Full Size PDP Development with SDR Structure for Improved Luminance and Low Power Consumption

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Abstract

Samsung's newly developed high luminance efficiency 42" VGA plasma display panel is introduced. A new discharge cell structure, SDR (Segmented electrode in Delta color arrayed Rectangular subpixel) has been applied to a full size panel for the first time. In this paper, we describe how this new discharge cell structure for high efficiency is integrated to an energy saving plasma display with better picture quality.

1. Introduction

1.1 Prior art

A plasma display panel with sufficiently improved luminance and luminous efficiency is designed to compete with other display device that consumes low power.

Several new ideas have been proposed in order to improve luminance efficiency of plasma discharge. One of the most impressive one is using RF-discharge, with which luminous efficiency was reported greater than 4 lm/W [1]. However, due to the complexity of driving circuit, it may have to deal with a cost problem. This needs further ripening to commercialize.

Some progress has been made using discharge gas comprising high Xe concentration. It is encouraging, for the reason that there is no need to change the conventional cell structure dramatically. From the test panel experiment, the luminance efficiency greater than 2 lm/W was reported. At the same time, the brightness was about 2000 cd/m2 [2]. This method has been already used in the commercial products. The efficiency can be made up by modifying cell structure and driving method [3]. However, a gas mixture with High Xe content makes firing and sustaining discharge take place difficult, and therefore, prior consideration is whether we find a way to make driving easy or we search for alternatives.

1.2 Segmented electrodes in Delta color arrayed Rectangular subpixels (SDR)

Previously, we demonstrated SDR structure simultaneously improves luminance and luminous efficiency in comparison with the conventional AC PDP [4], [5].

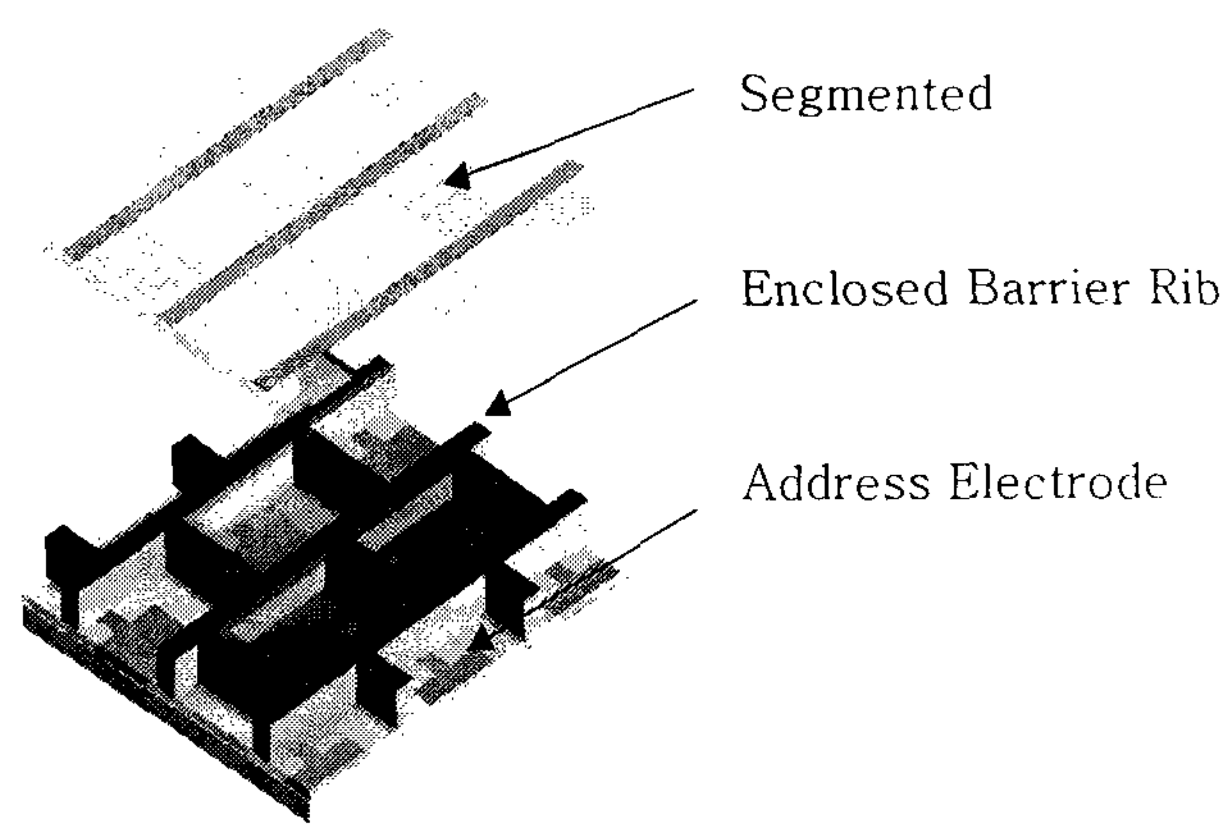

Figure 1. Exploded view of SDR structure

According to our 3-Dimensional numerical simulation, SDR structure consumes less electrical power for discharge at the slight expense of luminance, compared with the triode type with the same dimensional electrodes in a closed subpixel. Ray optic simulation also tells the subpixel geometry with an aspect ratio close to 1:1, has an advantage over 3:1, considering the usage of visible photons [6].

2. Panel Fabrication

2.1. Optimization of Design Parameters

According to our study as in Fig.2, it is preferable to have a long sustain electrode along the horizontal direction, in order to maximize brightness of the SDR structure.

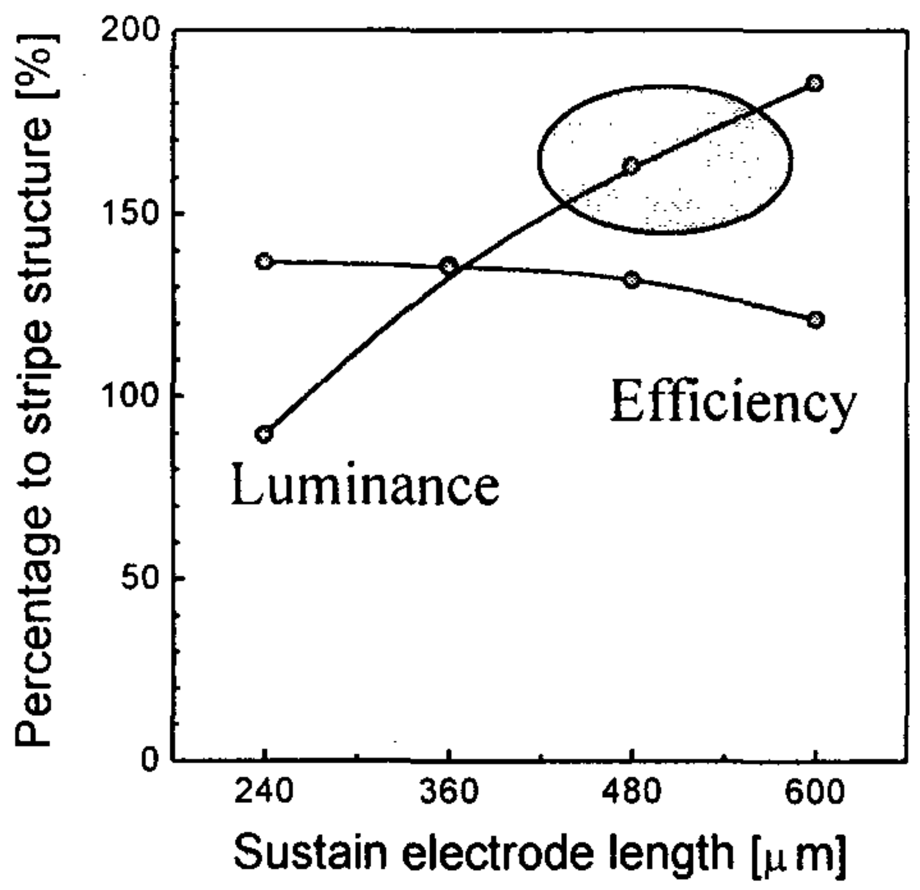

Figure 2. Dependence of sustain electrode length to the optical qualities

However, there is a trade off with the selectivity of cells, for the reason that all of three sub pixels should have one bus electrode in common. This might cause a cross talk between colors, though barrier ribs could minimize it. We were managed to solve the problem by removing some portion of a sustain electrode, of which the edge is not too close to that of its neighbor cells. Analogously, an address electrode that runs beneath the barrier rib could be trimmed out such that the nearest neighbors don't share the same one. Figure 3 shows how electrode design parameters give an effect on both luminance efficiency and cell selectivity.

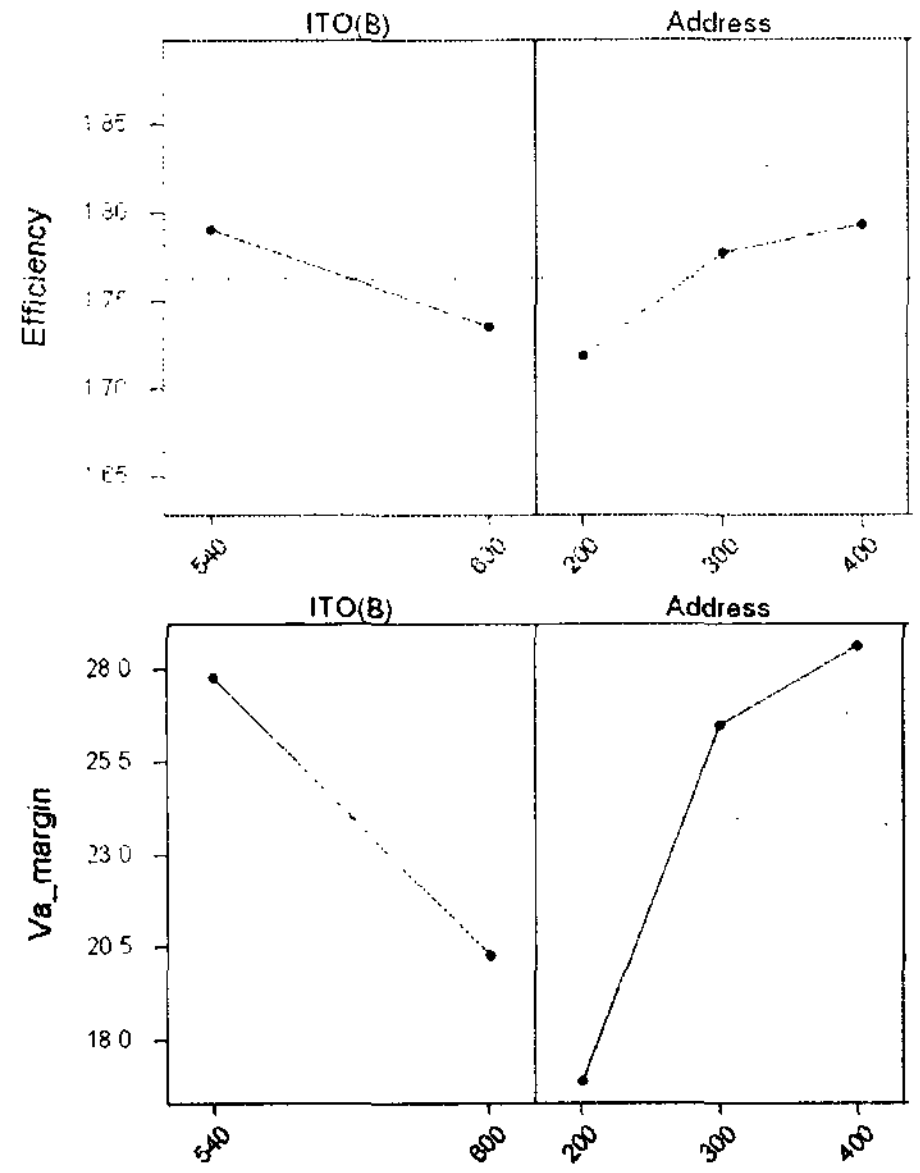

Figure 3. Contributions of electrode design to (a) efficiency and (b) addressing margin

Furthermore, the length of a sustain electrode of each colored subpixel can be varied to improve white balance of a display. It is advantageous over a nonsymmetrical cell type in a sense that you could expect the same effect by using symmetrical barrier structure. An example of application is shown in Figure 4.

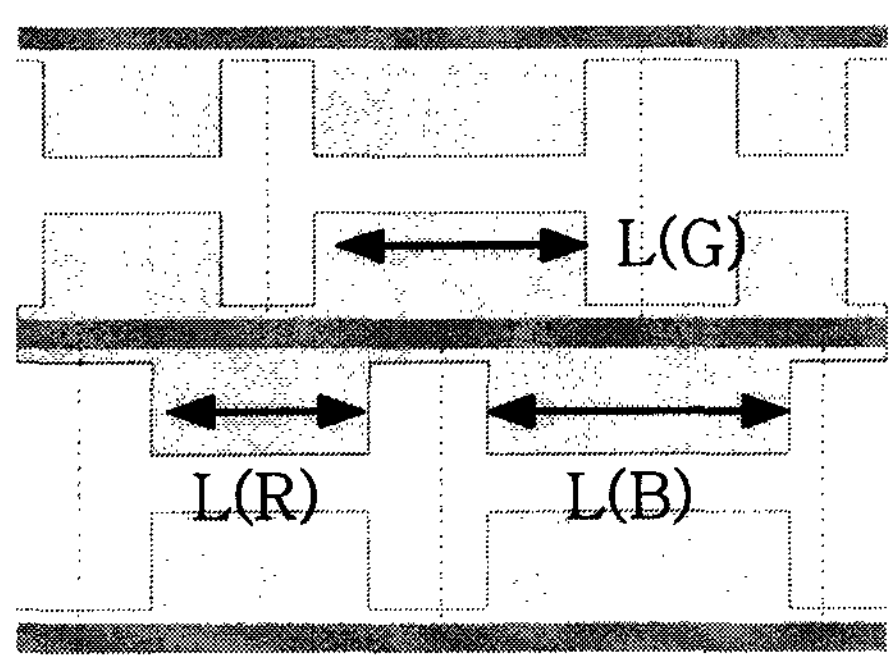

Figure 4. Nonsymmetrical ITO pattern to improve color temperature

2.2. Full Panel Fabrication

Table 1 is the panel specification of Samsung's 42" VGA PDP with SDR structure. Generally, all of conventional technologies are applicable to pattern this type of cell structure.

Table 1. Panel specification

Display Pixels	852 columns × 480 rows
Effective Display Area	932.94 × 532.8 ㎟
Display Pitch	1.095×1.11㎟
Subpixel Pitch	0.73 × 0.555 ㎟

It is very critical to have an upper image element exactly fit on lower one. Therefore, it requires careful dimensional management considering the thermal shrinkage of patterned substrates due to repetitive firing process. In addition, reducing the tolerance level of an alignment error is mandatory. Probably, one of the most difficult tasks is fabricating rear panel with a closed barrier rib pattern. If we want to come up with the conventional sand blasting technology, parameters such as blasting pressure and application time should be reset to make sure we create sufficient discharge space. A special treatment to coat the inner surface with the uniform thickness of phosphor is another requirement. An enforced mechanical strength of the closed barrier rib structure is a bonus, if any means that efficiently can remove unwanted gas or contaminants.

3. Performance of Panel and Module

Table 2 shows how the PDP module with SDR structure performs. For this particular sample, we used 5 % of Xe concentration in Ne-Xe mixture, because our goal was to optimize cell design parameters of the SDR structure first. As a result, 25 % of brightness and 35 % of luminance efficiency were improved. In another words, we are able to attain brightness of 1000 cd/m^2 even without using the high Xe concentration, but still maintaining electrical power consumption under 230 W. This can quickly bring to an idea that power consumption below 200 W is easily achievable by raising Xe concentration.

Table 2. Performance

Contents		Module
Peak	Luminance (cd/m^2)	1000
	Color Temp. (K)	~10,000
	Contrast Ratio	1500:1
Full White	Luminance (cd/m^2)	140
	Color Temp. (K)	~10,000
	Power (W)	220

The lifetime of this SDR panel has been compared with that of a conventional type. As in figure 5, it is shown that luminance and color temperature decay in time as slow as those taken from the reference.

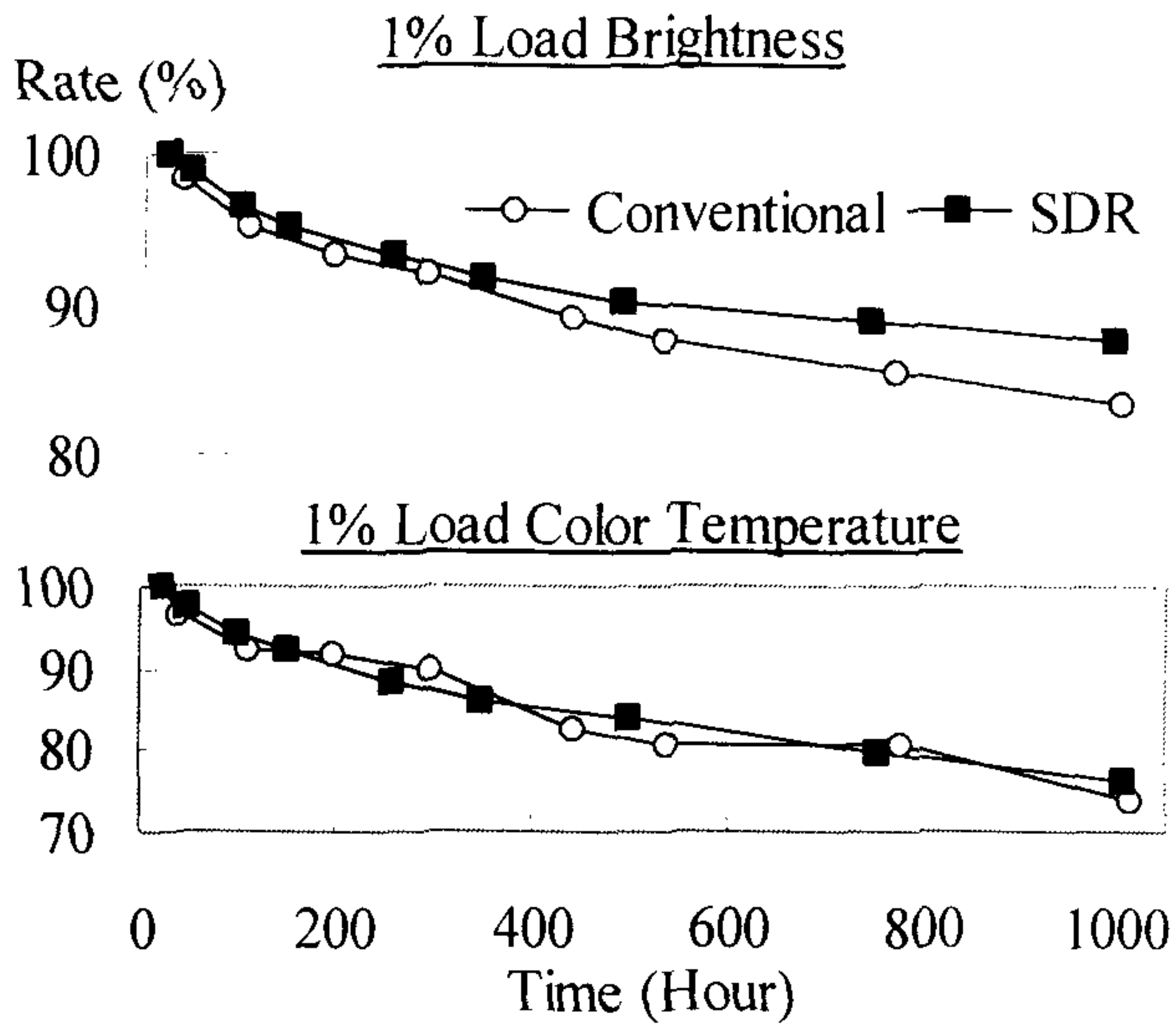

Figure 5. Lifetime comparison of SDR structure and a conventional type

4. Future work

Our goal is to perfect this SDR module to bring to market. There are a couple of problems to solve. First, to some people the edge of a picture may look too ragged because of the nature of a cell arrangement as in figure 6. These unnatural outlines may be smoothened by applying an image enhancement program that is under development. However, in the long run, a high-resolution format may be the best choice to solve the problem without having to modify image data, while high luminance efficiency can play more important role.

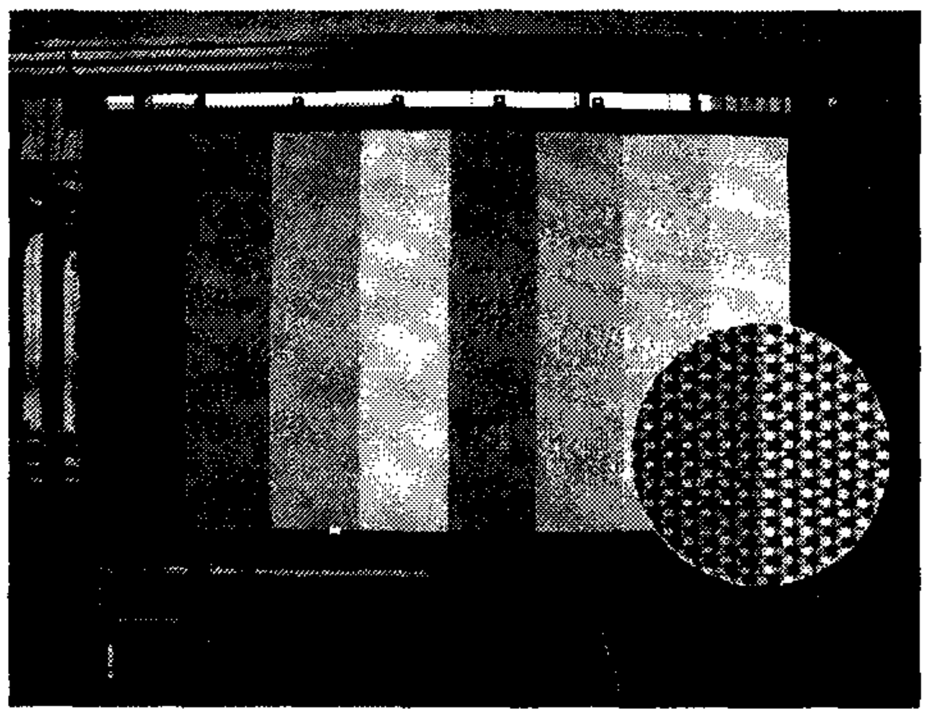

Figure 6. SDR structure realized to 42" VGA panel

Second, replacing black matrix to horizontal barrier rib may lower day light contrast ratio. In a short term, one suggestion is using a front glass with lower transmittance. In the mean while, several modified versions of the SDR structure that sufficiently absorb daylight but minimize the loss of luminance at the same time, are under test [5].

5. Conclusion

We have discussed the development of 42" PDP with SDR structure. A significant progress in luminance and power consumption has been made only by changing a cell structure. We are working on the adjustment of panel fabrication process using standard production lines.

6. References

[1] Kang, J. et al. "Panel Performance of RF PDP," *IDW'00*, p643 (2000)

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[3] *The 30th Consortium Meeting of Plasma Display Technology*, Tokyo, Japan (2001)

[4] C. K. Yoon et al. "High Luminance and Efficacy AC-PDP with Segmented Electrode in Delta Color Arrayed Rectangular Subpixels," *IDW'00* (2000)

[5] US Patent number 6,379,195

[6] C. K. Yoon et al. "Luminous Characteristics Analysis of a New SDR Cell Structure ac PDP," *SID'01*, p.1332 (2001)