A New Structure and Driving Scheme of PDP for High Luminous Efficacy

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Abstract

We have developed a new PDP cell structure called MARI(Multi Anode for Reduction of Ionic effect) and new driving scheme achieving a high luminous efficacy. The MARI PDP has middle electrode inserted between X and Y main electrodes. In the MARI PDP, reset and scan voltage is applied to middle electrode and sustain voltage is applied to X and Y electrode. Using a long gap sustain discharge we accomplished a high luminous efficacy. And we developed 42"full panel adopting MARI structure and new driving scheme and attained luminous efficacy of 2.35 lm/W.

Keywords : PDP, MARI, Cell Structure, Luminous Efficacy, Sustaining Electrode

1. Introduction

The PDP(plasma display panel) is one of the leading displays realizing 30 to 80 inches diagonal. But low luminous efficacy is still one of the major problems of the PDP. Therefore many companies research and develop new structure, driving waveform, gas composition to accomplish higher luminous efficacy.

The luminous efficacy of PDP is influenced by four steps - VUV(vacuum ultra violet) emission, VUV transport to phosphor, visible light conversion and visible light output [1]. Especially we are interested in ionic heating loss for sustaining discharge in VUV emission step.

Also it had been reported that average intensity of Xe infrared light on anode area increases as electrode length increases. On the contrary the infrared emission intensity above the cathode does not change [2]. Therefore we are interested in long electrode width and anode discharge. And we concentrated on cathode sheath. As in sheath region electrical potential rapidly increases, electron energy is mostly consumed by ionization energy [3].

We modified the cell structure to achieve higher luminous efficacy by reducing ionic heating loss and developed a new driving scheme for MARI PDP.

In this paper, we explain new cell structure (MARI PDP) and driving scheme in detail.

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2. Theory and Concept

First we had a simulation about electrode array and voltage input method. The MARI structure is shown schematically the Fig. 1. In the view of structure MARI PDP has characteristics that middle electrode(M electrode) is inserted between X and Y electrode to increase electrode length. At this time we had experiments to verify the sustaining driving condition with M electrode. We chose three conditions and had a simulation to confirm the working condition.

Simulation condition is divided three groups. One during sustain region M electrode always acts as anode during sustain region, other M electrode cathode, another

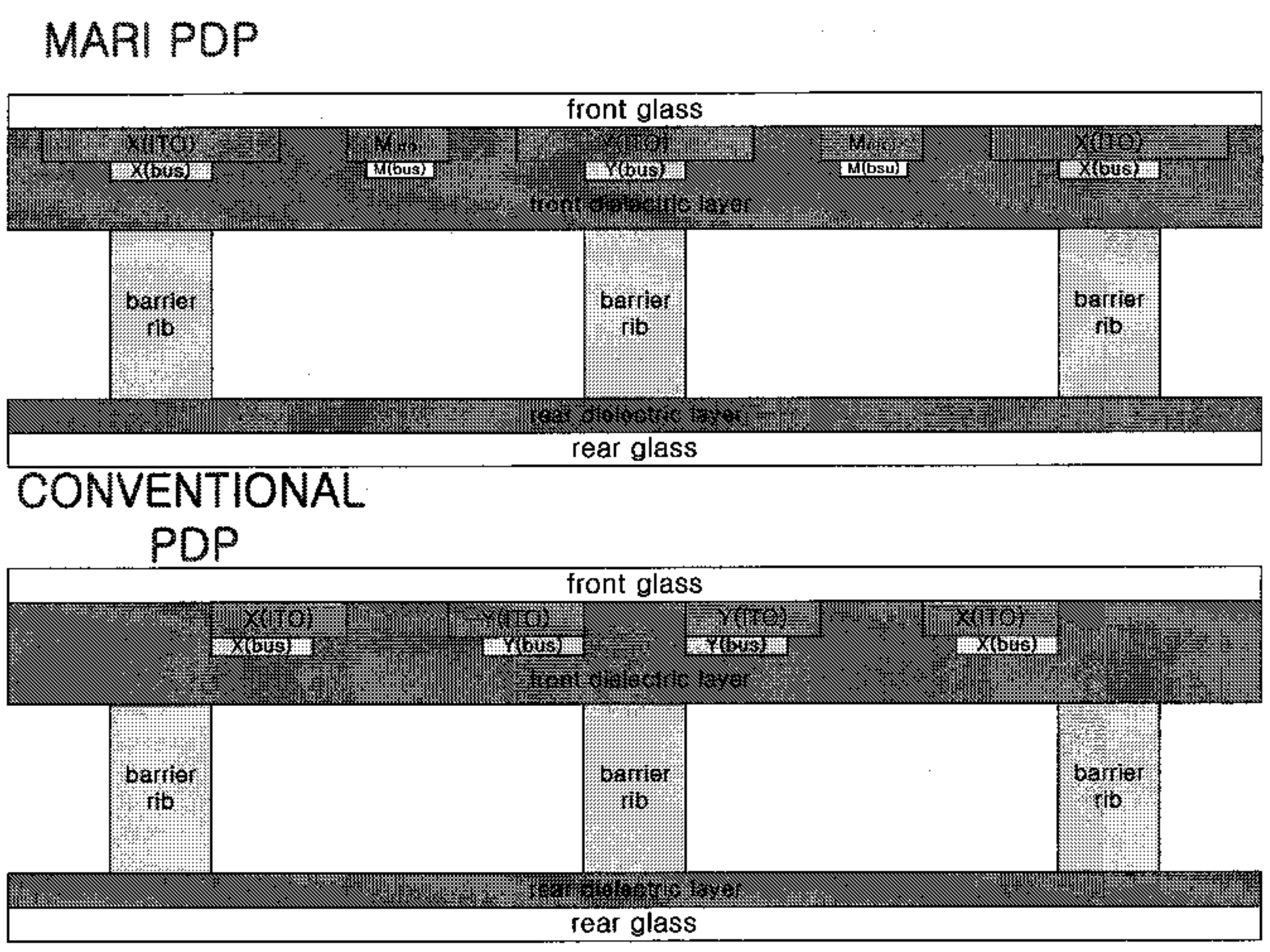


Fig. 1. MARI PDP structure.

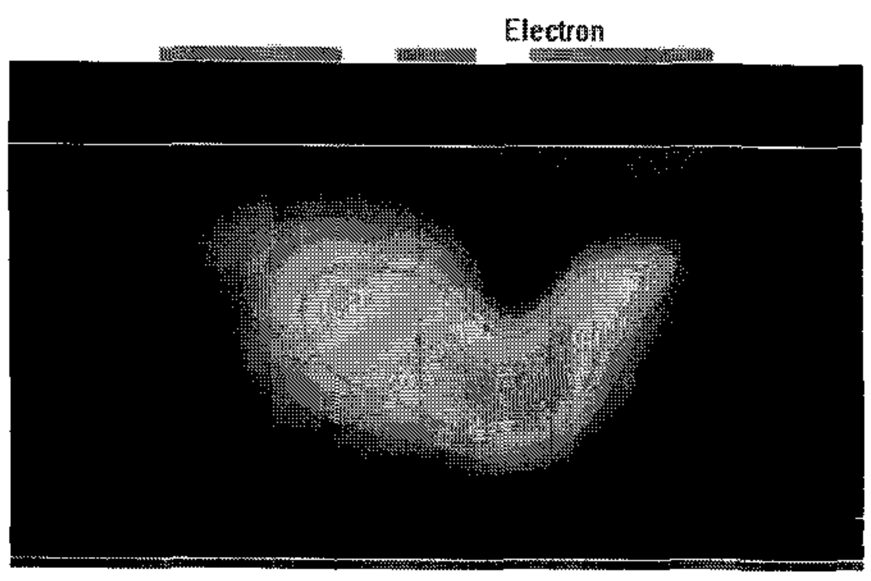
same voltage is applied to X and Y electrode. In last case, between M and X, Y electrode sustaining discharge occurs.

Fig. 2 shows simulation results with discharge possibility and shape. We used PROPDP 2-D simulator which is developed by SDI.

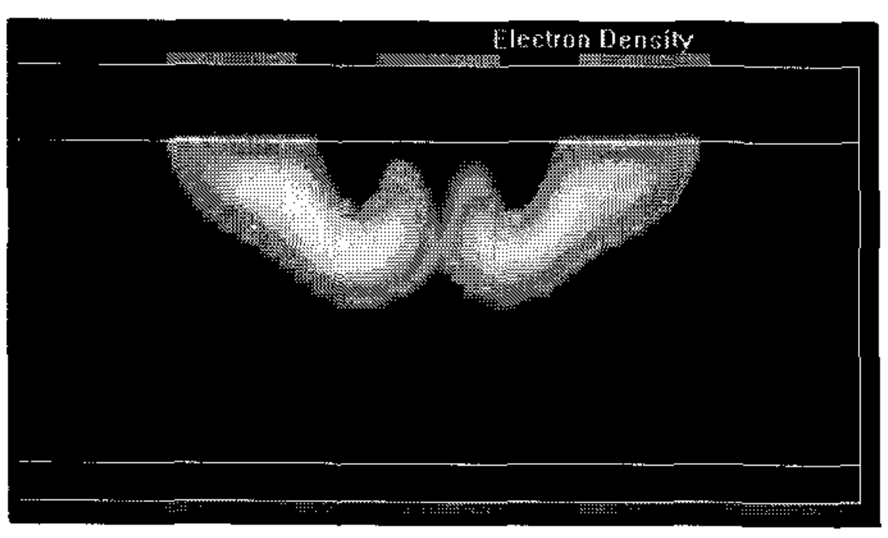
In case of M electrode acts as cathode, sustaining discharge does not continue. Therefore comparison with luminous efficacy data is impossible. In case of M electrode acts as anode, as shown in figure 2 we know that long gap discharge is formed, and discharge volume is large. And VUV excitation efficiency increases by 52 % in comparison with conventional PDP. In case of X and Y electrode is used common, we know that sustaining discharge is possible but because two short gap discharges (M and X electrode, M and Y electrode) are formed and discharge volume is small. VUV excitation efficiency decreases by 40 % in comparison with conventional PDP.

Fig. 3 shows electrode shape of MARI and conventional PDP. MARI PDP has smaller ITO electrode area for reduction of discharge current. Because width of M electrode is narrow, in the middle part M electrode cross section is large to enhance addressing ability.

As M electrode is used as scan electrode, it is possible that X and Y electrodes are commonly used and dead zone (non-discharge region) is reduced, therefore in MARI PDP the gap of X and Y electrode can be larger than conventional PDP. As it is possible to use long gap discharge in sustaining discharge, we can obtain higher luminous efficacy As the dead zone is reduced, X and Y bus electrode is located on barrier ribs. Hence open area ratio increase.



(a) M electrode acts as an anode



(b) X and Y electrode are common

Fig. 2. Simulation results.

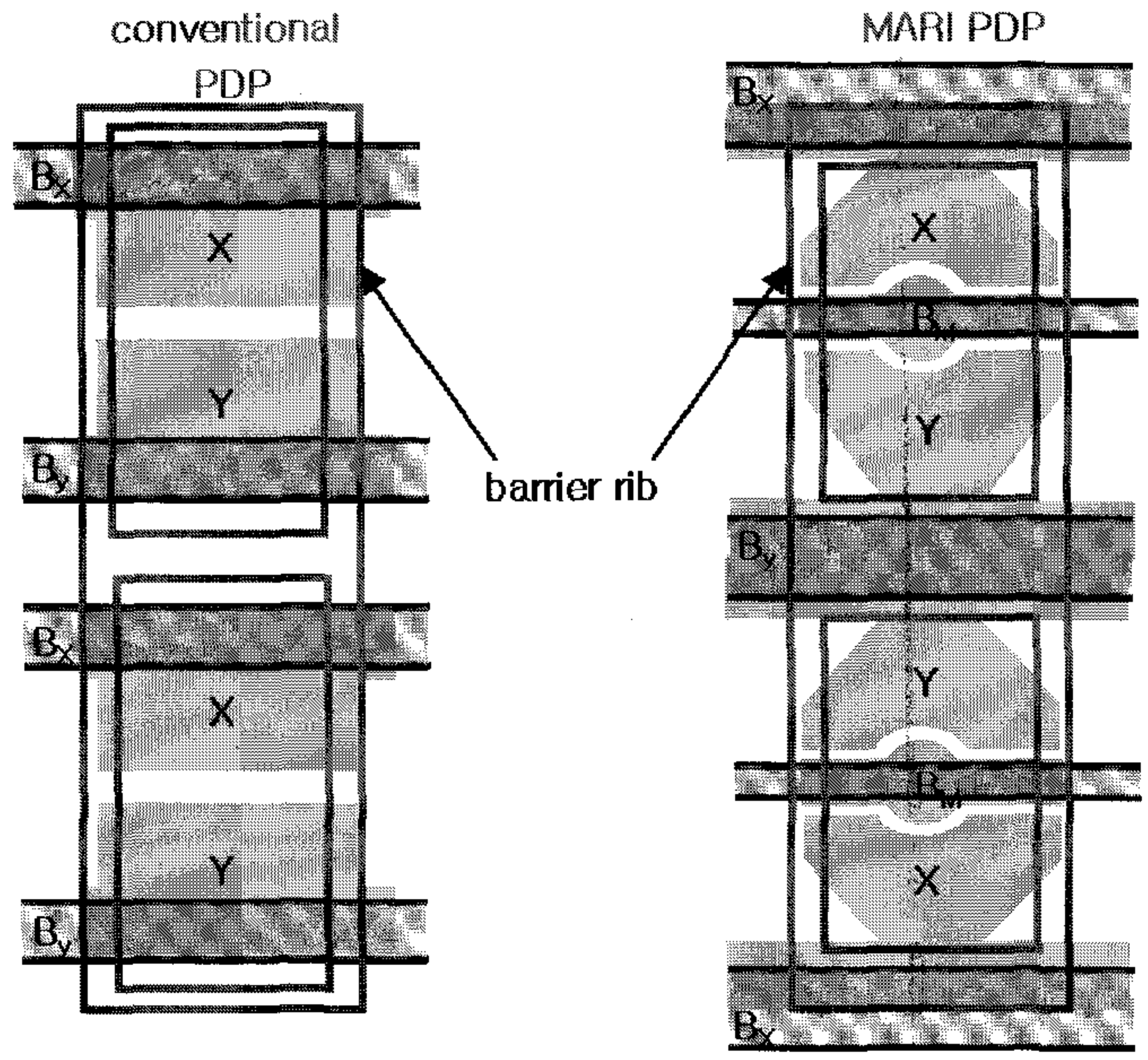


Fig. 3. Electrode shape of MARI PDP.

Because M electrode is inserted, it is difficult to arrange electrode terminal of M electrode. So we designed that the electrode terminal of M electrode is located at the Y electrode and solve the difficulties of electrode terminal.

For conventional PDP Y electrode is used as scan electrode but for MARI PDP, M electrode as scan electrode. As in MARI PDP between M electrode and address electrode discharge path is short, it is thought that addressing voltage is reduced. Also because reset waveform is applied to M electrode and the gap of M and X(or Y) electrode is smaller than conventional PDP, it is thought that reset voltage can be reduced.

In Fig. 4, driving scheme of MARI PDP is shown. Reset waveform is applied to M electrode. It occurs that a weak discharge between X and M electrode, between Y and M electrode. In reset falling region only between M and X electrode discharge occurs. And sustaining discharge begins after discharge between M and address electrode. In the first sustain period short gap discharge between X and M electrode occurs. It acts as trigger discharge. After that long sustaining discharge between X and Y electrode begins.

Also we had a simulation when driving scheme is applied to MARI PDP. We explain wall charge state of each

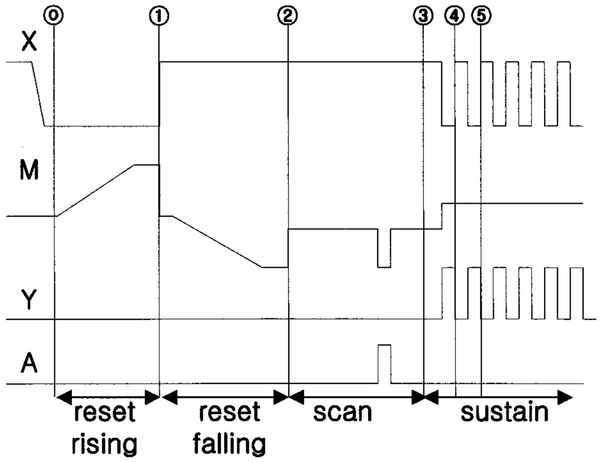


Fig. 4. Driving scheme of MARI PDP.

step – reset rising, reset falling, scan, sustain region. Simulation results are helpful to understand the driving mechanism.

First in reset rising region, between M and X, Y electrode discharge occurs. Above the dielectric layer of M electrode negative wall charges are accumulated. Because X and Y electrode electric potential are lower positive wall charges is accumulated.

In reset falling region wall charge state is formed to make addressing ease. Between M and X electrode discharge occurs and above dielectric layer of X electrode negative charges are accumulated and negative wall charges on M electrode decrease.

In scan region between M and address electrode discharge occurs and on side of X electrode there are negative wall charges, on side of M and Y electrode there are positive wall charges. After that sustaining discharge is possible.

In sustaining region wall charge state is stable with applying sustain pulse alternately on X and Y electrode. Simulation results confirm the driving possibility of MARI PDP and we made 42inch MARI PDP and check the working.

During sustain period we make the voltage of M electrode to be sustain voltage for holding negative charges to M electrode. Therefore ionic heating loss can be reduced.

As mentioned above, M electrode is involved addressing discharge and also involved in reset discharge. In the period of reset falling, bias voltage is applied to X electrode. So discharge not between Y and M electrode but X and M electrode occurs and weak light can be reduced to increase dark contrast ratio.

In conventional PDP, time of 1st sustain pulse is long but in MARI PDP time of 1st sustain pulse is same as the other sustain pulse. Because wall charge state is stable, it does not matter.

3. Results and Discussion

Fig. 5 shows the difference of light output between conventional PDP and MARI PDP. Light output is measured by photodiode.

In full white screen, light output of MARI PDP is stronger than that of conventional PDP. Also in peak white screen similar tendency appears. In light distribution graph, unusual point is MARI PDP has two peaks with one sustain pulse. In accordance with light output area and peak shape, we know that much light emits from equal input energy in

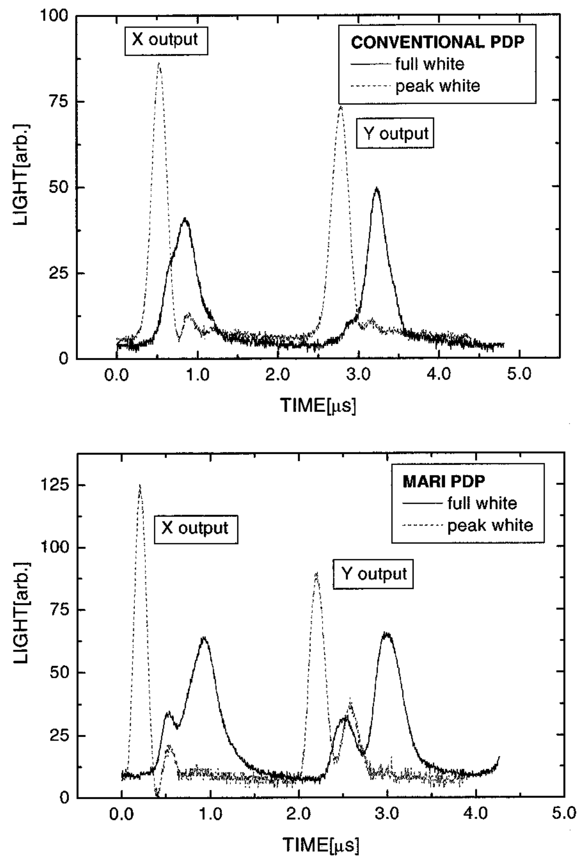


Fig. 5. Comparison of light intensity between conventional and MARI PDP

case of MARI PDP.

Generally X and Y electrode is mostly concerned in sustaining discharge. In MARI PDP it is possible to exchange of X and Y waveform because reset and scan voltage is applied to M electrode. Therefore unified circuit board can be used for cost reduction and circuit simplicity.

In usual PDP driving scheme during sustain period Y sustain waveform first is applied. And generally both X and Y waveforms consist of a sequence and are applied as pair. But in MARI PDP it does not matter that the last sustain pulse is either X or Y waveform. It is able to take odd number of sustain pulse in MARI PDP. It is named as NON-PAIR driving scheme which is shown in Fig. 6.

Therefore MARI PDP has a good ability to express a low grey scale for showing intermediate grey scale. In experiment the possibility is found. We will plan to continue experiments about NON-PAIR driving scheme.

We measured the value of power consumption of MARI PDP and LCD by an hour for same display source. It is observed that the power consumption of MARI PDP is lower than that of LCD by 30W. Therefore we know that

MARI PDP consumes lower power and have high luminous efficacy.

In this experiment, the luminous efficacy of 42inch SD MARI PDP is 2.35 lm/W. The panel input power is measured by linear power supply. In table 1, measured value is shown. Gas is composed of Xe12 %-He10 %-Ne bal., total pressure is 450 torr and sustain voltage is 225 V.

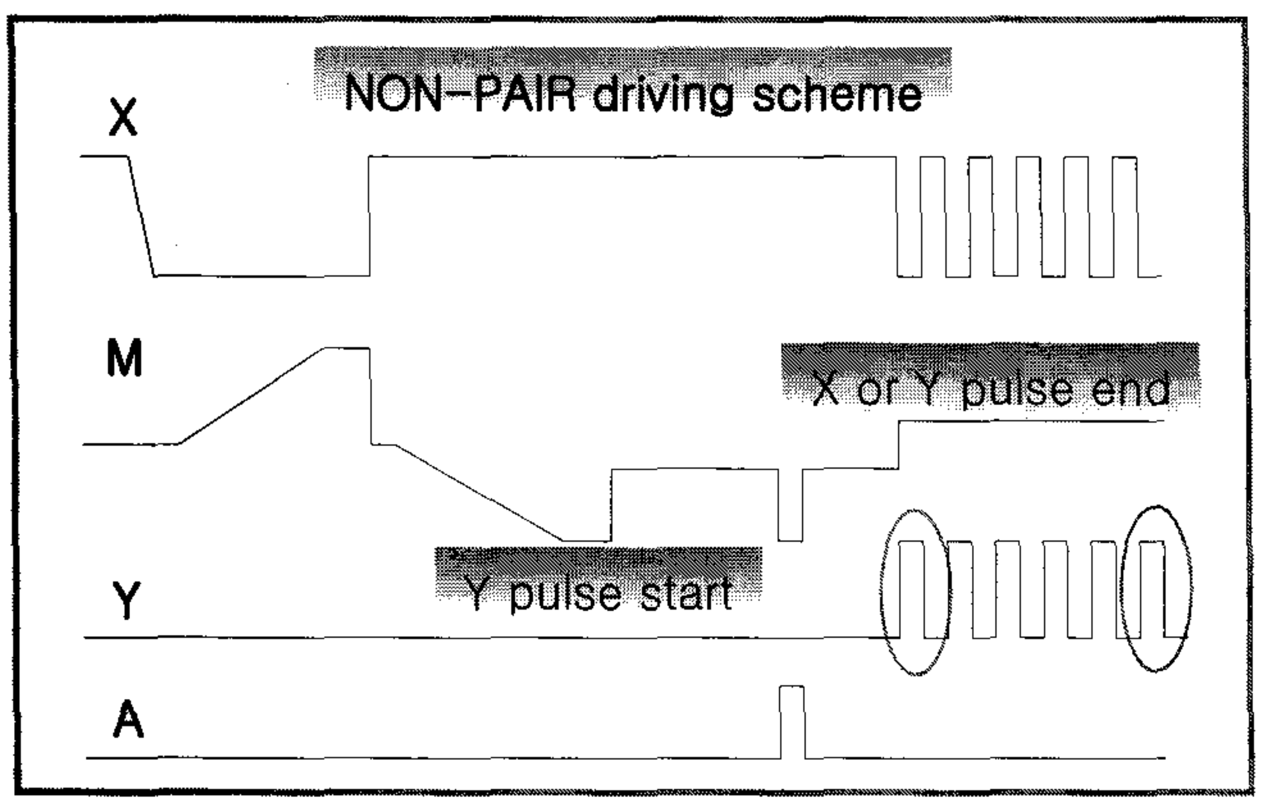


Fig. 6. NON-PAIR driving scheme.

Table 1. Luminous efficacy of MARI PDP

Luminance(peak white)	1200 cd/m^2
Luminance(full white)	206 cd/m^2
Power(full white)	201 W
Luminous efficacy	2.351 m/W

4. Conclusion

We suggested a new structure, MARI PDP which has a M electrode between X and Y electrode and driving scheme. M electrode is involved in reset and scan discharge and X and Y electrode are mainly involved in sustain discharge. We have developed 42 inch MARI PDP which has a high luminous efficacy with a long gap sustain discharge.

We are interested in the method to let lower sustain voltage by improving waveform and electrode shape and interested in using of high Xe gas for higher luminous efficacy. And we will continue to research driving scheme and circuit to reduce power consumption. We also think MARI PDP is suitable for high definition PDP, therefore we plan to make higher resolution MARI PDP.

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