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The Performance of AC PDP with Grooved Dielectric Structure in High Xe Contents

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Abstract

We reported an AC PDP structure with grooved front panel dielectric layer. The structure exhibits low breakdown voltage, better luminance, and better endurance to crosstalk in high Xe contents. It also shows less luminous efficacy then conventional structure because of the thinner dielectric layer, but we can apply the higher Xe contents to the grooved dielectric structure, which results in the higher luminous efficacy. We made experiments with the Xe contents from 4 to16% and total gas pressure from 400 to 600Torr. The grooved dielectric structure shows the improvement of 20% luminous efficacy and 17% luminance. The firing voltages lower about 40V at 600Torr and Xe 12, 16%. The discharge characteristics of grooved dielectric structure are verified also with 2D simulation.

1. Introduction

Recently, the research on the luminous efficacy improvement with high Xe contents gas is very popular. Although the high Xe gas mixture raises the breakdown voltage significantly, it is essential breakthrough to increase luminous efficacy. To apply high Xe contents gas mixture to commercial product, there are several problems to solve.

Firstly, the breakdown voltage increases as the Xe contents increase. To lower breakdown voltage, geometrical variations or low-pressure gas condition, and sustain frequency variations have been tried.[3, 4, 5] They achieved sustain voltage around 250V keeping luminous efficacy high. Secondly, in high Xe contents gas, there exists crosstalk instability because of the excessive supply of the priming particles from adjoining cells. So there is a certain limitation applying high Xe contents and pressure. Also the increment of luminous efficacy saturates with increasing Xe contents of 20%[6], so we have to obtain the highest efficacy below 20% without drawbacks of high Xe gas mixture.

In other to minimize crosstalk instability in high Xe contents gas, we have to confine discharge in the pixel area. We tried a grooved front dielectric layer structure to make the stronger electric fields selectively around the electrode gap. Also the higher gap fields can decrease the breakdown voltage. In general, the thinner front dielectric layer increases luminance but decreases luminous efficacy as well because of the higher field strength. However, if we can keep sustain voltage to low level in high Xe contents gas, we can apply further Xe concentrations to the grooved dielectric layer structure over the limitation of convention structure. We can increase the luminous efficacy to that of conventional structure level or even more. The 2D numerical simulation study on the suggested structure is also performed.

2. Experimental

We have used 2-inch diagonal SDR test panel[7], with monochrome green phosphor under continuous sustaining of 50kHz, 25% duty pulses.

The groove on the front dielectric layer is designed as is depicted in Fig. 1. The groove pattern is fabricated with wet etching and the Fig. 2 is the overview of the groove patterns.

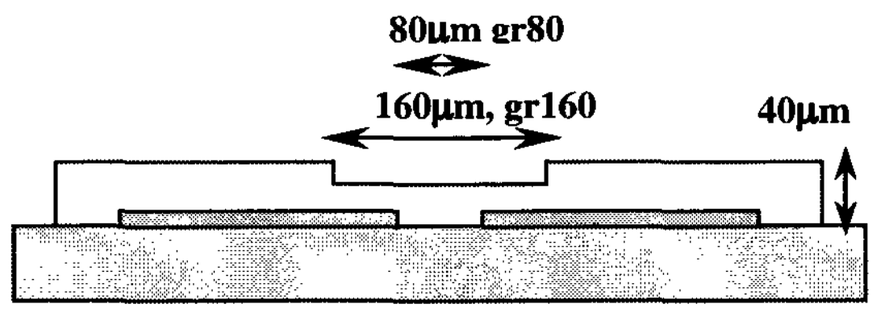


Fig. 1 The designed groove dimensions on front panel

In Ne-Xe gas mixture, we obtained panel characteristics as a function of the Xe contents of 4, 8, 12, 16% and total gas pressures of 400, 500, 600 Torr.

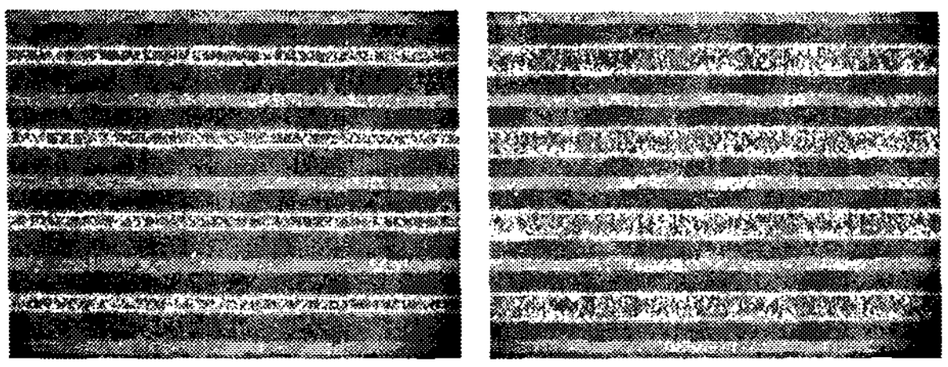


Fig. 2 Overview of fabricated groove on the front dielectric layer(gr80/left, gr160/right)

3. Experimental Results

The Fig. 3 is the panel characteristics as a function of Xe contents from 4 to 16%, when the total pressure is 600Torr. The grooved dielectric structures lower the firing voltage about 40V then that of the conventional structure.

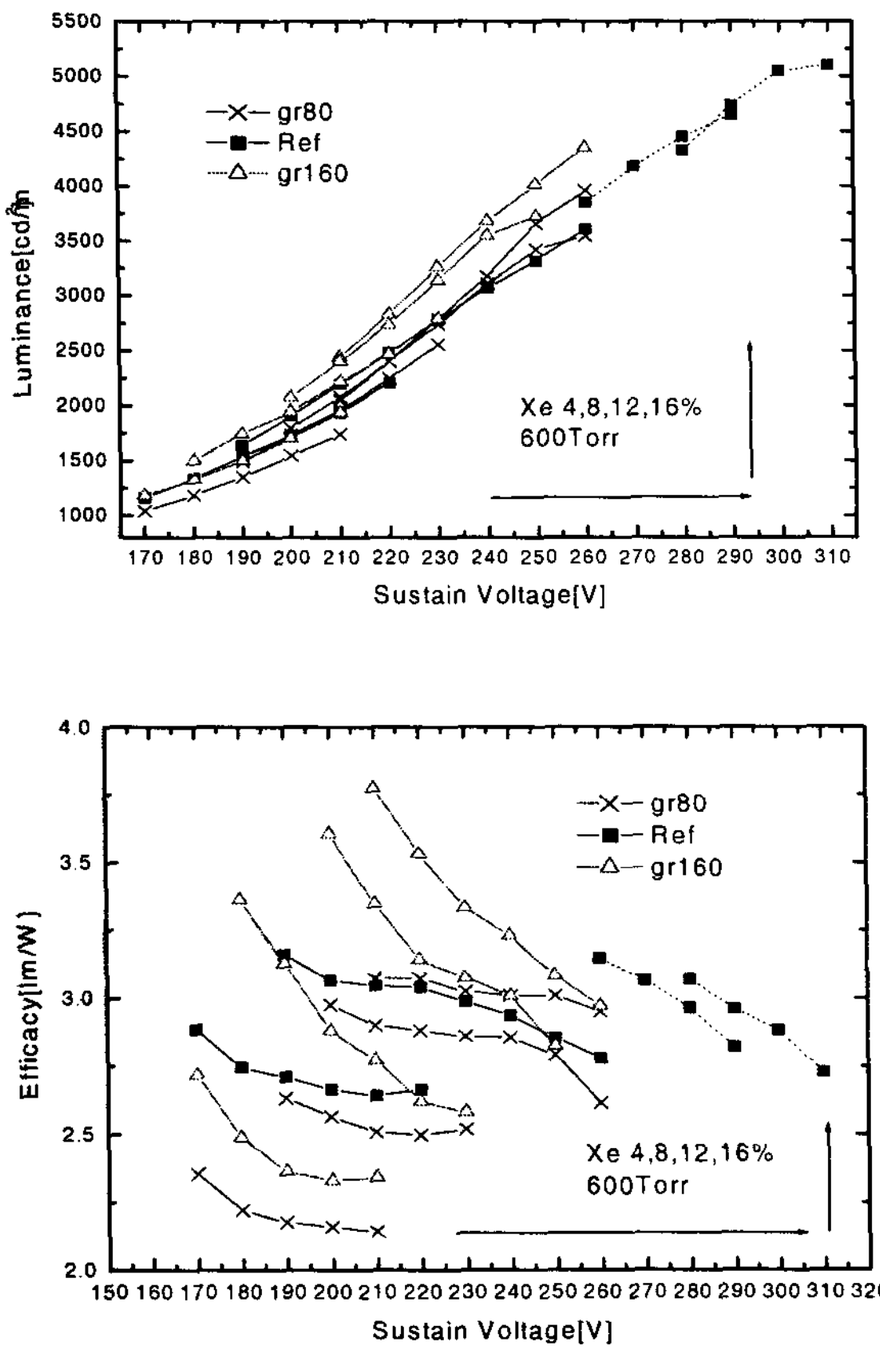


Fig. 3 Luminance and Luminous Efficacy of grooved dielectric layered(gr80,gr160) and reference structures

The luminance is around same level or the higher. Also the luminous efficacy is 20% higher because of the applicable Xe contents is larger in the grooved dielectric structure.

The broken line of the reference means that the crosstalk instability occurred at that gas mixture and we cannot obtain the characteristic data at the lower sustain voltage part. The luminous efficacy of gr160 shows rather steep variation then that of the reference as the sustain voltage increases. Especially the low voltage part of the wider groove structure(gr160) shows the higher luminous efficacy than the others. We have verified the discharge mechanism for those characteristics with 2D numerical simulation.

4. 2D Simulation Results

We have verified the experimental results through 2D simulation with conventional scale structure. We have obtained the similar results that reflect the trends of experiments well. In fig. 4, the wider groove structure(gr480) shows the steep varying VUV efficiency and high efficiency around low voltage parts.

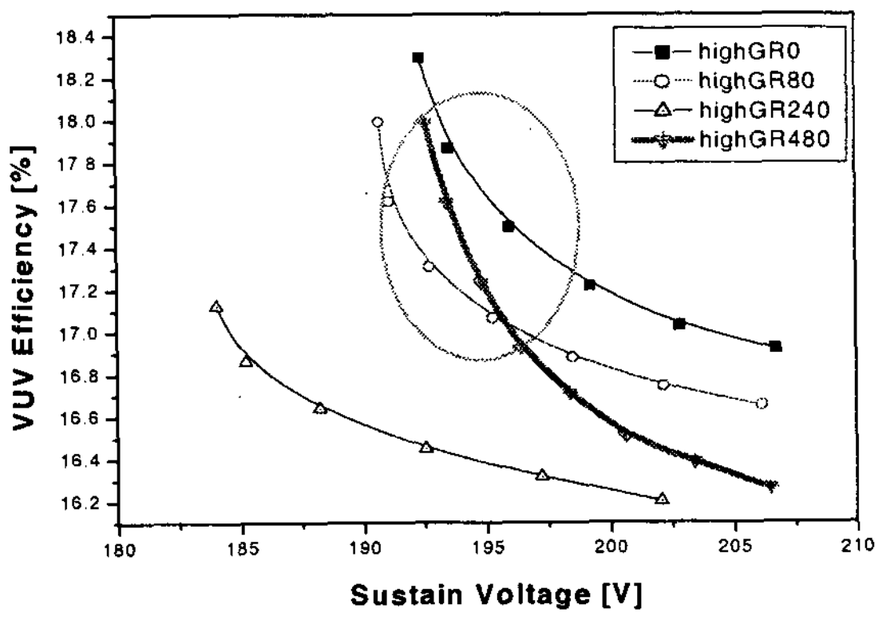
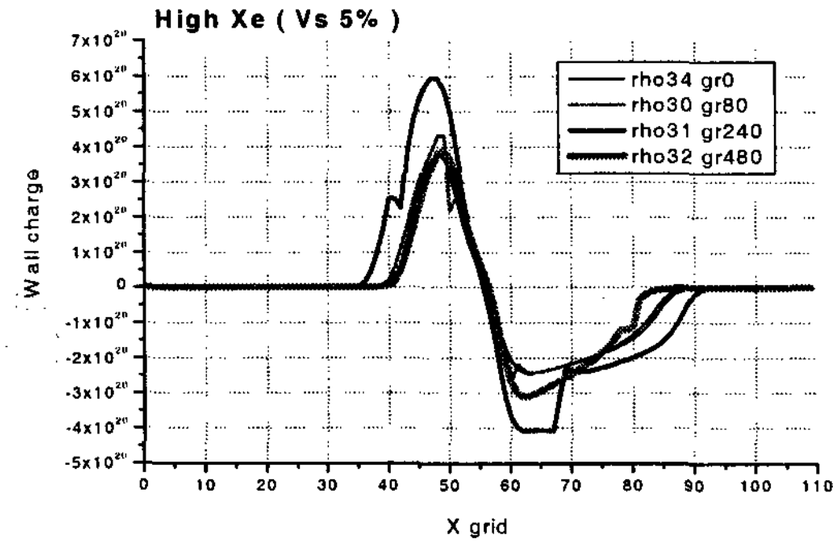


Fig. 4 VUV efficiency with high Xe gas condition

The steep variation of luminance efficacy is due to the high field strength that lowers rho2[1], which means the excitation efficiency of electron. The high efficiency around low voltage parts is due to the high increasing rate of rho1, the electron heating efficiency. Fig 5. shows that the larger accumulation of wall charges on the cathode occurs in the wider groove(gr480) in high Xe gas mixture as the sustain

voltage increases. It shows that the localized strong sheath in high Xe condition enhances the rho1[1] especially in low voltage region.



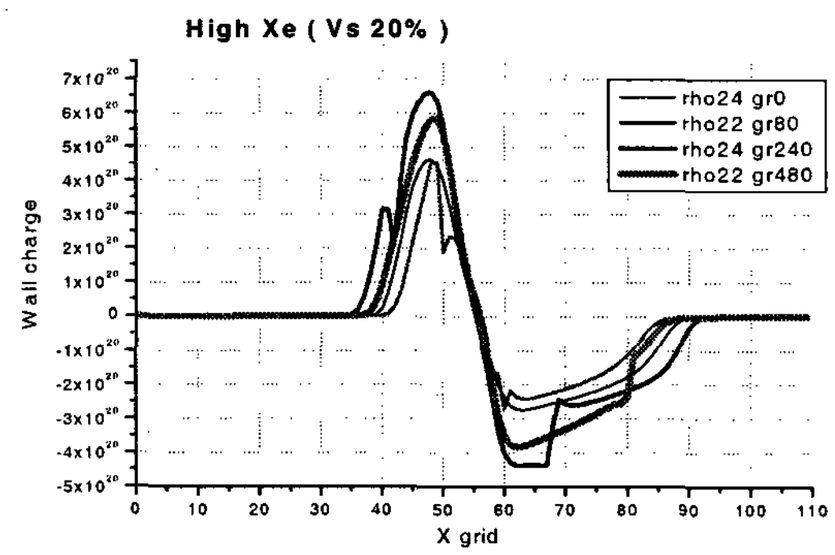


Fig. 5 Wall charge distribution in Vs away from Vsmin by 5, 20% of sustain margin

4. Conclusion

We suggested the grooved dielectric layer structure for high Xe gas environment. The grooved dielectric structure exhibits the stable discharge in high Xe gas conditions and better luminance. We can obtain the higher luminous efficacy using the more Xe contents to the range the reference structure cannot discharge stably. So we can obtain about 20% luminous efficacy increment than that of reference SDR in Xe 16%, 600Torr. The strong gap field allows the lower breakdown voltage around 40V at Xe 12, 16% 600Torr. We also verified that the efficient-low voltage part of the grooved dielectric structure is due to the strong localized sheath and rho1 in high Xe gas condition.

5. References

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