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Keynote

MTK2 Color Plasma Display and Process Technologies for Making Fine Structures in Large Area

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1. Introduction

The 21st century is a visual information located society in the making. One day, people in far away places will be able to talk and exchange information with each other through large-screen displays just as if they were together. This multimedia age will require large-area, wall-hanging, high-definition TVs and interactive communication displays. The plasma display panel (PDP) meets the requirements of such a display because of its good display quality, emissive technology, wide viewing angle, flicker-free images, and its simple manufacturing processes which enable its large size.

Fujitsu began manufacturing a 21-in.- diagonal and a 42-in.- diagonal full-color AC plasma displays in 1993 and 1996, respectively[1],[2]. Many PDP players are also demonstrating 40-in.-diagonal class PDPs and developing facilities for large area color PDPs with big investment. Large area color PDPs have moved toward a volume-production stage from a development stage. This paper will discuss the history of color plasma display development, color PDP technologies including the process to make fine structure in large area, future trend and applications.

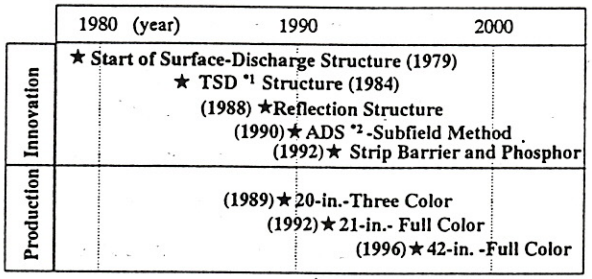


Fig. 1 History of color PDP developed at Fujitsu

2.Color PDP technologies

In 1979, the author started to study the surface discharge color plasma display to realize a full color plasma display [3],[4]. Figure 1 shows the history of color PDP development at Fujitsu. There are two important inventions for panel structure and driving technologies. A three-electrode surface-discharge plasma display panel (TSD-PDP) realized a practically available color plasma display.

Figure 2 shows the panel structure of the first practical color PDP. On the front glass plate, there is a pair of parallel display electrodes. These are multi-layered transparent and bus electrodes. They are covered by a dielectric layer and a protecting

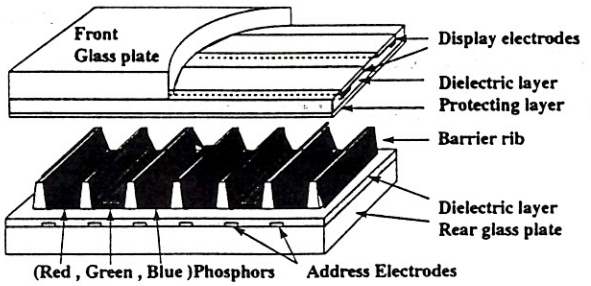


Fig.2 Color PDP structure developed by Fujitsu

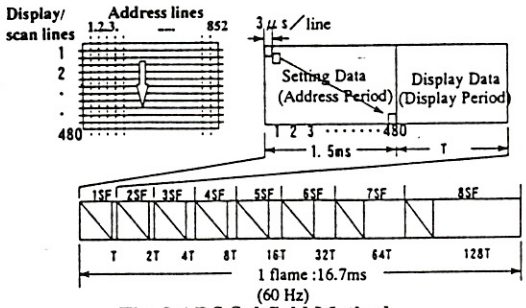


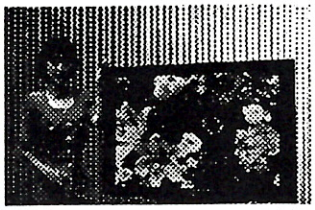
Fig. 3 ADS Subfield Method

(ADS: Address-Display-Period-Separated)

layer. The address electrodes are on the rear glass plate. Between the address electrodes are striped ribs that prevent electrical and optical crosstalk between adjacent cells. The red, blue, and green phosphors are formed inside cells. The front and rear glass plates are assembled with a cavity gap of about 100 μ m, and the Ne + Xe gas mixture is introduced into this cavity. This simple panel structure enables large area color plasma display and its volume-production.

To display full-color images using an inherent memory system of AC-PDP, a panel must display six- to eight-bit gray scale, or 360 to 480 sub-frames-per-second for moving images. To realize the rapid gray scale drive, the address- display-period-separated (ADS) sub-field method was developed as shown in Fig.3. In the address period, the system initially builds-up a wall charge in the selected discharge cells across the entire screen. Then the system simultaneously imposes discharge-sustain pulses across the entire screen for the display period. This causes successive discharge to take place only in the discharge where wall charges have accumulated, resulting in display. This new rapid-driving system achieves a fast driving speed of less than 3 μ s/scan line, and could also achieve more than 6-bits moving and static image display.

The 21-in.- diagonal and 42-in.-diagonal plasma displays are now available as a practical unit using the technologies described above. The each display's resolution was designed to be compatible with the 640 x 480 VGA standard to target the public information display market for 21-in.-diagonal PDP and with 852 x 480 wide TV format to target the TV and also public information market for 42-in.-diagonal PDP.



Item	Performance
Display Area	920mm x 518mm
Aspect Ratio	16 : 9
Number of Pixels	852 (R,G,B) X 480
Pixel Pitch	1.08mm X 1.08mm
Number of Colors	16.7 million
Luminance	350cd / m
Viewing Angle	> 160 degree
Power Consumption	300 W max
Weight	18Kg

Fig.4 A 42-in.-diagonal color PDP

Figure 4 shows a sample display of the 42-in.-diagonal full-color PDP. The panel has good color purity, a white peak area luminance of 350 cd/m^2, a wide viewing angle of more than 160 degrees, and 16.7 million colors. These characteristics are

comparable to that of a CRT.

3.Plasma Display Fabrication Process

Figure 5 shows the fabrication processes for color plasma displays. The transparent display conductive

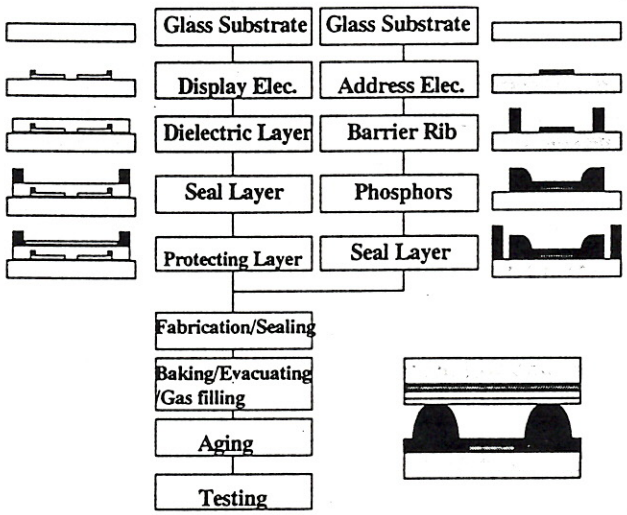


Fig.5 Fabrication process for color PDP

film are deposited and then etched as strip pattern with a photorithgraphy technologies and then narrow Cr/Cu/Cr bus electrodes are formed on the side of the transparent electrode on the front glass plate. The electrodes are called as display electrodes and . are covered by a printed white glass frit layer which is baked to turn into transparent dielectric layer. The MgO protecting layer is evaporated on it and airtight sealing layer is formed on the side of glass plate.

Address electrodes are made by using sputtering and photorithgrathy techniques. These are also covered by a dielectric layer. The stripe barrier ribs are formed on both side of the address electrodes. The stripe red, blue and green phosphors are deposited on side wall of ribs and on the dielectric layer. The seal layer is also deposited on the side area on glass plate.

The two substrates are assembled so that the display electrodes and address electrodes are orthogonal each other and then baked to glue up by the melted glass seal layer. The panel is baked and filling gas is introduced in the cavity through the inlet glass tube and then tip off the glass tube. The panel structure has advantages of no necessity of accurate arrangement for assembling because of the striped rib and phosphor structure.

One of the most important processes is to make fine rib structure. The barrier rib with a dimensions of 30-50 μ m width and 100-150 μ m height has to be accurately arranged in an large area of 1.0 m^2. Although, printing technologies have been ordinary used for making rib, sandblasting technique shown in Fig. 6 has become a main process to make it because of the high accuracy. And other new technologies with photorithgraphy technologies have been investigating to realize a high productivity and low cost .

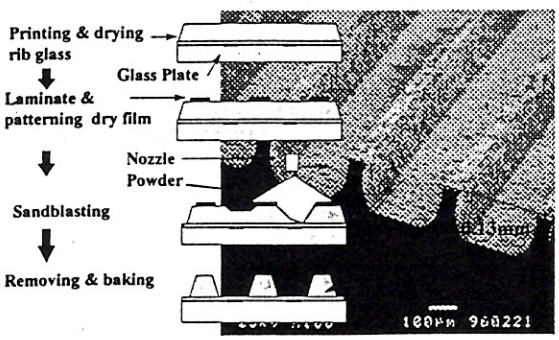


Fig.6 Sandblasting Method

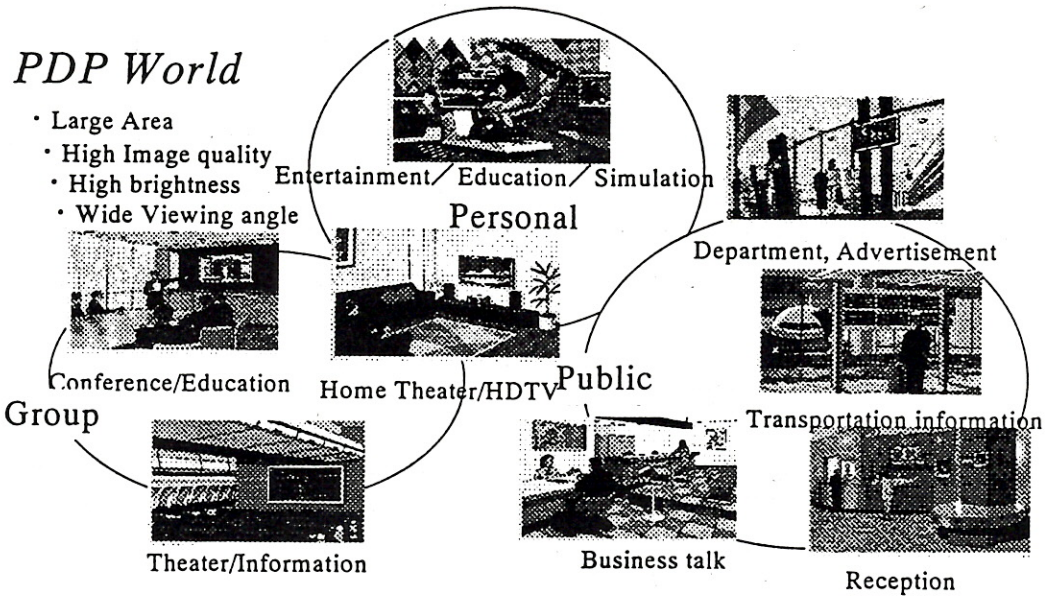


Fig.7 Markets for large area color PDPs

4.Future trends of color PDP

Plasma displays have been proven to be the most promising flat panel technology for the large-area display. A 21-in.-diagonal PDP is used in applications that require a flat panel display and thin package. The first application for the color PDP is the niche market of public information displays, such as in a stock exchange, transportation terminals, and hotels, etc. This is because the PDP's initial production quantities are limited and it must compete with the high-quality and low-cost CRT in the same market. However, 42-in.-diagonal PDP is now available and will defeat the limitation of penetration in the market. Large area HDTV and multimedia displays are needed in the 21st image information society. The CRT's bulk and weight are disadvantages that may enable the PDP to claim a bigger share of the market, especially in home application. High resolution PDPs of diagonal size from 20 to 70-inches are the future target developed and will open a new market as shown in Fig.7.

5.Conclusion

This article has reviewed the development of practical, full-color AC plasma displays; the technologies used for the 42-inch full-color plasma display; and prospects for large-area displays, including HDTV. The plasma display panel has demonstrated its suitability for large-area displays. Once large-screen PDPs are put into practical use, the primary markets will be HDTV and multimedia displays, although the workstation market also presents an opportunity for 20- to 70-inch diagonal, high-resolution displays.

Because plasma displays are digital devices, they have an advantage for multimedia display applications, which will be achieved by combining both HDTV and multimedia technologies. The

author expects that PDPs will eventually become a standard display device for linking human beings together in the visual information society of the 21st century.

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