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

BOE Technology Group

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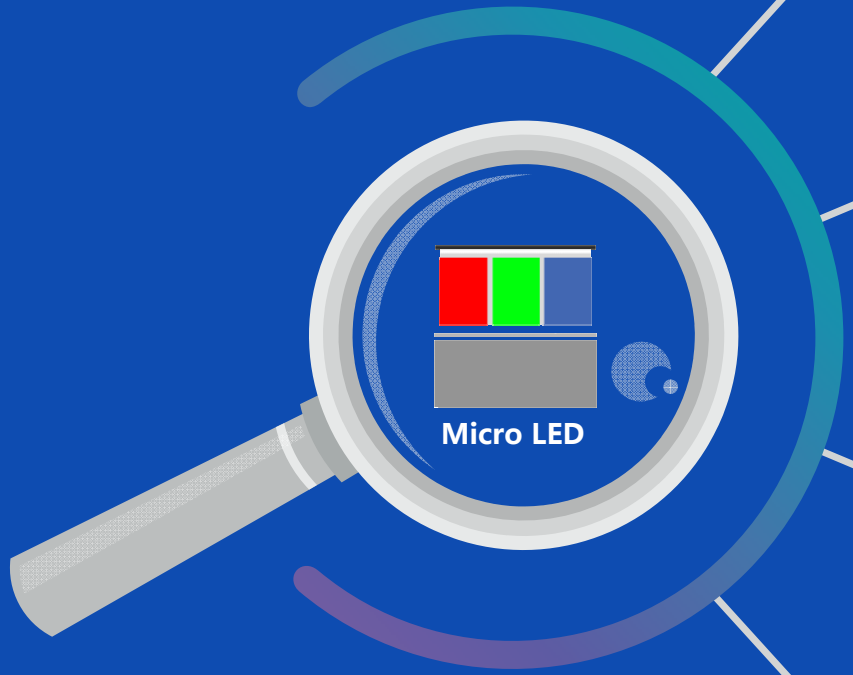
2021.3.25

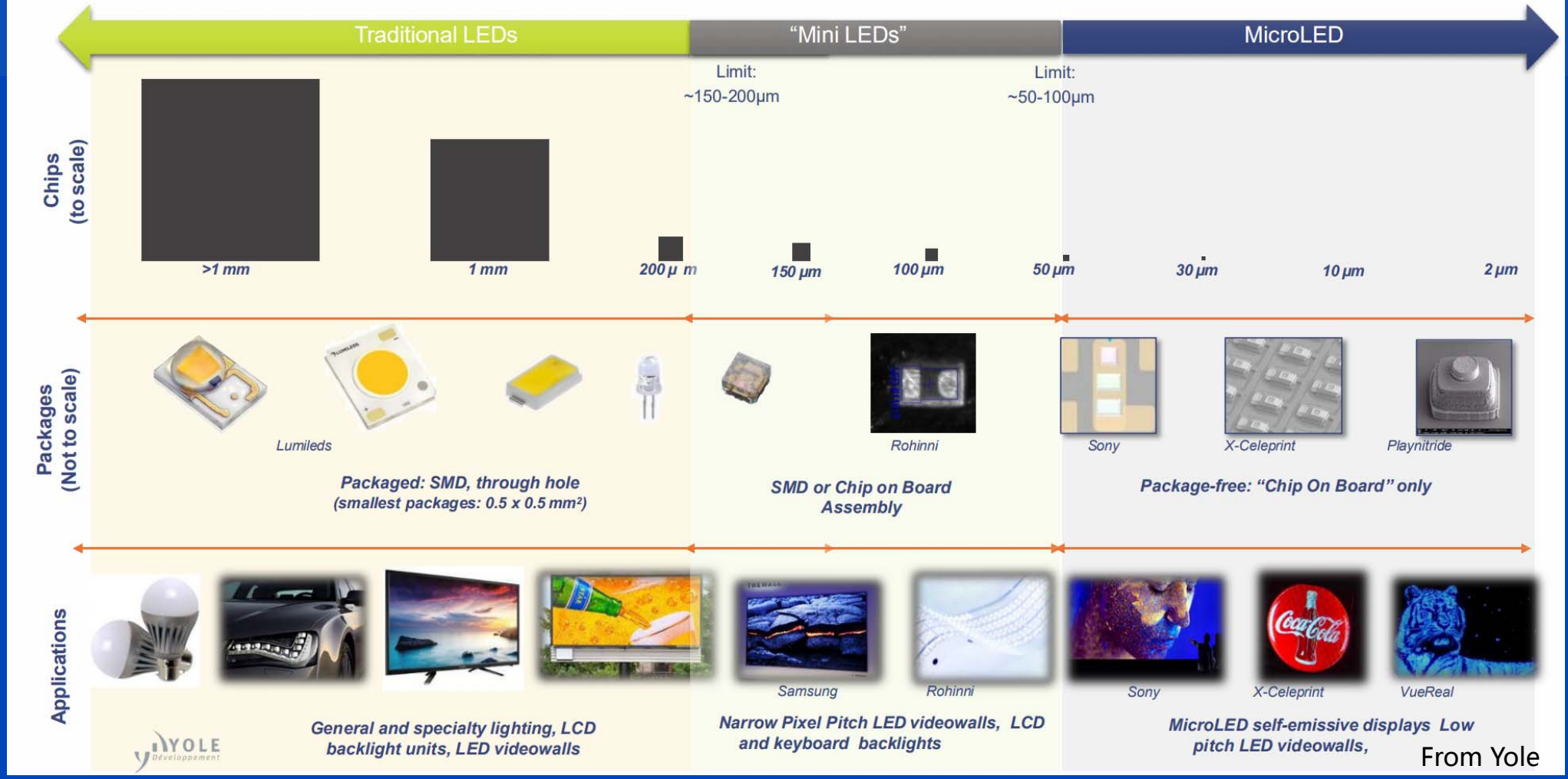
CHANGE LIFE WITH HEART

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

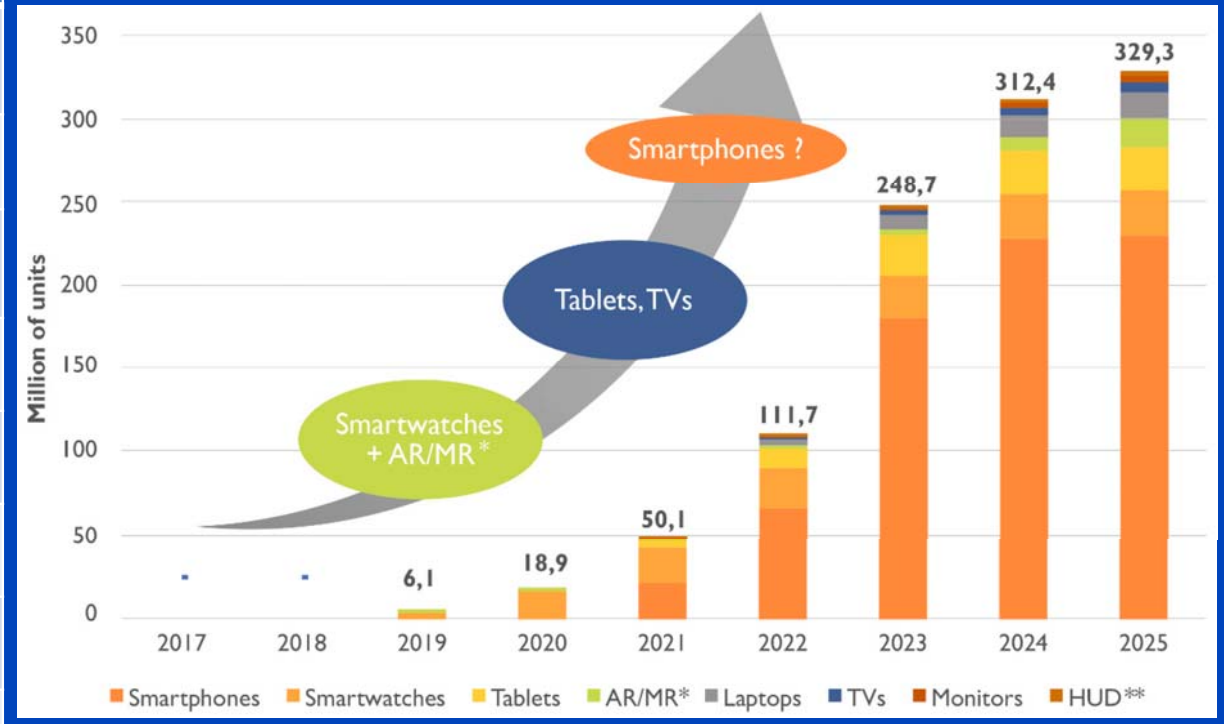


From Yole

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

➢ 1. The background of Micro LED & Mini LED Display

Display	LCD	OLED	Micro-LED
Technology	Color CF+backlight	Emissive	Emissive
EQE	Low	Medium	High
Brightness(cd/m 2)	3000	1000	100000
Contrast	1000:1	10000:1	1000000:1
CRI	75%NTSC	124%NTSC	140%NTSC
lifetime(h)	60k	20-30k	80-100k
Response time	ms	us	ns
Power	High	60-80% of LCD	30-40% of LCD
Operating temperature	-40℃~100℃	-40℃~100℃	-40℃~100℃

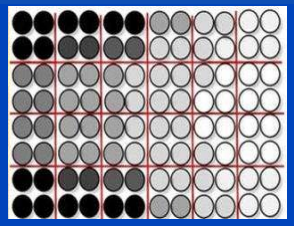


As the size of LEDs decreasing, applications transition from illumination to display

➢ 2. The application of Micro LED & Mini LED Display

Solution

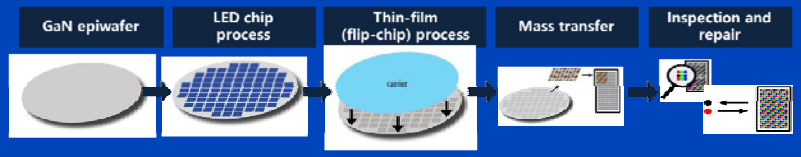
LCD Panel



Mini-LED BLU

■ 1，Mini-LED BLU+LCD

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

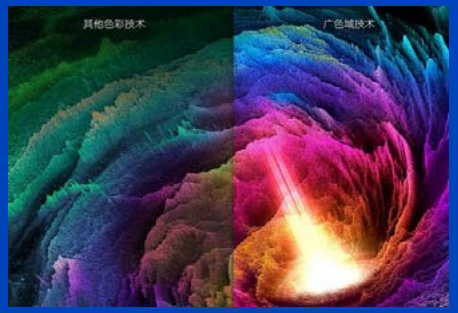


■ 3，Realize high-resolution mobile display through mass transfer, bonding and mass repair

Application

Ultra high contrast

Ultra-high brightness



Oversize Display

Flexible display

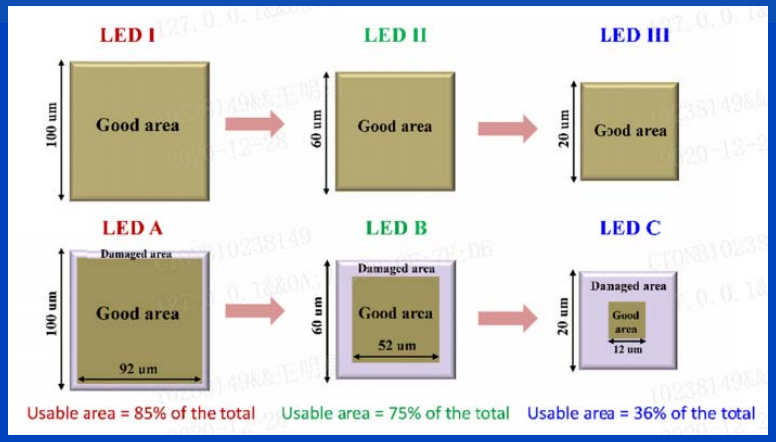
Ultra high resolution

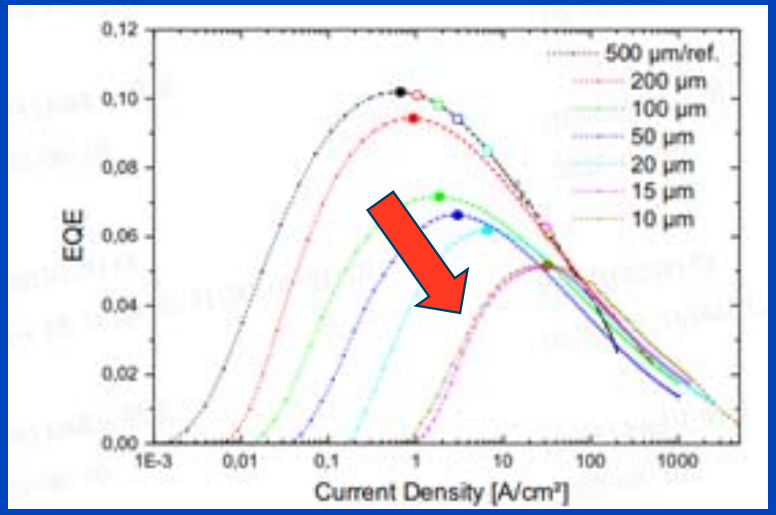
From Internet

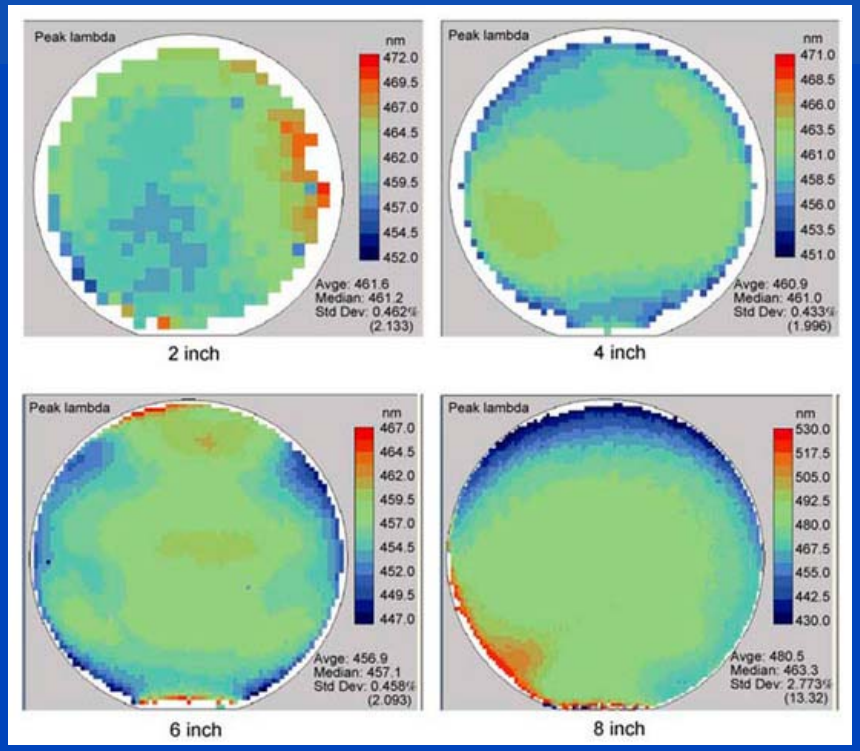
➢ 3. The challenge of Micro LED & Mini LED Display

3.1 Micro LED& Mini LED EPI & Chip process

LED chip process







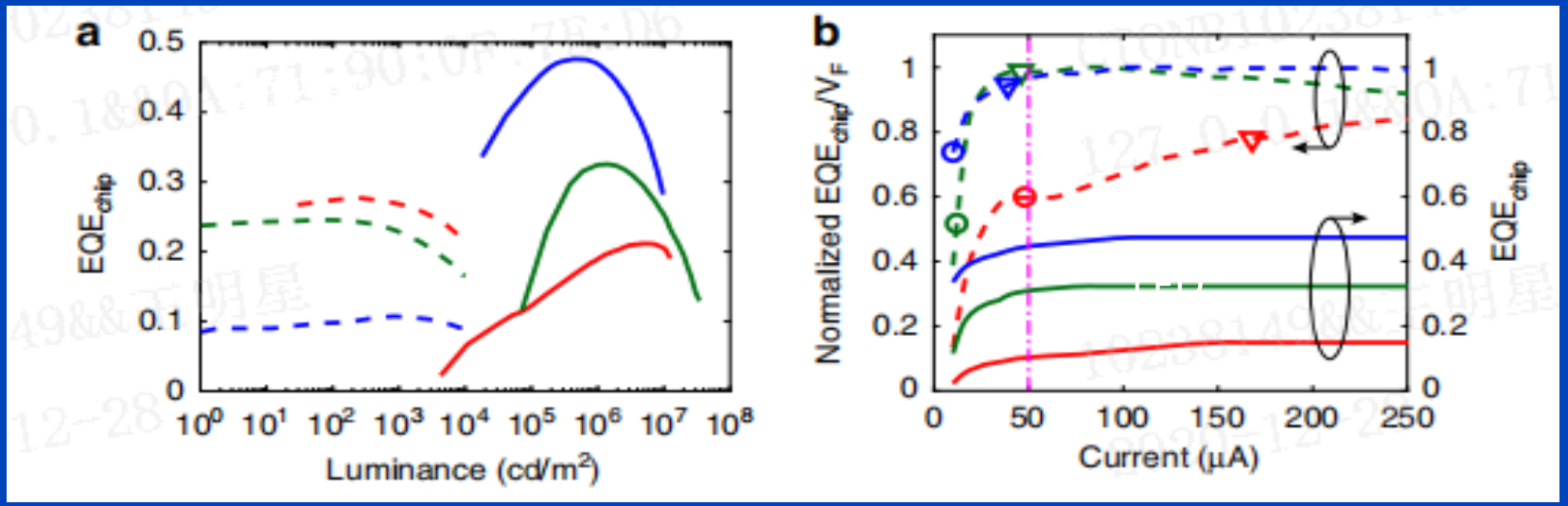
1，Affected by etching, sidewall defects will be introduced. When the size of the LED is reduced, the proportion of sidewall defects will increase and the EQE will drop significantly.

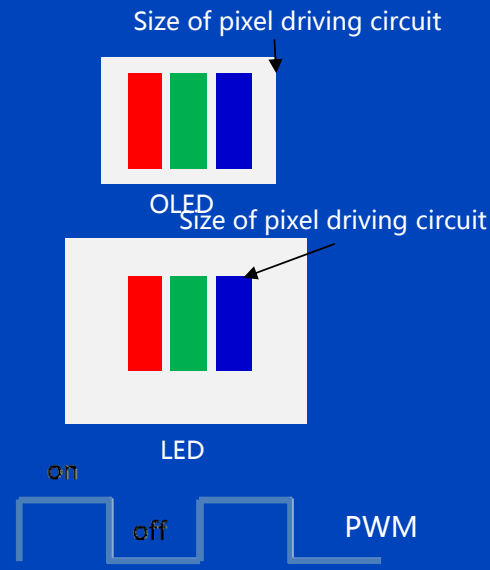
2，EQE peak shifted to a high current density, it is not good for low-current driving；

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;

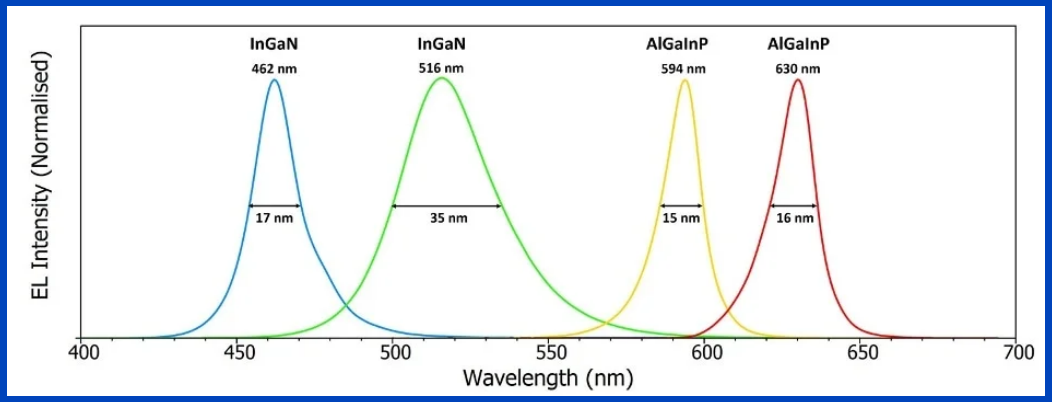
3. At low gray scale, EQE is too low, the power is high, and PWM design has the problem of flicker;

4. IR Drop & Power reducing

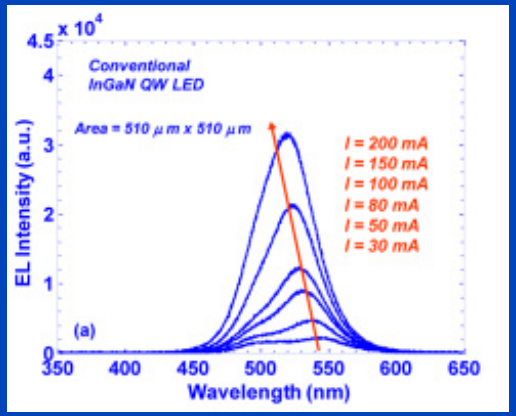
Huang et al. Light: Science & Applications (2020) 9:105

➢ 3. The challenge of Micro LED & Mini LED Display

3.3 Color purity and gamut

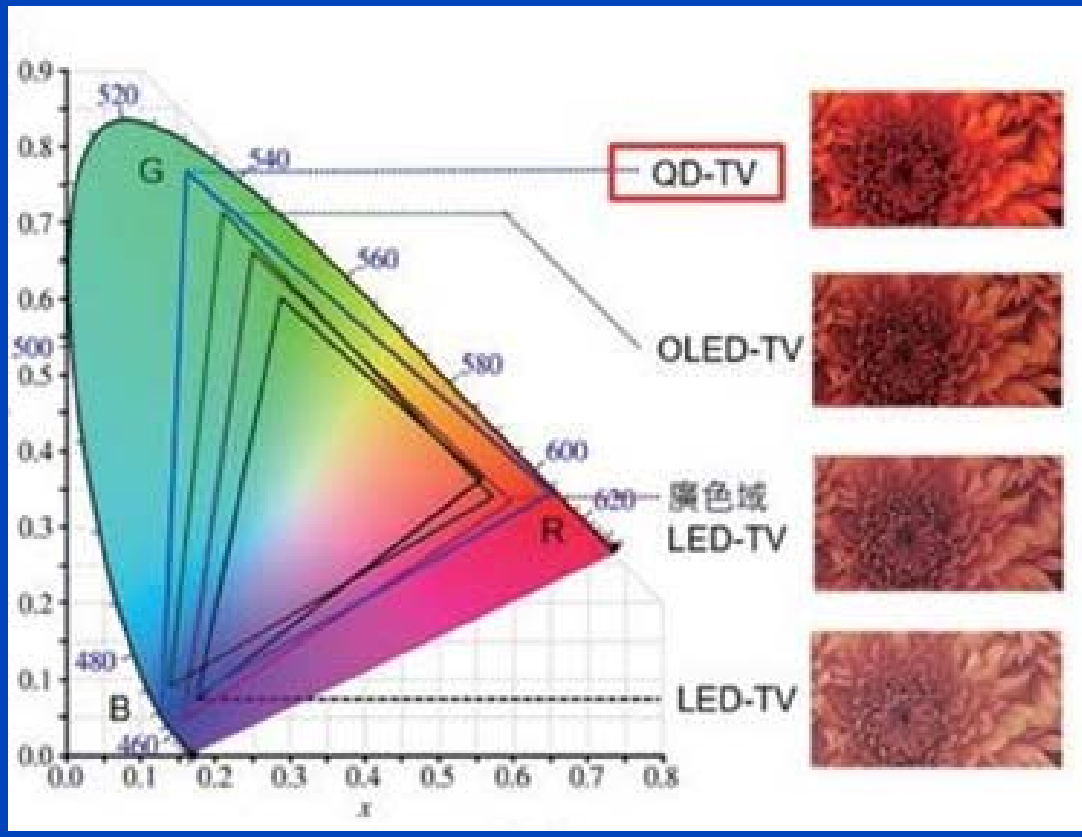


Typical FWHM of LED wavelength



1, The FWHM will affect the color purity,

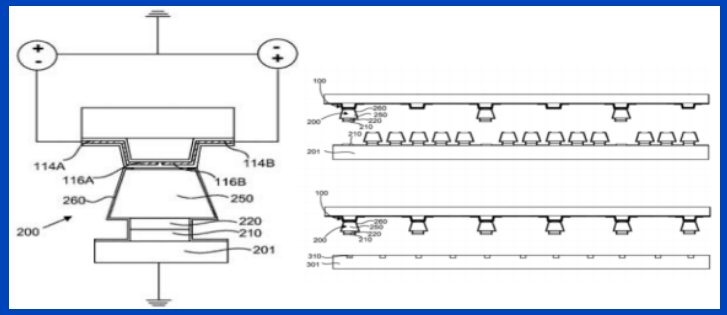
2. Wavelength changes under different current, causing chromatic aberration



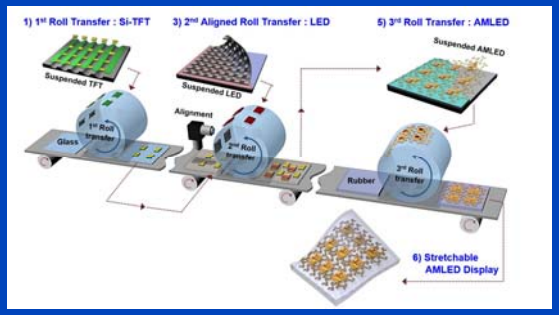
From Taiwan Industrial Technology Research Institute

➢ 3. The challenge of Micro LED & Mini LED Display

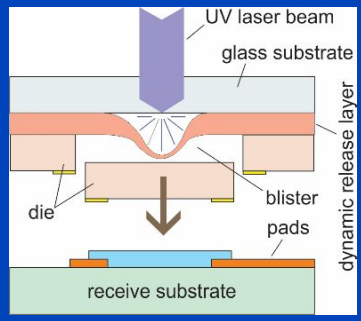
3.4 Mass transfer



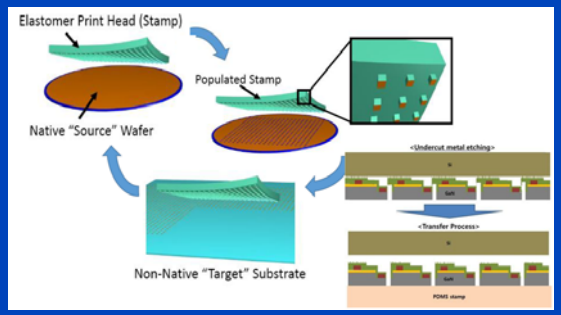
Electrostatic adsorption



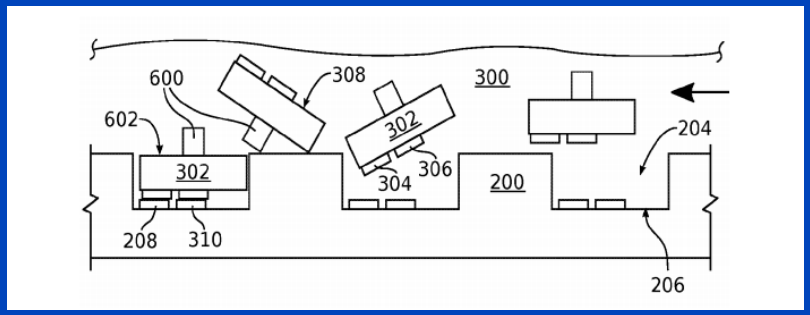
Roll to roll transfer



Laser transfer



Stamp transfer



Fluid transfer

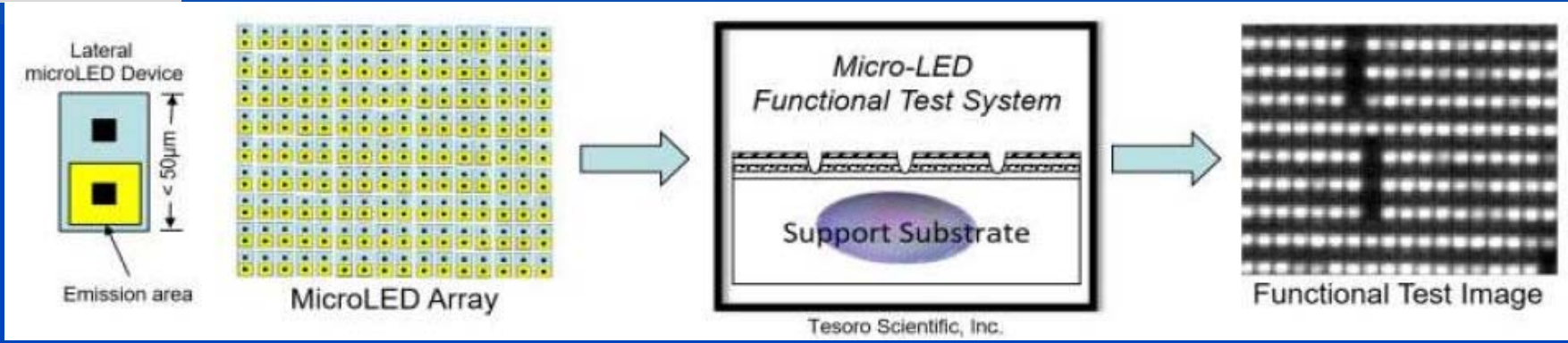
1, transfer accuracy
2, efficiency
3, yield
4, cost

➢ 3. The challenge of Micro LED & Mini LED Display

3.5 Inspection and repair

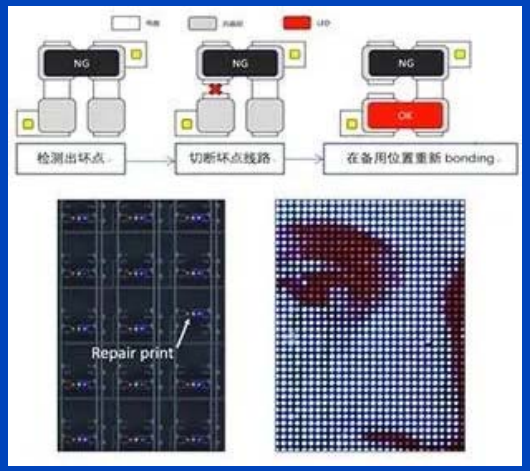
➢ Inspection
PL/EL inspection

Efficiency ???

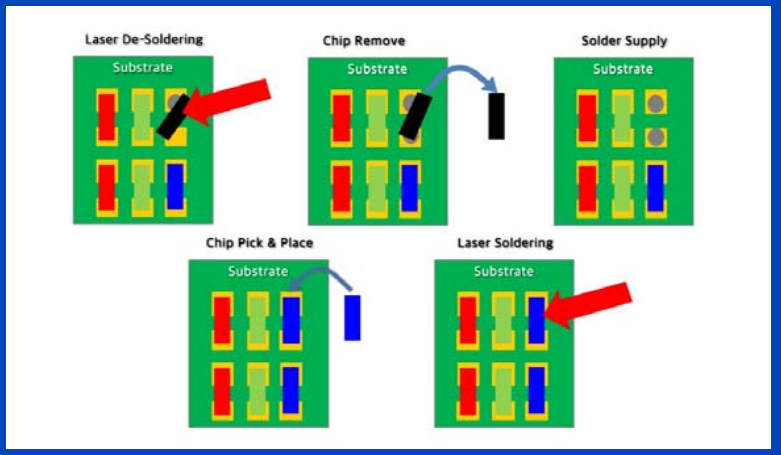


➢ Repair
- Redundant circuit
- Laser repair

Mass repair ???



Redundant circuit



Laser repair

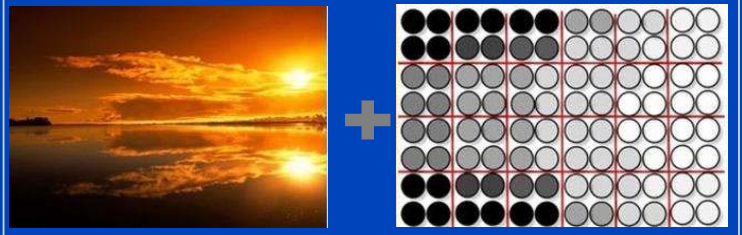
➢ 4. BOE Micro LED & Mini LED R&D

□ 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



LCD Panel　　Mini-LED BLU

- ✓ Significantly improve the display quality of LCD products through Mini-LED BLU (local dimming zones>1000, contrast ratio 1 million:1, brightness ≥1000nit)

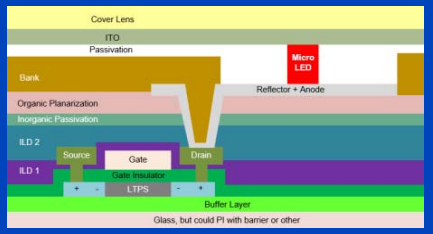
MiniLED Display

- ✓ Targeting glass-based PM display to realize large-size seamless splicing display, mass production in 2021

- ✓ Realize full-area dispaly 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

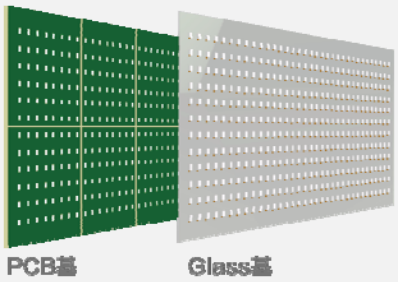


- ✓ LTPS BP+Micro LED

➢ 4.1 BOE Mini LED B/L

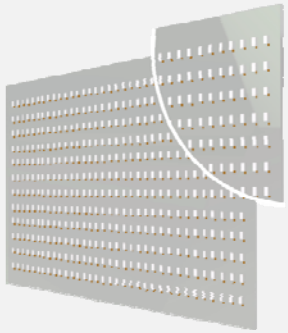
- **BOE Mini LED backlight technology is low-cost Glass based, high brightness, high partition, full-size or less splicing, and high transfer efficiency.**

Integrated light board design



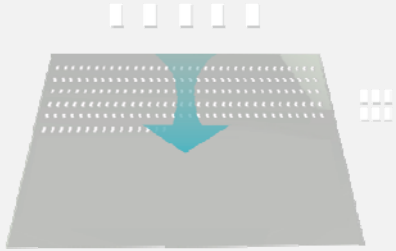
Slim designFull page, less splicing
Low warpage
High stability and reliability

AM driving



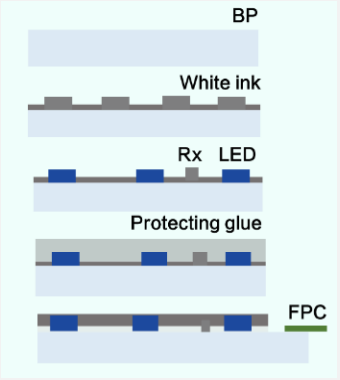
Ultra-high Peak brightness1000nit+
Excellent thermal conductivity: low resistance metal Cu
1000~5000+ local dimming zones

high transfer efficiency



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

Process



Low-cost Glass based

➢ 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

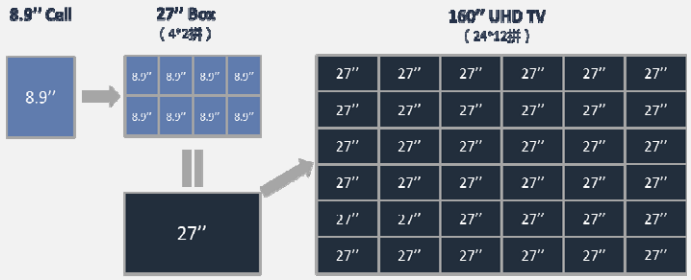
TV 75”
(BOE IPC2020)

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

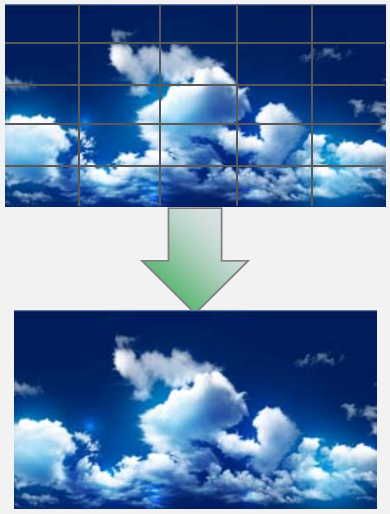
- **BOE Mini LED display technology is seamless splicing, high brightness, and flicker-free.**

Arbitrary splicing



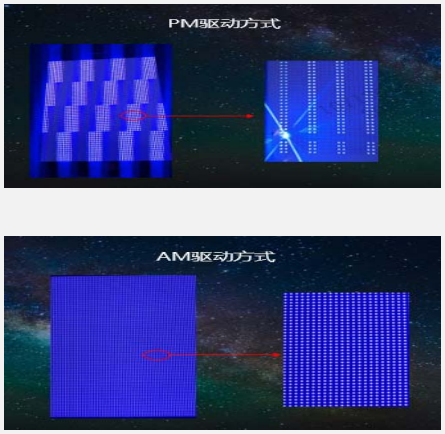
Slim design
Low warpage
High stability and reliability

seamless splicing



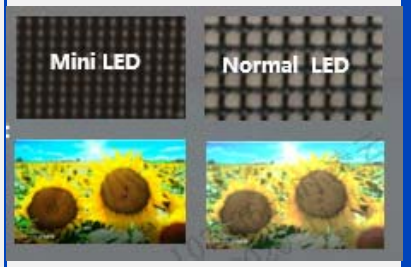
Double-sided process

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 0.9
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.

EPIC European Photonics Industry Consortium

ISA International SSL Alliance

BOE

THANKS

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