88-in. MicroLED Tiling Display for Commercial Display Application

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Abstract

Vistar has developed a new generation of 88 inch Micro-LED display, with improvement in visual quality, in terms of uniformity at blackness level and viewing angle. After the construction of the first Micro-LED pilot line in Mainland China in Aug 2020, followed by the initialization of the first Micro-LED mass production line construction in 2023, Vistar is expected to release its first product model in later 2025 for global buyers.

Author Keywords

Micro-LED; Tilling Display; Mass Transfer;

1. Introduction

Micro-LED (Micro-Light Emitting Diode), with advantageous properties of long lifetime, high contrast ratio and brightness compared with OLED and LCD，is considered to be the next generation of display technology [1,2] There has been exponentially growing number of Micro-LED demos and products being announced over the past several years, in various form factors and applications. For example, Samsung announced a series of Micro-LED TVs named “the Wall” in 146 inch, 110 inch, 88 inch, and so on. PlayNitride launched two full color Micro-LED panels with 232 PPI and 132 PPI (Pixel Per Inch), the size of the panels are 3.12 inches and 2.65 inch, respectively.[3] Tianma launched 5.04 inch, 7.56 inch, 9.38 inch and 11.6 inch Micro-LED display demos. For example, Samsung showed 54inch and 211 inch transparent LED display with up to 60% transparency. Samsung and LG both showed stretchable and flexible Micro-LED display with 20%-25% stretchbility. AUO showed Micro-LED auto display applications such as 17.3 inch interactive transparent car window display, and roll-able Rear Seat Entertainment (RSE) system display. Tianma showed wearable 1.63inch 403 PPI Micro-LED display [3] and 8.07 inch high PPI transparent abnormal-shaped display. JBD announced several AR Micro-LED monochromatic and full-color micro displays.

Among all the tracks where players racing towards the productization of Micro-LED technology, large size commercial display is considered one of the most promising start. It has growing number of products announced over the past few years, such as 76 inch, 89 inch, 101inch , and 114 inch TV’s by Samsung, as well as the 136 inch large display by LG. BOE also showed P0.9 162 inch large display. Playnitride showed 145 inch large display.

Micro-LED’s properties such as high reliability and high brightness makes it the perfect candidate for high-end TVs and commercial displays applications. Vistar is focused in this criteria, with abilities of LTPS manufacturing, mass transfer process, mass inspection/repair, encapsulation and module, as well as driving architecture design. Compared to The Micro-LED panel is composed of millions of RGB (Red, Green, Blue) LED chips and backplane which is made from different substrate.

In addition, low PPI displays such as high-end TVs and commercial displays has another benefit that the distance between any two pixels is spacial such that it is roomy enough to fit in GOA driving circuits, edge wiring and side wiring etc. Therefore compared to AMOLED and other type of display technologies, Micro-LED can be made into bezel-less forms, spliced in-between two pixels, which brings out unique features and market appeals of Micro-LED technology.

Figure 1 Comparison between various kinds of tiling displays. TFT based Micro-display is the most promising solution in delivering seamless display experience.

At SID 2024, Vistar (together with Visionox) showed the 88 inch 4K front-assembly tilling display[4], combining 288 pieces of 4.78 inch display module, with up to 100% light-up yield, <3.5% reflection, 1000 Nits brightness, 98% DCI-P3 color gamut and 1024 grayscale (10bit) color depth.

Figure 2 The new generation 88 inch tiling display, with improved visual quality in black level and in-between-panel uniformity.

As shown in Fig 2, Vistar has manufactured a new generation 88 inch tilling display, with upgrade in display quality such as <20um seam between panels, △E<0.5 blackness uniformity, up to 170°/170°viewing angle and improved uniformity, as well as 240h running reliability at 60℃ temperature / 90% humidity condition.

2. Experiments

A series of fabrication steps are conducted to make each

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individual display module, including array process, sidewiring process, mass transfer and repair, encapsulation and module process, demura and testing, etc.

Backplane fabrication: the back plane is fabricated with front wiring, back wiring and side wiring, during which excess glass bezel is cut off with laser treatment.

Transfer & repairing: LEDs are bonded to a temporary carrier, and then transferred onto the TFT panel via stamp transfer. Multiple stages of repair are conducted in order to ensure a 100% light-up yield.

Encapsulation & module process: the panel is encapsulated and COF bonded. And then it goes through complex demura, color tuning process, becoming a full functional display module.

3. Results and Discussion

In additional to the existing fabrication steps, several novel techniques are developed and implemented into the new model to further improve display quality.

First, a novel black ACF technology is developed. Compared to traditional ACF bonding technique, in which an Ink Jet Printing (IJP) or black matrix (BM) process is required after mass transfer to realize the black finish on the panel, the new black ACF technology simplifies the fabrication process by combining the mass transfer and blackening processes into one single step, eliminating the need of separate blackening process. It greatly reduces the process complexity and hence improves the yields and lowers the cost. Additionally, black ACF provides much better blackness uniformity as shown in Fig 3, which reduces the noticeability of the seams between panels at low grayscale.

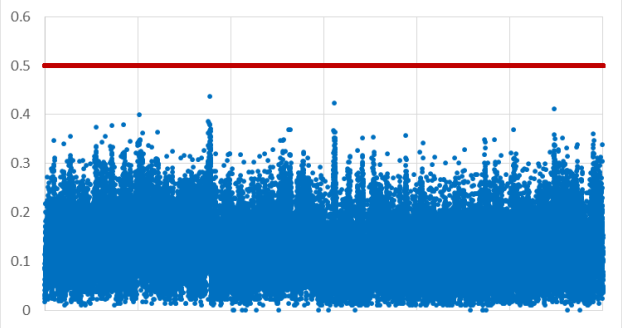

Figure 3 Multiple blackness data are collected across various panels. The blackness level are calculated and compared, with most data falling in △E<0.35, qualified for high end display specs which requires △E<0.5.

In addition, a new generation of Micro Lens Array (MLA) is developed, which applies on the panel surface in order to normalize the emission profile and gives a more uniform viewing experience, especially at large angles. As a result, the final product has viewing angle as large as 170°/170°, a great improvement over last year's model which has 50°/50°.

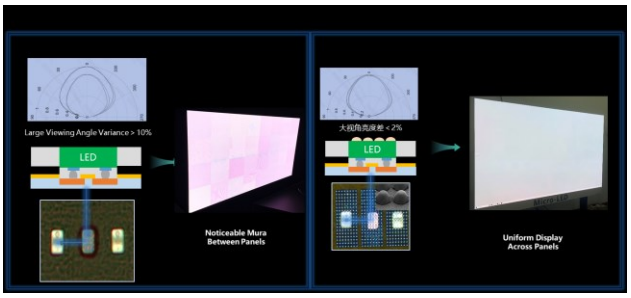

Figure 4 MLA structure are implemented to greatly improve in-between-panel mura caused by bad LED uniformity, which dramatically reduces noticeability of panel mura and provides uniform viewing experience across panels, especially at large viewing angle.

Furthermore, a novel Terminal Repair technology is developed. Usually, to achieve a 100% light-up display module, multiple stages of repairing is needed. This new repair technique takes a final ensuring repair at terminal product format, where a single defect caused before the last minute can cause a piece of display module to fail. This greatly increases the yield and lowers the total cost.

4. Conclusion

We successfully developed an 88 inch display with improved picture quality, in terms of blackness uniformity, picture quality at large viewing angles, and seams improvements. It takes a further step close to productization of Micro-LED displays for commercial display and high-end TV applications.

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