

MINILED FOR DISPLAY APPLICATIONS: LCD AND DIGITAL SIGNAGE

MARKET & TECHNOLOGY REPORT - OCTOBER 2018

MiniLEDs bring new strength to LCD players in the battle against OLED and enable increased LED adoption on digital signage.

KEY FEATURES

- Detailed analysis of miniLED technologies in two major display applications: high performance LCD and narrow pixel pitch LED direct view display digital signage.
- Key players and supply chain
- Detailed LCD segment analysis and forecast: TV, smartphone, monitor, automotive
- Device volume forecast
- Direct view LED display forecast for Surface Mounted Device (SMD) and Chip On Board (COB) technologies and by pixel pitch
- Cost aspects
- LED epiwafer volume forecast

OBJECTIVES OF THE REPORT

Understand miniLED display technologies:

- Benefits and drawbacks vs other display technologies
- Key technology bricks and associated challenges, cost drivers.
- Technology roadblocks

LED by established LEDs, which applications could miniLED displays address and when?

- Detailed analysis and roadmaps for major display applications
- Cost analysis
- How disruptive are they for incumbent technologies?

Competitive landscape and supply chain:

- Identify the key players
- MiniLEDs' impact on the LED and display supply chains

MINILEDs AND MICROLEDs: DIFFERENT TECHNOLOGIES FOR DIFFERENT APPLICATIONS

The excitement about microLEDs has grown exponentially since Apple acquired technology startup Luxvue in 2014. All major display makers have now invested in the technology and other semiconductor or hardware companies such as Intel, Facebook Oculus or Google have joined the pool.

Amidst this flurry of news and activity, a new term emerged in early 2017: miniLED. The technology is often described as a stepping stone, bridging the technology and application gap between traditional LEDs and microLEDs. However, there is no commonly accepted definition of either term. As the names suggest, size is a critical aspect. Building on a consensus from the many companies surveyed, microLEDs are typical below 50µm along their sides, although the bulk of the activity is skewed toward the smaller dimensions, typically in the 3-15µm range. By default, miniLEDs fill the size gap between microLEDs and traditional LEDs. But more than size, the technology and manufacturing infrastructure requirements and the applications differentiate the two. While microLEDs require

major technology breakthroughs in assembly and die structure, as well as a significant overhaul of the manufacturing infrastructure, miniLED chips are just scaled-down traditional LEDs. They can be manufactured in existing fabs with no or little additional investment.

On the application side, microLEDs' promise lays in the realization of disruptive, high pixel density self-emissive displays, while miniLEDs can be used to upgrade existing Liquid Crystal Displays (LCDs) with ultra-thin, multi-zone local dimming backlight units (BLU) that enable form factors and contrast performance close to or better than Organic Light Emitting Diodes (OLEDs). On the business-to-business side, miniLEDs are promising for the realization of cost-effective, narrow pixel pitch LED direct view displays used in digital signage applications such as in retail, corporate and control room applications.

The report discusses the different chip structures considered for the various applications.



MINILED ADOPTION IS FIRST DRIVEN BY HIGH-END LCD DISPLAYS

For smartphone applications, miniLEDs are facing a strong incumbent in OLEDs, as their cost to performance ratio has already gained the technology a strong position in high-end/flagship segments.

OLED is expected to further increase its share and become dominant as the number of suppliers and global capacity increase dramatically over the next five years and cost continues to drop.

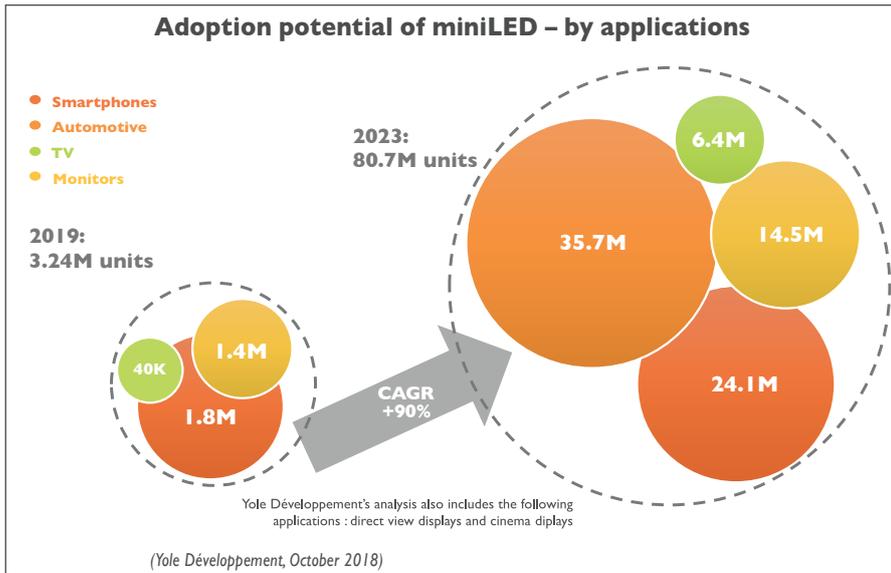
MiniLEDs, however, have a card to play in various small to mid-size high added-value display segments, where OLEDs have been less efficient at overcoming its weaknesses such as cost, lack of availability and longevity issues such as burn-in or image retention. In tablets, laptops and high-end monitors for gaming applications, miniLEDs could bring excellent contrast, high brightness and thin form factors at lower cost than OLEDs. The automotive segment is especially compelling, first because of its strong growth potential in terms of volume and revenue, and also because miniLEDs can deliver on every aspect auto-makers are aspiring to: very high contrast

and brightness, lifetime, conformability to curved surfaces and ruggedness. Regarding the last point on ruggedness, miniLED offers significant benefits over OLEDs since they only use proven technologies, LED backlights and liquid crystal cells, not much different from already established LCDs. Automakers therefore don't have to make a leap of faith and hope the new technology will meet the demanding lifetime, environmental and operating temperature specifications they require.

On the TV side, miniLEDs could help LCDs bridge the gap and regain market share against OLEDs on the high-end, large sizes above 65", and most profitable segments. This opportunity is all the more enticing to panel and display makers that have not invested in OLED technologies and see the potential to extend the lifetime and profitability of their LCD fabs and technologies.

For direct view LED displays, miniLEDs used in conjunction with Chip On Board (COB) architecture could enable higher penetration of narrow pixel pitch LED displays in multiple applications, hence increasing the serviceable market. Die size will evolve continuously toward smaller dimensions, possibly down to 30-50µm in order to reduce cost. Adoption in cinema is still highly uncertain but even modest adoption rates would generate very significant upsides.

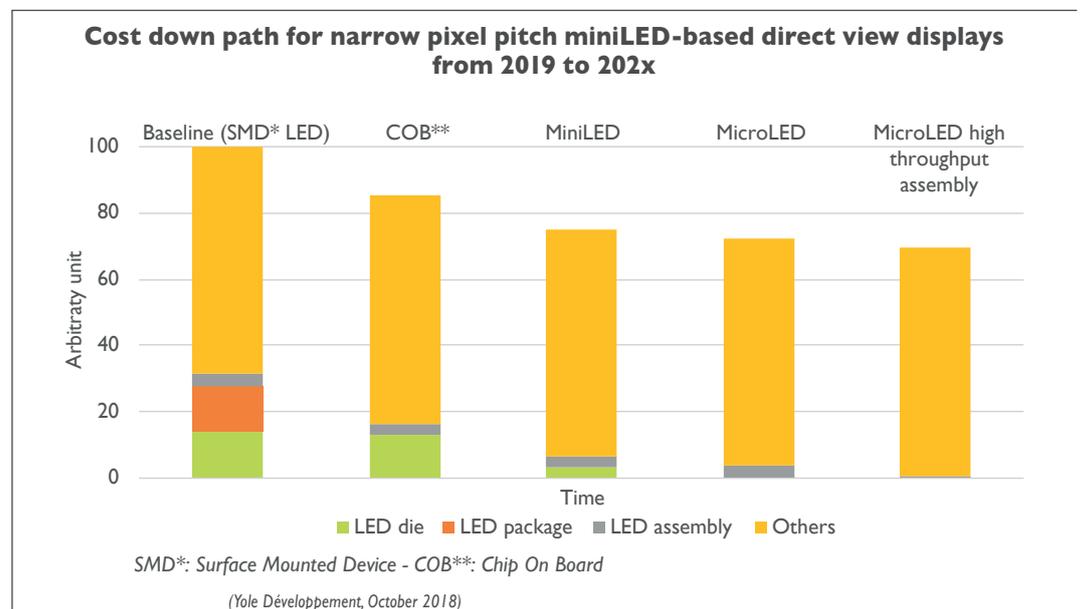
The report provides detailed adoption and volume forecasts for each application.



INCREMENTAL INNOVATIONS AND LIMITED INVESTMENTS – BUT SUPPLY CHAIN DISRUPTIONS

Unlike microLEDs, which require sizable investments, miniLEDs can be manufactured by established LED chip makers in existing fabs without any major investments. Yet they have the potential to create major disruptions by essentially eliminating LED packaging companies from the LCD as well as the large LED video-wall digital signage supply chains.

For many major LED packagers, those applications represent a significant fraction of their revenue. The most exposed are reacting quickly by either moving up the supply chain and offering full miniLED backlight modules, such as Refond and Lextar, or by developing new innovative packages that still allow them to surf the miniLED wave. For example, companies such as



Harvatek or Nationstar’s new “4-in-1” Surface Mount Device (SMD) packages allow LED direct view display makers to alleviate a critical obstacle for miniLED adoption: the need to retool and transition from an SMD to a direct die bonding assembly philosophy.

MiniLEDs should benefit chip makers by increasing their available market. Some are trying to cash in on the opportunity and move up the supply chain by offering miniLED packages and/or BLU modules. For example, Epistar is spinning off but keeping control of its miniLED activities.

A remaining question is how fast equipment makers will develop new generation of miniLED-specific assembly tools that will help speed up adoption by reducing manufacturing costs. Key attributes for such tools are much higher throughput and the ability to handle smaller dies, 100µm or smaller. Various routes are investigated, including upgrade of traditional

die assembly technology or more disruptive processes inspired from the vast body of work and technologies being developed for microLEDs. The first to market is Kulicke & Soffa which recently introduced a tool co-developed with startup Rohinni.

The availability of tools capable of efficiently handling smaller dies will in turn enable LCD and LED direct view display makers to further reduce cost by reducing the die size to the smallest level required for each individual applications.

Ultimately, for most of the targeted segments, miniLEDs offer performance close to the incumbent technologies like OLED for high-end consumer displays and SMD LEDs for narrow pitch digital signage. Cost will therefore be a major driver or showstopper for adoption.

The report discusses the major cost contributors and cost-down paths.

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