Electrical and Optical Characteristics of Color ac-PDP with a New Cell Structure

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Abstract

A plasma display panel(PDP) with a new discharge cells are investigated electrically and optically. These cells have the structure of a long discharge path length and a small electrode area. They have shown a higher luminous efficiency and a lower power consumption about 30 ~ 40% improvement than the conventional standard ac PDP cells.

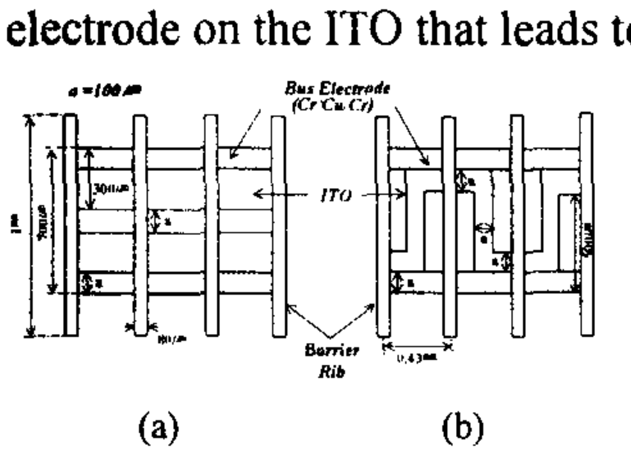
Introduction

Full color plasma displays have received attention as a possible candidate for large area flat panel displays. It has advantages over conventional display technologies by screen size, thickness, durability and wide viewing angle. The usual method of achieving color in the plasma displays is to excite the phosphors for the three primaries R, G, and B with the VUV radiation produced in the gas discharge.[1-3] The present stage of the development of ac PDP, however, is not satisfactory with regard to the luminance and the luminous efficiency.

In the present study, in order to increase in the luminous efficiency and decrease in the power consumption of the plasma display, a new type ac PDP cells have been investigated.

Experimental

Fig. 1 shows the construction of conventional and new type sustaining electrodes in the discharge cell. The characteristic feature of new type sustaining electrode is the meander electrode gap. These cells have a longer discharge path length and a smaller electrode area than conventional standard ac PDP cells. The two reasons of designing these structure are as follows.: Since the point showing maximum electric field is the gap part between sustaining electrodes, the discharge is initiated in the edge of gap. Moreover, the maximum generation spots of VUV in ac PDP cells is also the edge of sustaining electrode.[4-5] To compare with the electrical and optical characteristics, two kinds of cells as shown in Fig. 2 (a) and (b) are made on a panel and have tested under the same experimental conditions. The sustaining electrodes are made of a transparent conductive thin film (ITO) with the Cr/Cu/Cr bus electrode on the ITO that leads to low resistance.



(a)Conventional electrode
(b)Meander electrode

Fig. 1 The schematic diagrams of the conventional and the new type sustaining electrodes in the discharge cell

Fig. 2 shows the schematic diagram of discharge test chamber used for measuring the electrical and optical characteristics. The vacuum chamber is a cylinder type of 200 ㎜ diameter, and 80 ㎜ height. The upper part is made of quartz view-window to investigate the optical characteristics of the samples. The pressure is measured with an pressure transmitter (Setra co., Model 280E) with a digital indicator (GLA co., MD-100) from atmospheric pressure to 1 Torr. For glow discharge test, an ac square pulse, which can be controlled in the frequency range of 5 to 50 ㎑, and in the voltage range of 0V to 300V, is applied to the cells.

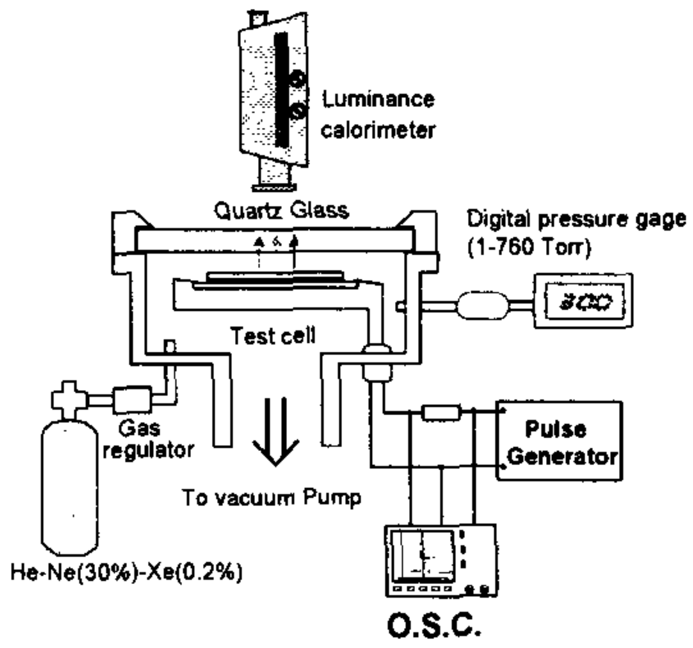


Fig. 2 The schematic diagram of the discharge test chamber

In this study, the test samples are prepared by assembling the rear and front panel. And then the test samples are installed to the discharge test chamber. It is exhausted at first up to $\sim 10^{-6}$ Torr in order not to be affected by the residual gases. Thereafter, the He-Ne(30%)-Xe(0.2%) gas is filled to a given working pressure. The electrical and optical characteristics of samples are tested after 1hr aging process. The electrical tests include the firing voltage (Vf), the sustaining voltage (Vs), and the current waveform operating with 30 ㎑ square wave voltage drive. The firing voltage is measured by progressively increasing applied voltage to initiate the discharge, and then the sustaining voltage is measured by reducing their applied voltage to the point at which the ON cells begin to extinguish. The luminance of the samples are measured by the colorimeter (BM-7). The method used for calculating the luminous efficiency is as follows. [7-8]

$$\text{Luminous efficiency} = \frac{\pi \times \text{luminance(cd/m}^2) \times \text{Area(m}^2)}{\text{Power consumption(W)}}$$

Results and discussion

Fig. 3 shows the transparency of the test front panel. The visible light luminance is measured by colormeter for the light passing through the MgO thin film, the dielectric layer, the ITO electrode, and the front glass. The transparency of MgO thin film used for protective layer is over 95% in the range of visible light.

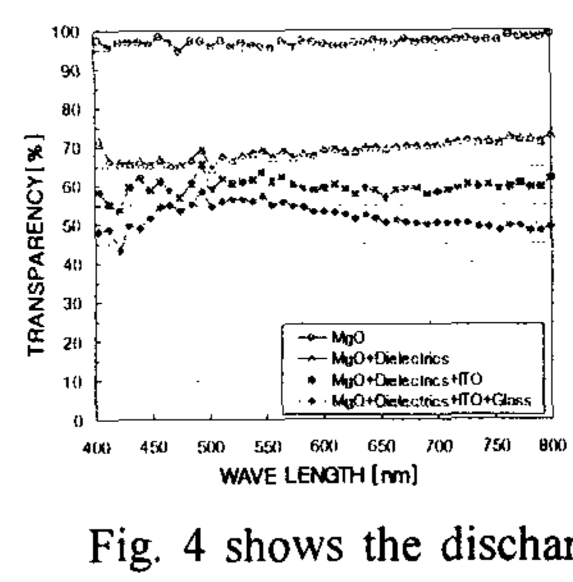


Fig. 3 The transparency of the front panel of ac PDP

Fig. 4 shows the discharge voltage characteristics for the two kinds of the samples operated with He-Ne(30%)-Xe(0.2%) mixed gas. The firing and sustain voltages both of the standard and the test sample decrease first as the gas pressure increase. After showing minimum value at about 250~300 Torr the voltage inrease thereafter.

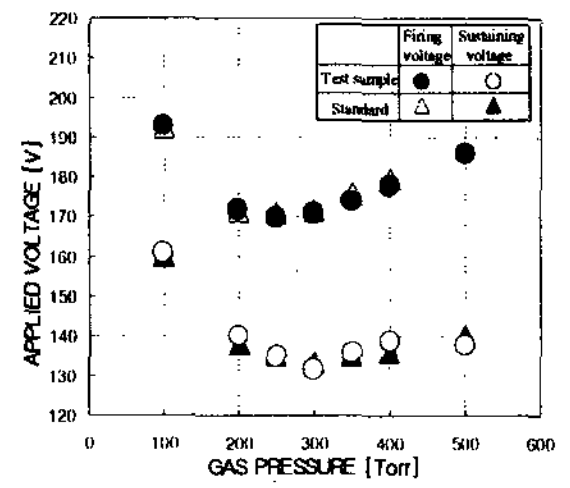


Fig. 4 The discharge voltage characteristics for the two kinds of samples as a parameter of gas pressure (He-Ne(30%)-Xe(0.2%))

Fig. 5 shows the luminance characteristics of the two kinds of the samples as a parameter of working gas pressure of the He-Ne(30%)-Xe(0.2%) penning mixture gas. The applied voltages are fixed with 160 or 170V. The fixed applied voltage is determined at a level between the firing and sustaining voltage. The luminance of the samples decreases gradually as the gas pressure increases. It is considered to be due to the decrease of the collisional conversion rate of Xe* to Xe2* and the increase of diffusion loss of Xe*. For low xenon concentrations (0.2%), metastable xenon(Xe*) atoms are either ionized by subsequent electron collision or diffuse to the pixel boundaries liberating their stored energy upon impact with interior. As a result

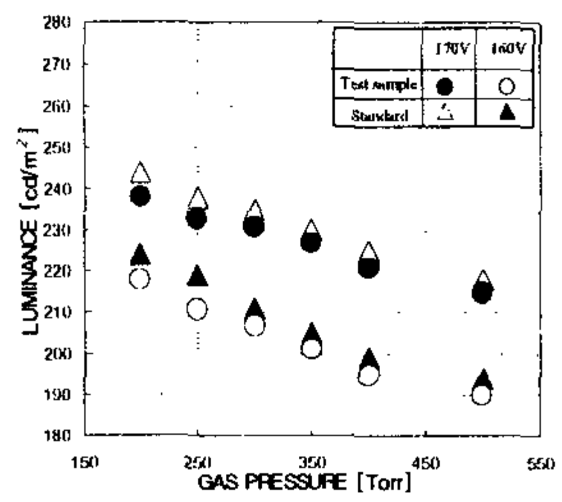


Fig. 5 The luminance characteristics as a parameter of gas pressure for the two kinds of the samples

Fig. 6 shows the power consumption as a parameter of luminance. The test conditions are as follows.; He-Ne(30%)-Xe(0.2%) gas pressure is 300 Torr. And, the applied voltage in order to get a given luminance is in the range of 140~170V. The power consumption increase monotonously as the luminance increases. However, the difference of the samples decreases as the luminance increase. Generally, the power consumption of the new structure is less than that of the standard. It is considered to be due to the reduction of discharge current.

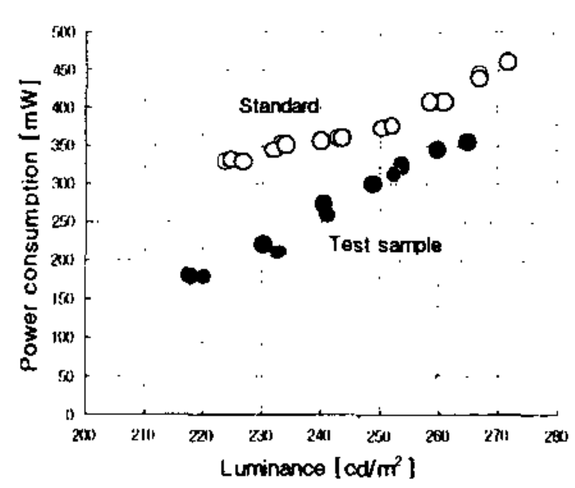


Fig. 6 The power of consumption as a parameter of the luminance for the two kinds of the sample

Fig. 7 shows the luminance and luminous efficiency as a parameter of applied voltage. The luminance of two kinds of the samples are increased with the applied voltage. And, the luminous efficiency of new test sample is higher about 40% than that of the standard sample at low voltage region. Its results may be explained by the following reasons. The current peak of the new test sample decrease about 40%, because of the reduction of the electrode area. So, the power consumption of the test sample is less than that of the standard.

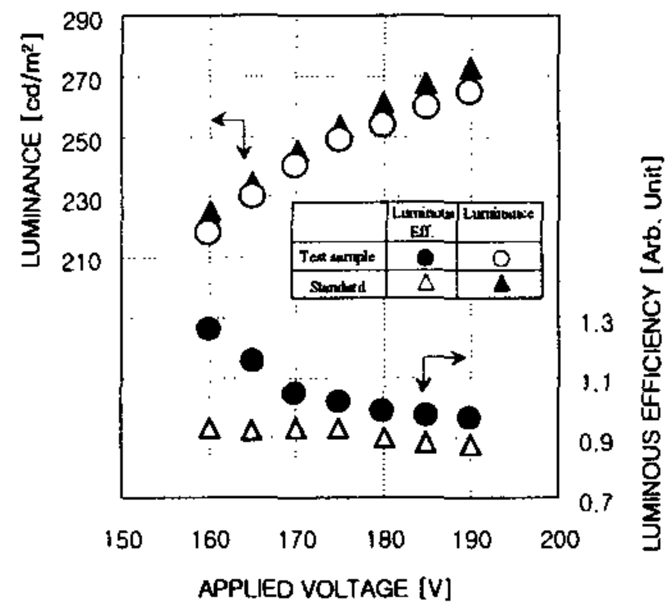
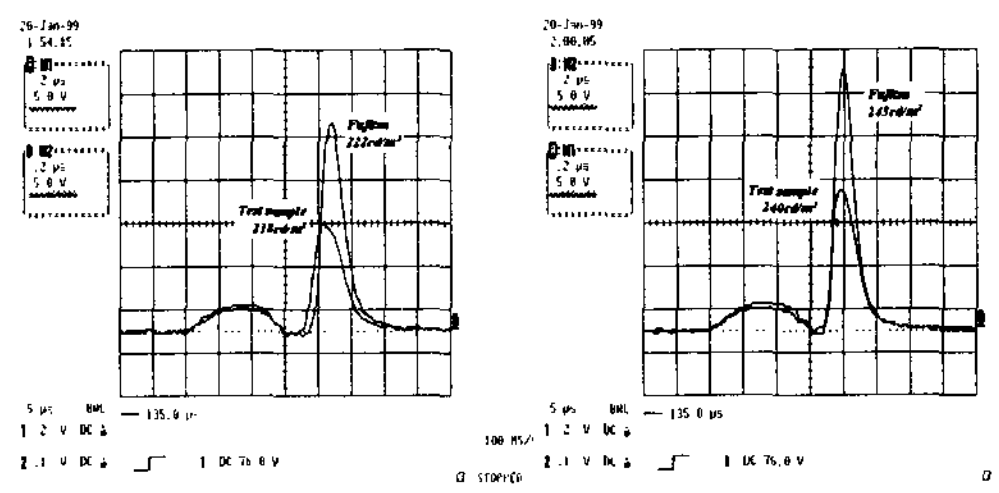


Fig. 7 The luminance and luminous efficiency as a parameter of the applied voltage for the two kinds

Fig. 8 shows the discharge current waveform of the two kinds of the samples. The test conditions are as follow.; He-Ne(30%)-Xe(0.2%) gas pressure is 200 Torr. The applied voltages of Fig. 11 (a) and Fig. 11 (b) are 160V and 170V, respectively. A current waveform has two peaks. The first peak part shows the displacement current which charges the stray capacitance of PDP cells, and the second peak part of the waveform shows the discharge current. Comparing with two kinds of the samples, there is a little difference in the displacement current. However, the discharge current of the new structure sample decreased about 40% than standard samples. It is considered to be due to the reduction of electrode area in new structure test sample. And, this is enables the design of low power-monolithic driver ICs, which also reduce the cost of the driver circuit.



(a)Applied voltage 160V (b)Applied voltage 170V

Fig. 8 The discharge current wave forms as a parameter of applied voltage

Conclusions

A new type ac plasma display panel with the longer discharge path length and the smaller electrode area than the conventional standard ac PDP is investigated. The power consumption of the new type ac PDP is less about 40% than that of the conventional standard. As a result, the luminous efficiency of the test sample is about 40% higher than that of the conventional standard sample at low voltage region. The current peak of the new structure is decreased about 40%, because of the reduction of the electrode area.

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