14.4 Color TV Display with AC-PDP

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Introduction

Plasma display panels (PDPs) have been placed on the market as character and graphic display devices of superio quality. Color TV display has frequently been attempted to DC-PDPs over the past 10 years at various research laboratories [1,2,3]. However, "Wall-hanging TV" using PDPs has never been realized until today, contrary to the earlier predictions that its development would be a simple matter. The difficulty lay in the fact that the brightness and luminance efficiency of color PDPs are not sufficient for the application of actual use in moving images.

In the past, an attempt was made to evelop a full-color panel using ordinary AC-PDPs [4]. But this project was discarded due to color crosstalk and color phosphor degradation caused by ion bombardment. Since then, no color picture has been possile on AC-PDPs.

For the past several years, it has been considered that brightness can be improved by increasing the amount of light-emmiting-time using the memory function of the panel. Therefore, research on the actual color panel has been directed forward luminance efficiency. In developing our recent color panel, two types of panels have been used to improve this efficiency: the pulse-memory type in which the plasma in the discharge cell constitutes memory function by means of remaining charged particles [5], and a new type of AC-PDP, the so called surface discharge plasma display panel (SD-PDP) [6,7,8].

The disadvantages pf the ordinary AC-PDPs have been eliminated in the SD-PDPs with its parallel discharge path and phosphor creen surface structures.

This paper decribes the first attempt of displaying a color TV image on a SD-PDP which has many advantages over ordinary AC-PDP and/or DC-PDP which has its electrodes on the faceplated standing opposite to each other.

Color SD-PDP

Construction of the panel

The construction of a SD-PDP discharge cell is shown in Fig. 1. In contrast to the ordinary AC-PDP, there are two electrodes (x and y directions) of the back glass substrate, and the tricolor phosphors (red; $(Y,Gd)BO_3$:Eu, green; Zn_2SiO_4:Mn and blue; $BaMg_2Al_{14}O_{24}$:Eu) are coated on the front substrate opposite each

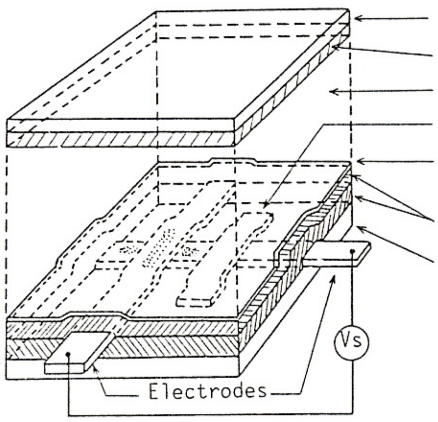

Fig. 1 Unit cell in the surface discharge AC-PDP

discharge point where the electrodes cross each other. While the driving voltage is being applied to the electrodes, gas is discharged parallel to the surface of the back substrate through the influence of an electric field. Consequently, the ions and electrons do not pass to the front glass surface coated with phosphors. Also ion bombardments which degrade the phosphor on ordinary AC panels do not occur in SD-PDPs.

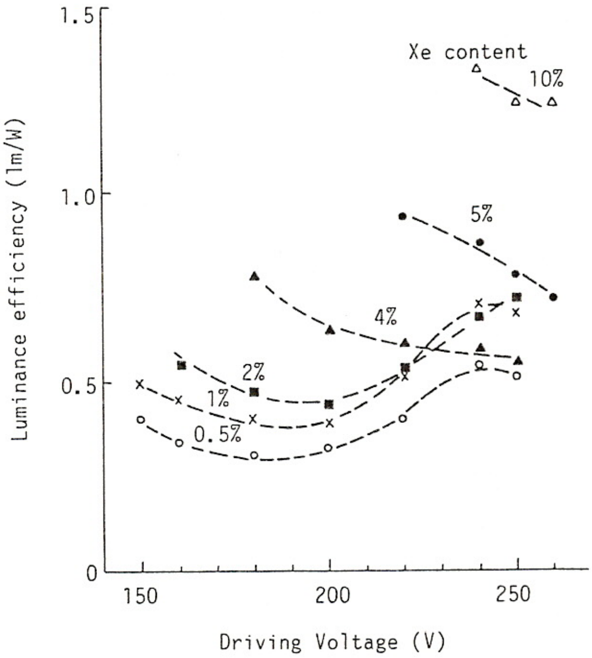

Fig. 2 Luminance efficiency of a SD-PDP in green phosphor.

Our new panel has 100 x 100 discharge cells within a 0.5 mm-pitch which is only half that in DC panels used for displaying TV pictures up to the present. The phosphors and black-matrix layers on the front glass are coated by a thickfilm printing technique to prevent a reduction in photoluminescent efficiency by a 147 nm excitation from a He-Xe mixture gas discharge.
The display area is 50 x 50 mm^2 and only one spacer is placed in the center of the panel. The several cells in the panel thus do not operate.

Luminoance Efficiency

The luminance efficiency of the panel is very important. Both ordinary AC-PDP and SD-PDP have outstanding luminance efficiency. The efficiency of the SD-PDP is shown in Fig.2 along with the panel driving voltage and Xe content in the He-Xe gas mixture. Compared with that of ordinary AC-PDP, the driving voltage of the SD-PDP is rather high, being 50 % or even more. The efficiency of this panel is sufficiently satisfactory for realizing an actual flat panel display. On increasing the Xe content, luminance efficiency is improved so much as to reach 1.3 lm/W at 10 % of Xe in green phosphor.

Color Representaion

The color gamut which indicates the capacity for color purity may possibly be reduced as a result of UV light crosstalk in the panel, where the neighboring cells of different color are luminated by UV light in the desired discharge cell exciting the normal phosphor. This disadvantage may result in ordinary AC-PDP quality and thus be unsuitable for a color display device.

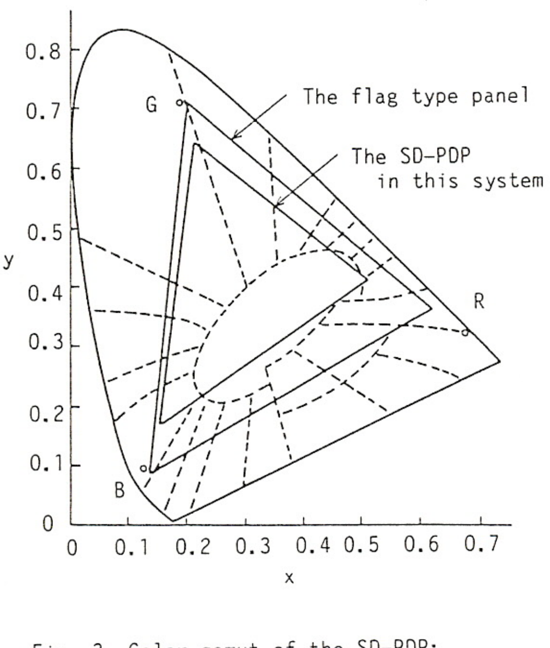

Fig. 3 Color gamut of the SD-PDP: o shows NTSC primary color.

Fig. 3 shows the SD-PDP color gamut. Each discharge cell in this SD-PDP has one primary color phosphor in three colors, compared to the flag type SD-PDP in which the three portions are coated with three primary color phosphors and also the NTSC primary color. The inner triangle indicating the SD-PDP's is somewhat less in area than the outer one of the flag type. However, in contrast to the ordinary AC-PDP, the are of gamut is as same as that of CRT and image representation is possible.

TV Display

Display System

The system diagram is shown in Fig. 4. The TV receiver is modified so as to obtain the red (R), green (G) and blue (B) analog signals and synchronizing pulses. The analog signals are then converted into 6 bit parallel PCMs by A/D converters and stored in the field memory containing 24 4k-RAMs. The panel is driven time-sequencially by 5 subfields corresponding to each PCM from LSB to MSB.

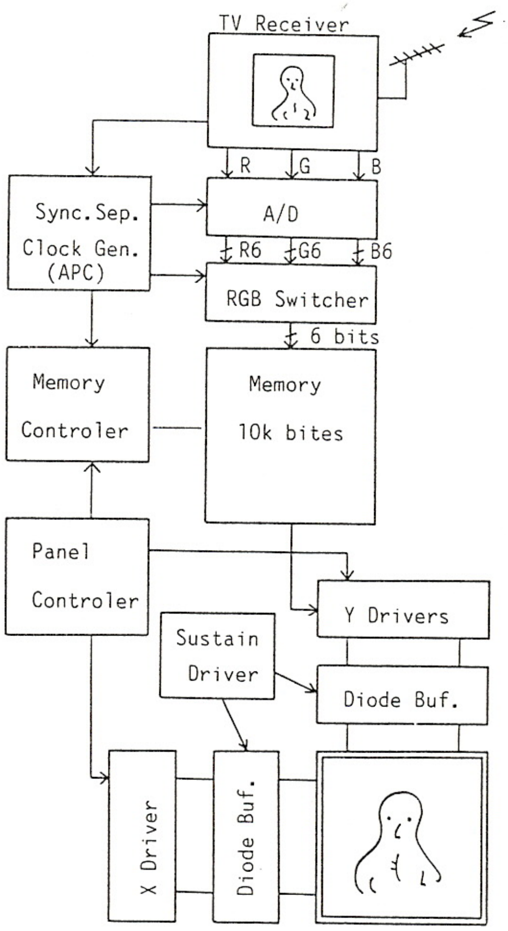

Fig. 4 Block diagram of TV display system

The system is limited to a lesser range of representation of gray by the driving circuit devices used in this system.

The driving technique of the system is the same as that in the ordinary AC-PDP character display except for a fairly high driving voltage (sustain pluse is 160 volts and writing pulse, 230 volts).

The memory access timing is shown in Fig. 6. The memory is devided into four blocks for each bit of PCM. The data from A/D vonverter were stored for 100 lines in one frame and read out in each subfield of PCM sequencially. The panel was accessed at first in LSB sub-field by writing pluse. After 8 sustain pulse cycles the erasing pulse is applied to the each line. The next bit subfield has 16 cycles. And MSB subfield has 128 sustain pulse cycles. Totally the cycles of brightest area are 255 sustain periods in one frame.

The panel access timing for 4 sustain pulse cycles is shown in Fig. 7. There is an access period for writing and one for erasing between sustain pulses.

Table 1

System Performance

Display Area	50 x 50 3	mm^2 inches
Cell Pitch	0.5	mm
Numbers	100 x 100	
Brightness in White	25 7.3	cd/m^2 fL
Luminance Efficiency	0.2	lm/W
Power Input	20	mW/cm^2
Gray Scale	32	levels
Sustain Frequency	75k	Hz
Pulse	160	volts
Writing Pulse	230	volts
Gas Content	He-Xe(2 %)	
Pressure	600	Torr

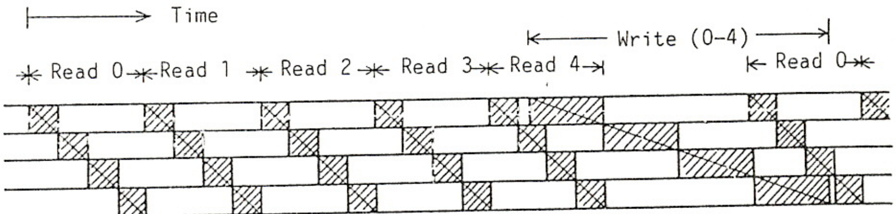

Fig. 5 Memory access timing chart.

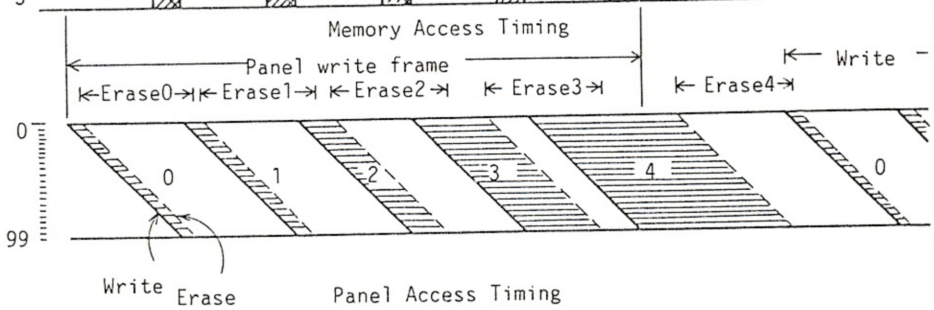

Fig. 6 Panel access timing chart

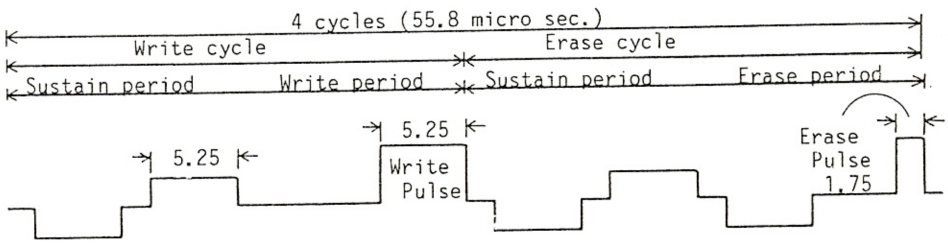

Fig. 7 Panel access in 4 sustain pulse cycles.

unit: micro sec.

System Performance

Several specifications and the performances of this panel system are listed in Table 1.

32 levels (5 bits) are not sufficient to represent TV pictures, due to the relationship between sustain frequency (75k Hz) and the driving technique. In this system, since the old type character display driving technique was used, driving circuit devices such as t4ansistors and FETs impose a limit on the sustain frequency. Therefore definite panel specification within the response time could not be determined. In general, the response time of the AC-PDP become quicker with an increase in driving voltage.

Also, since brightness is linear to the sustain pulse numbers per second, the display image was not particularly brighter than the new type DC-PDP [5].

Fig. 8 is the photograph of the displayed TV picture on our system. Inspite of the monochrome photo, the moving image shows the good picture quality.

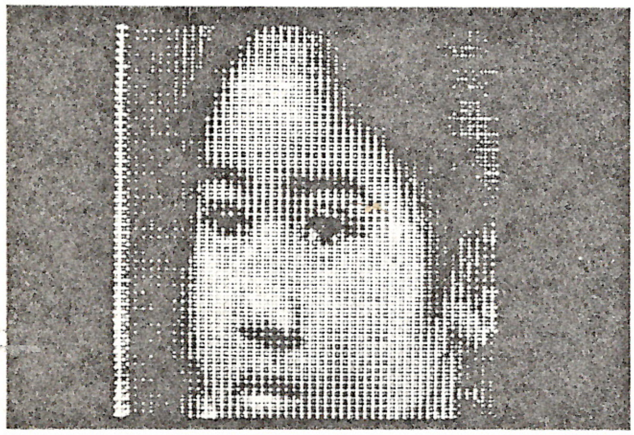

Fig. 8 The photograph dispalyed TV picture in our system.

Our new panel system has not been completed and many problems remain to be solved:

1) elimination of the spacer from the panel, which must not be appear in the display area as defect dots.
2) elimination of UV light crosstalk which causes a decrease of color purity.
3) increase quickness of response time which governs brightness, grayscale representation and the numbers of access dots per field.

Conclusion

In this paper the first attempt at a TV picture display using new type of AC-PDP that is so called surface discharge plasma display panel has been decribed. Although many problems remain to be solved, this panel has many advantages:

1) bright display capability using a memory function.
2) fine-pitch and capacity for large size display area through simplisity of structure.
3) capability of long-life of the for separation between discharge space and phosphor layers.
4) improvement of the color crosstalk compared with the ordinary AC-PDP.

This system makes possible a detailed picture of good quality with a lesser degree of color crosstalk than originally.
The SD-PDP holds promise as a panel by which future "Wall haning TV" may become a posibility.

Acknowledgment

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