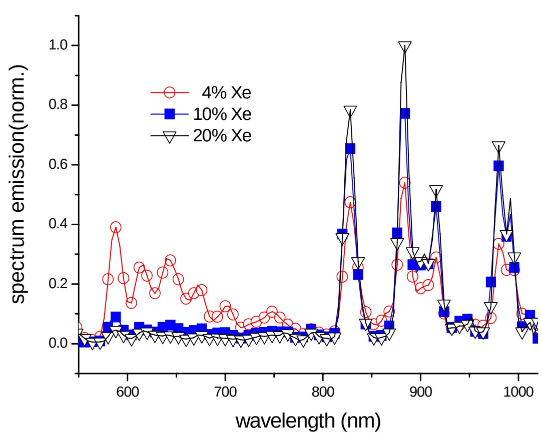

Figure 4. Spectrum in macro-cells for different Xe content

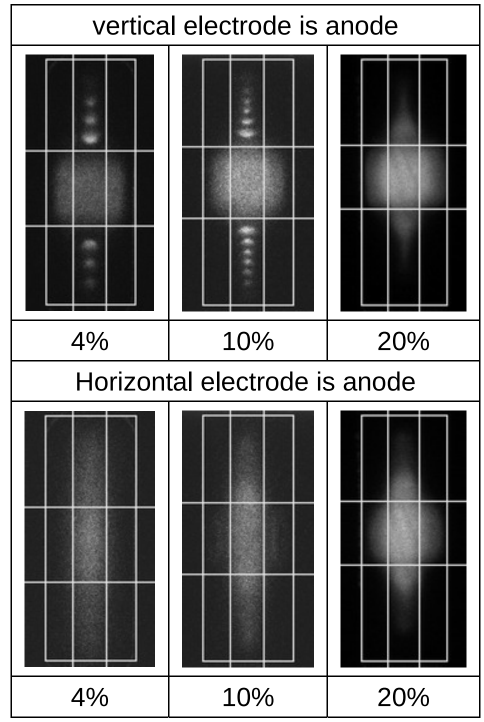

Figure 5. The spatial distribution of light emission in sustain period

As Xe content increases, the spatial distribution of light emission also changes. Fig.5 shows the accumulated emission images in half sustain period for increasing Xe content. Here the driving sustain voltage is 170V for 4% Xe, 170V for 10% Xe and 210V for 20% Xe. The striations were observed when the vertical electrode is anode and limited by the cell when the horizontal electron is anode. The emission intensity becomes stronger as Xe content increases. At the same time, the number of the anode striations increases and the gap of the striation decreases. When the content of Xe reaches 20%, no striations can be observed. It is also found that the discharge area in 20% Xe cell is more restricted in cross area of the two electrodes when the sustain voltage is the same as the other two cells (not presented here). So, the sustain voltage should be increased in high Xe cells. As shown in fig.5, the discharge reaches close to the cell wall when the sustain voltage increases to 210V in 20% Xe cell. Because the phosphor of the SMPDP is evaporated on the side surface of the cell, the high Xe content combined high voltage can excite the phosphor more efficiently.

3.2 Discharge voltage and delay

The drive voltage and addressing speed are important factors for driving the panel. When Xe content increases, the work voltage and the discharge delay also changes. Fig. 6 shows the measured results of fire voltage and minimum sustain voltage as Xe content increases. Compared to the 10% Xe content, the firing voltage increases by 20% while the minimum sustain voltage only increases by 6% in 20% Xe cells. Thus, the static voltage margin which is related to the addressing margin increases by 50%. The increased fire voltage is due to the lower secondary electron emission coefficient in high Xe content cells.

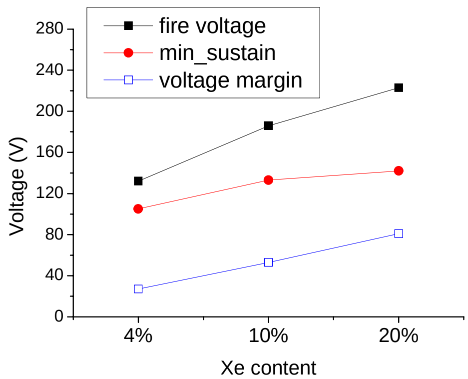

Figure 6. Fire voltage and minimum sustain voltage as a function of Xe content

Fig. 7 shows the measured sustain discharge delay for increasing Xe. Pulse1 represents the discharge when the vertical electrode is anode and pulse 2 represents the discharge when the horizontal electrode is anode. As shown in Fig. 7, the discharge delay in sustain period is reduced for increasing Xe content under the same sustain voltage. This indicates that the sustain frequency can be increased in high Xe content. Thus, the luminance and contrast can be improved.

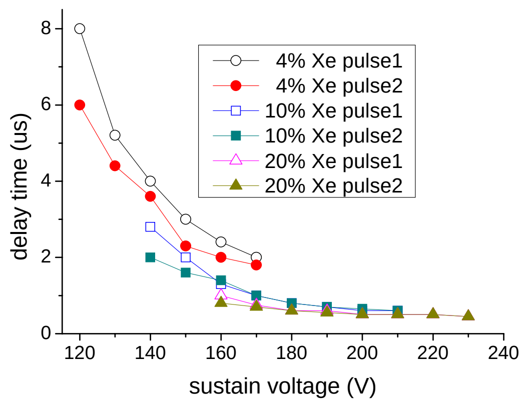

Figure 7. The sustain discharge delay as a function of sustain voltage

3.3 Discharge efficiency

Fig. 8 shows discharge efficiency for increasing Xe content. Here, we use the relative IR emission efficiency to represent the discharge efficiency [6]. Since the intensity of Xenon infrared emission are proportional to those of the Xenon VUV emission and the Ne visible emission is closely related to the total energy deposition in the discharge, the relative IR emission efficiency is a good indicator for UV emission efficiency. As shown in fig. 8 the discharge efficiency is greatly improved in high Xe content cell. The increase is due to the higher Xe-excitation efficiency and electron heating efficiency. The results also show that the discharge efficiency is reduced when sustain voltage increases.

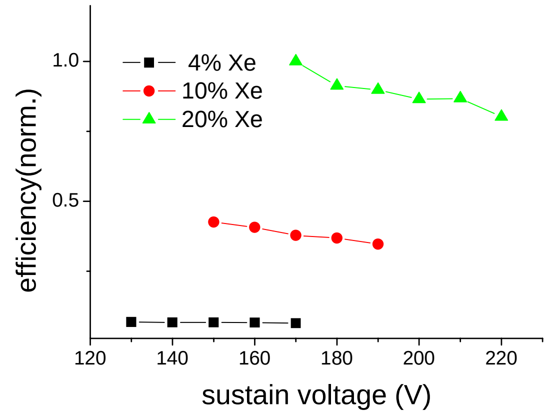

Figure 8. The discharge efficiency as a function of Xe sustain voltage

4. Conclusion

The discharge characteristics of Xe content in SM-PDP are studied in this paper. Results show that as the Xe content increases, the infrared Xe emission increases while the visible Ne emission decreases. The number of the anode striations increase and the gap of striations decrease when the Xe content increases. The fire voltage and the minimum sustain voltage increases as Xe content increases. The static voltage margin increases by 50% when Xe content increases form 10% to 20% Xe. It is also found that the sustain discharge delay becomes small in high Xe content cell. So high sustain voltage and sustain frequency can be used in high Xe panel for obtaining high luminance and high contrast in SM-PDPs.

The discharge efficiency is greatly increased in high Xe content cells and reduced when sustain voltage increases. The results help us to understand the discharge characteristic of SM-PDP and optimize the performance of SM-PDPs. It suggests that using high Xe content is a practical way to obtain high discharge efficiency in SM-PDPs.

5. Acknowledgement

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6. References

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