The Challenges faced by development of Micro-LED & Mini-LED Display

BOE Technology Group
Ke Wang
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Outline

1. The background of Micro LED & Mini LED Display
2. The application of Micro LED & Mini LED Display
3. The challenge of Micro LED & Mini LED Display
4. BOE Micro LED & Mini LED R&D
1. The background of Micro LED & Mini LED Display

As the size of LEDs decreasing, applications transition from illumination to display.
1. The background of Micro LED & Mini LED Display

As the size of LEDs decreasing, applications transition from illumination to display.

<table>
<thead>
<tr>
<th>Display</th>
<th>LCD</th>
<th>OLED</th>
<th>Micro-LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Color CF+backlight</td>
<td>Emissive</td>
<td>Emissive</td>
</tr>
<tr>
<td>EQE</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Brightness(cd/m²)</td>
<td>3000</td>
<td>1000</td>
<td>100000</td>
</tr>
<tr>
<td>Contrast</td>
<td>1000:1</td>
<td>10000:1</td>
<td>1000000:1</td>
</tr>
<tr>
<td>CRI</td>
<td>75%NTSC</td>
<td>124%NTSC</td>
<td>140%NTSC</td>
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<tr>
<td>lifetime(h)</td>
<td>60k</td>
<td>20-30k</td>
<td>80-100k</td>
</tr>
<tr>
<td>Response time</td>
<td>ms</td>
<td>us</td>
<td>ns</td>
</tr>
<tr>
<td>Power</td>
<td>High</td>
<td>60-80% of LCD</td>
<td>30-40% of LCD</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-40°C~100°C</td>
<td>-40°C~100°C</td>
<td>-40°C~100°C</td>
</tr>
</tbody>
</table>
2. The application of Micro LED & Mini LED Display

Solution

1. Mini-LED BLU+LCD

2. Mini-LED Display, Seamless splicing, oversize Display

3. Realize high-resolution mobile display through mass transfer, bonding and mass repair

Application

Ultra high contrast

Ultra-high brightness

Oversize Display

Flexible display

Ultra high resolution

From Internet
3. The challenge of Micro LED & Mini LED Display

3.1 Micro LED & Mini LED EPI & Chip process

1. Affected by etching, sidewall defects will be introduced. When the size of the LED is reduced, the proportion of sidewall defects will increase and the EQE will drop significantly.

2. EQE peak shifted to a high current density, it is not good for low-current driving;

3. Wafer wavelength yield
3. The challenge of Micro LED & Mini LED Display

3.2 The AM pixel driving circuit of Micro LED & Mini LED

Compared with OLED, the EQE of blue Micro LED is significantly better than OLED, but the brightness of LED is too high, which is not good for display.

1. The brightness of the high EQE area is too high, and PWM driving is required;
2. The current demand in the high EQE area is higher, and a larger area is needed for the pixel circuit, which is not good for high-resolution display;
3. At low gray scale, EQE is too low, the power is high, and PWM design has the problem of flicker;
4. IR Drop & Power reducing
3. The challenge of Micro LED & Mini LED Display

3.3 Color purity and gamut

1. The FWHM will affect the color purity,
2. Wavelength changes under different current, causing chromatic aberration

From Taiwan Industrial Technology Research Institute
3. The challenge of Micro LED & Mini LED Display

3.4 Mass transfer

- Electrostatic adsorption
- Roll to roll transfer
- Laser transfer
- Stamp transfer
- Fluid transfer

1. Transfer accuracy
2. Efficiency
3. Yield
4. Cost
3. The challenge of Micro LED & Mini LED Display

3.5 Inspection and repair

- Inspection
  - PL/EL inspection
  - Efficiency ???

- Repair
  - Redundant circuit
  - Laser repair
  - Mass repair ???

Redundant circuit

Laser repair
Based on the backplane technology, BOE actively promotes Micro & Mini LED technology and product development.

**Micro LED technology**

- **MiniLED B/L**
  - Aiming at the glass-based Mini LED BLU to achieve LCD performance upgrades, mass production in 2021
  - Significantly improve the display quality of LCD products through Mini-LED BLU (local dimming zones > 1000, contrast ratio 1 million:1, brightness ≥1000nit)

- **MiniLED Display**
  - Targeting glass-based PM display to realize large-size seamless splicing display, mass production in 2021
  - Realize full-area display through seamless splicing of Mini-LED small-size displays (7” to All size, Pitch ≤ 0.9mm)

- **MicroLED Display**
  - Combining the advantages of BOE backplane, respond to the market, coordinate development, and develop as soon as possible
  - LTPS BP + Micro LED
4.1 BOE Mini LED B/L

- BOE Mini LED backlight technology is low-cost Glass based, high brightness, high partition, full-size or less splicing, and high transfer efficiency.

**Integrated light board design**
- Slim design
- Full page, less splicing
- Low warpage
- High stability and reliability

**AM driving**
- Ultra-high Peak brightness 1000nit+
- Excellent thermal conductivity: low resistance metal Cu
- 1000~5000+ local dimming zones

**High transfer efficiency**
- Efficient transfer 100HZ (10 times the regular Pick and Place method)
- High accuracy

**Process**
- Low-cost Glass based

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BP
White ink
Rx LED
Protecting glue
FPC
4.1 BOE Mini LED B/L

- BOE MiniLED backlight covers full-size display products, including automotive, medical, MNT, super-size TV, etc.

**Automotive 12.3” (BOE IPC2019)**
- 500+ local dimming zones
- 1,500 nits Peak brightness
- 1,000,000:1 contrast ratio
- 85% NTSC
- 9.00 mm thickness
- 8 bit + FRC

**Monitor 27” (BOE IPC2020)**
- 1,000+ local dimming zones
- 1,000 nits Peak brightness
- 1,000,000:1 contrast ratio
- 99% DCI-P3
- 8.9 mm MDL thickness
- 8 bit + FRC

**TV 75” (BOE IPC2020)**
- 5000+ local dimming zones
- 1,500 nits Peak brightness
- 1,000,000:1 contrast ratio
- 80% BT2020
- 8.9 mm MDL thickness
4.2 BOE Mini LED Display

- BOE Mini LED display technology is seamless splicing, high brightness, and flicker-free.

- **Arbitrary splicing**
  - Slim design
  - Low warpage
  - High stability and reliability

- **Seamless splicing**

- **AM driving**
  - AM driving
  - LTPS or oxide TFT
  - Fine Pitch <1.0mm

- **Black**
  - Black silicone + Transparent silicone
4.2 BOE Mini LED Display

- BOE Mini LED display focus on super-size displays, including large-size TVs, indoor/outdoor public displays, theaters, etc.

- **55” (BOE IPC2020)**
  - Glass Based
  - Pixel Pitch 1.8mm
  - Single Panel 8.9-inch

- **55” (BOE IPC2020)**
  - Glass Based
  - Pixel Pitch 0.9mm
  - Single Panel 8.9-inch

- **162” (BOE IPC2020)**
  - 5000+ local dimming zones
  - 1,500 nits Peak brightness
  - 1,000,000 : 1 contrast ratio
  - 80% BT2020
  - 8.9 mm MDL thickness
Summary

1. Micro LED & Mini LED has many advantages and new applications, and is an important part of future display;
2. Micro LED & Mini LED still faces many challenges, especially for chip process, pixel driving circuit, color purity and gamut, Mass transfer, Inspection and repair;
3. The development of Micro LED & Mini LED requires the cooperation and efforts of all process stages.
THANKS