

25.3: The High Performance Scalable Display with Passive OLEDs

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Abstract

This paper describes a newly developed scalable Passive OLED Display System. The display dimension is no longer limited due to the seamlessly linked module structure. In the class of flat displays over 100 inches in dimension, passive OLED offers potentially significantly lighter weight as well as thinner thickness. A new design technology encompasses passive OLED units linked together to form a larger display without showing joint seams. The development also incorporates a technique to equalize individual display panel. A 155 inch (3.93m) prototype using 2,880 OLED panels have been fabricated. The display can offer the clear character and HD-TV images with wide-viewing angle.

1. Introduction

The history of VLSD (Very Large Scale Display) has gone through four generations of different technologies as shown in Fig.1. First was Mitsubishi's Diamond Vision using combination of cathode ray tubes of R, G, and B as a pixel. Second generation used bimetallic CRT's combined into a matrix. Third and current generation uses LEDs as the pixel element. As the passive OLED technology came into practical use, it brought out strong key features such as potentially lower cost, wider viewing angle, higher image quality and better performance under sub-freezing temperature. Passive OLED is now widely used in devices such as cellular phone displays and automobile dashboards. In an effort to apply passive OLED units to form a scalable VLSD, a new technology has been developed to eliminate visible borders between OLED units. This paper discusses a successful result for scalable VLSD consisting of 3mm pixel pitch passive OLED panel.

2. Design Targets

The following general design targets were considered at onset. They are: Realization of a highly reliable scalable VLSD with no discernible seams between the adjacent modules. Initially it is required to maintain initial brightness for 5 years and costs less than those using LED. The display of high quality images with high brightness, high contrast with physically lighter weight and thinner thickness.

3. Implementation

3.1 The Development Concept

3.1.1 Cost Performance

The display consists of the passive OLED, where the existing manufacturing technology and facility can be utilized to attain higher cost-performance.

3.1.2 Design Freedom

The thinner and lighter display structure enables even curved surface display.

3.1.3 Seamless and Scalable

The display consists of multiple modules with no discernible seams between adjacent units and they can be combined to any size.

3.1.4 High Picture Quality

The resultant display has the performance of high brightness, high contrast and high resolution images.

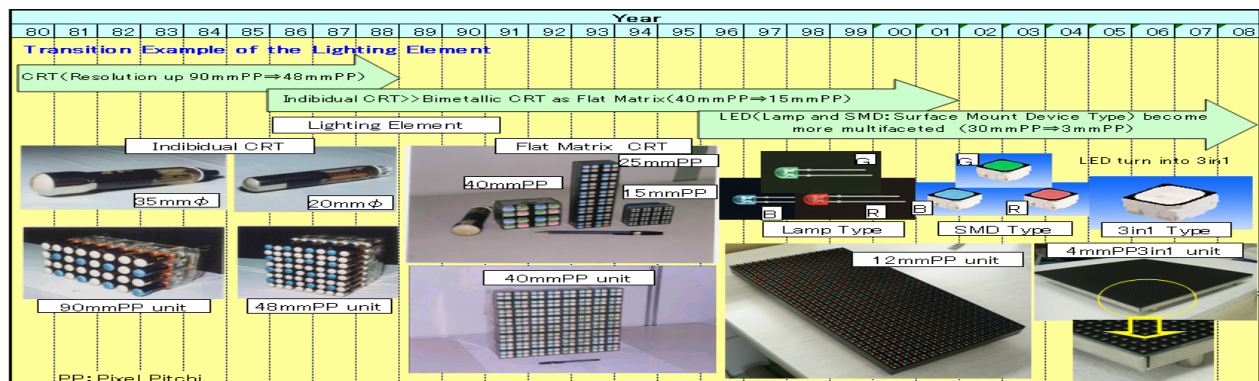


Fig. 1 History of VLSD Technology

3.1. Display Panel and Module Unit

3.1.1. Getting Around Unequal Pixel Pitch

As shown in Fig 2, ordinary display panel has the same inter-pixel gap in the panel as that between the adjacent panels. Inter-pixel Gap includes the seal, electrode area and tolerance for tiling and those restricts the aperture-ratio (brightness) of the pixel. By reducing the inter-pixel gap as shown in Fig 3, the brightness and useful life have been significantly improved. Observing from viewing distance the pixel structure is not noticeable, and the increased brightness improved the image quality. Improvement was expected from the computation, the actual result was confirmed by the observation of the display. As for the pixel structure, we rearranged the sub pixel like horizontal stripe based on the subjective evaluation test. We tested for the minimum viewing distances for 17 viewers, where the pixel structure becomes imperceptible for overall images (still image and moving image). Fig. 6 shows the test result and we plot the average distance and the error range (standard deviation). As a result, the horizontal stripe was better for shorter viewing distance.

3.1.2. Display Panel and Screen Structure

Fig 3 shows the color pattern of the OLED panel. OLED panel in this case has unequal pixel pitch for improved brightness as mentioned above. The distance between two pixels within the panel, and distance between two pixel located across the border are the same. This results in eliminating all borders between pixel modules. Fig 4 shows the screen structure. A subunit consists of 4 OLED panels, and the unit consists of 4 subunits. These fundamental modules can form displays with various dimensions including curved surfaces as Fig.5.

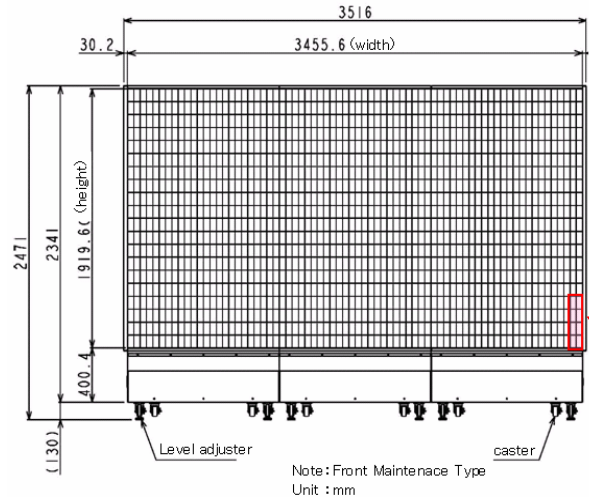


Fig. 4 The Construction of the screen

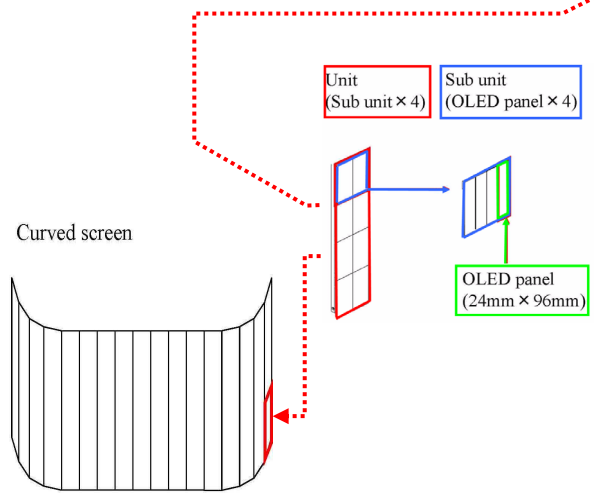


Fig. 5 The Configuration of Curved Screen

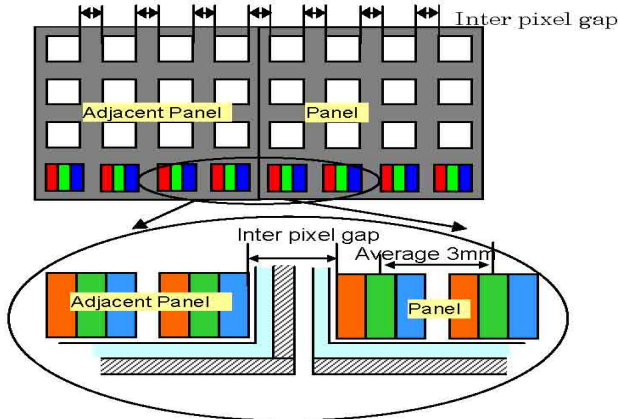


Fig. 2 Normal pixel arrangement

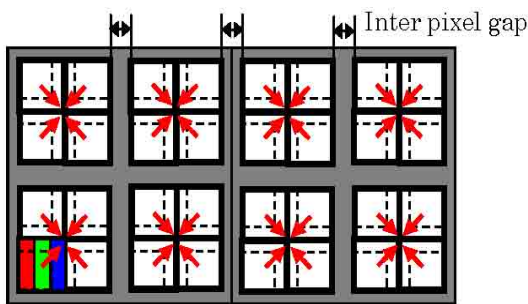


Fig. 3 High brightness pixel arrangement

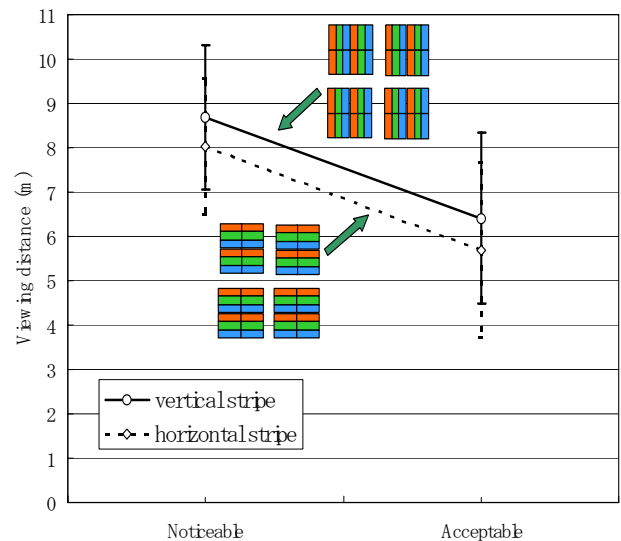


Fig. 6 The Subjective Evaluation

3.1.3. Improvement of Brightness and Life Time

A thorough investigation of material and device structure resulted in higher luminance and longer life of the OLED. Fig 7 demonstrates one example of performance improvement of a blue device. By applying new OLED material and optimizing the structure, a device gained higher output and longer life over conventional devices.

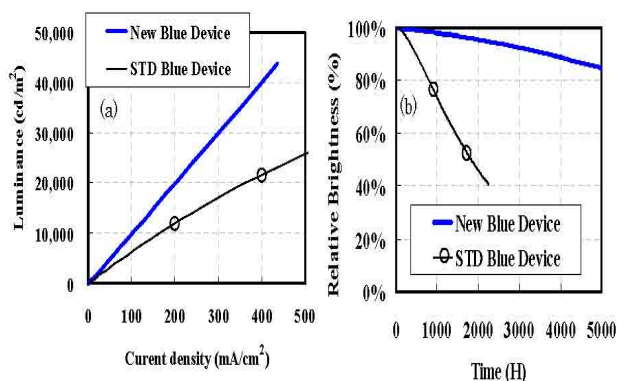


Fig7 (a) Blue device performance. External quantum efficiency of the new Blue Device is 7.2% at 400 mA/cm².

(b) Lifetime decay curve of blue devices for 500 cd/m² and 1/64 duty pulse driving at room temperature.

3.3. The dive for high quality image

The screen has been driven by the integrated circuit specially designed for passive OLED with high performance. The gray scale is processing as 4,096 levels in each color.

4. Result

4.1. The feature of display and Specification

OLED-System Indoor Display	
Display device	Organic light-emitting diode
Pixel arrangement	
Resolution	111,111 pixels/sq.m
Max. brightness	1,500cd/sq.m (Target)
Processing (Gray scale)	Each color has 4096 gradations
Brightness adjustment level	64 levels
Min. viewing distance	More than 2m
Power supply	3phases 3wires 200V 50/60Hz
Life time (half brightness)	Approx. 20,000 hr (Target)

Fig.8 Specification of screen

4-2 The Screen on CEATEC Japan



Photo 1 : The Screen demonstrating on the Stage of CEATEC 2009 (The Sub-Unit of Passive OLED is shown on upper right)

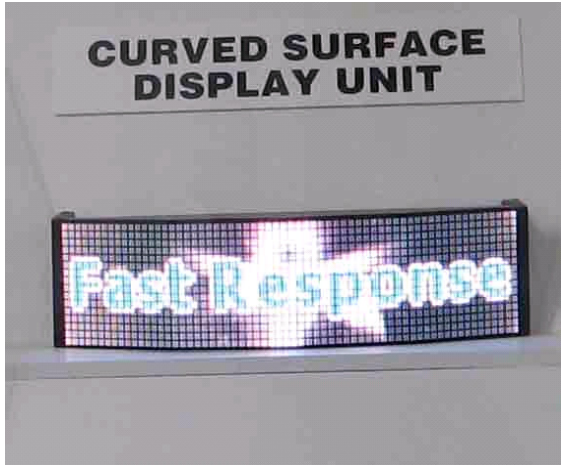


Photo 2 The Curved Surface Display Unit

4-3 The Prospective application



Photo 3 Digital Signage in bright-light condition with Curved surface)



Photo 4 Flight Information Display Board

5. Conclusion

5.1. The status of performance

5.1.1 155 In Scalable Display with 3mm Passive OLED was shown at CEATEC with excellent result.

5.1.2 Brightness and useful life to improve greatly in the near future.

5.2. The Future Plan

5.2.1 High resolution display using this technology will find application in the control room for supervisory monitor systems.

5.2.2 It is expected that the display of this type will be used widely in digital signage industry. Its light weight, thin thickness and curved surface offer many advantage.

5.2.3 3D display without need for special eye-glasses can be developed.

6. Acknowledgements

We would like to express our special thanks to our partner Idemitsu Kosan Co., Ltd for improvement of the OLED material.

7. References

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