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Effect of Micro Light Emitting Diode for Electronic Device Display Use

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ABSTRACT

WriteAs visual display technology advances, the demand for high-quality, energy-efficient displays continues to rise. Consumers and manufacturers are looking for innovations that offer superior image resolution while minimizing power consumption. OLED (Organic Light Emitting Diode) has dominated the display market for decades, known for its deep black color, low power usage, and elimination of backlighting. However, OLEDs still face challenges in terms of long-term energy efficiency and display durability. In response, Micro Light Emitting Diode (Micro-LED) has emerged as the next-generation display technology. Micro-LEDs use microscopic LEDs as a direct light source, eliminating the need for a backlight and resulting in higher brightness, sharper contrast, faster response time and longer lifetime. They also have an ultra-thin, integrated design and exhibit strong resistance to extreme temperatures and humidity. These advantages make Micro-LED a promising candidate to replace OLED as the future standard in display technology. With its optimal combination of visual performance, energy efficiency, durability, and design flexibility, Micro-LED is a major advancement that is poised to reshape the display industry.

1. INTRODUCTION

As visual display technology develops, the need for screens with high quality and good energy efficiency is increasing. Consumers and manufacturers of electronic devices are looking for display technologies that are able to present superior quality image resolution, but have low power consumption.For about decades, OLED has dominated the display market (Parbrook et al., 2021). OLED is a screen that has a panel of organic elements that can emit light when electrified. In general, OLED is widely used in television and smartphone devices because it has several advantages, including lower power consumption, the ability to produce deeper and deeper black colors, and does not require a backlight to display images (Ismail et al., 2022). However, although OLED has several advantages, it also still has several shortcomings, especially in terms of the quality listed in table 1 and its energy efficiency is still not very optimal.

As a response to the limitations possessed by OLED technology, these limitations can encourage the development of new display technologies that are superior, one of which is Micro light Emitting Diode (Micro-LED). Micro Light Emitting Diode (Micro-LED) technology is seen as a new generation in display technology, Micro Light Emitting Diode is a display technology that uses millions of micrometer-sized light-emitting diodes as a direct lighting source without the need for backlight like LCD. As time goes by, electronic devices tend to lead to designs that are thinner, smaller, and more efficient. Micro Light Emitting Diode presents several advantages in the form of a high degree of miniaturization, has a thin and integrated design, and has advantages in brightness, contrast, very fast response, and long life (Zhang et al., 2023). Micro LED displays have received great interest due to their excellent properties compared to OLEDs such as high light efficiency, fast response time, low power consumption, wide operating temperature, high water-oxygen, and long lifetime (Parbrook et al., 2021).

Over time, the need for high-quality, energy-efficient displays that are increasingly compact in size has led to innovations in display technology. Micro-LED comes as a potential solution that is able to cover some of the limitations of previous technologies such as OLED. with a high level of miniaturization. superior light efficiency, fast response time, low power consumption and long service life, Micro-LED shows an optimal combination of visual performance, energy efficiency, and design flexibility. Therefore, Micro-LED as a technology that can replace conventional display technology and become a new standard in the future display industry.

2. METHODS

This article was compiled using a literature study approach, presented descriptively and comparatively, based on 40 international scientific journals. The journals selected are from reputable and credible publishers that provide a comprehensive discussion of Micro-Light Emitting Diode (Micro-LED) technology. The aspects covered include materials, advantages and disadvantages, material classification, efficiency, specifications, characteristics, manufacturing processes, implementation in electronic devices, and current challenges in Micro-LED technology.

Data collection was conducted by searching and filtering scientific articles through online databases such as ScienceDirect, MDPI, and others. The selection was based on topic relevance, publication year, and the required technical specifications. The analysis was conducted by categorizing journal findings into key themes, including classification, working principles, materials, advantages and disadvantages, material classification, efficiency, specifications, characteristics, manufacturing processes, and implementation in electronic devices. Data compilation and presentation were carried out collaboratively by all group members. Each piece of data presented in this article is supported by relevant journal citations, organized systematically through scientific explanations and comparison tables to reinforce the discussion.

In practice, each member was responsible for different subtopics, such as constituent materials, working mechanisms, and the Micro-LED manufacturing process. This division of tasks ensured that all aspects of Micro-LED technology were thoroughly explored and well-structured. This article focuses specifically on Micro-LED technology to provide a more in-depth, systematic, and relevant analysis aligned with the title and theme. The selection of this topic is based on the growing relevance of Micro-LEDs as a next-generation display technology, known for their high energy efficiency and display quality in electronic devices.

3. RESULTS

3.1 Definition of Micro-Light Emitting Diode in electronic device

Micro Light Emitting Diode (Micro-LED) technology is seen as a new generation in display technology. Micro Light Emitting Diode is a display technology that uses millions of micrometer-sized light-emitting diodes as a direct lighting source without the need for backlights such as LCDs, the characteristics of Micro Light Emitting Diodes are high levels of miniaturization, have a thin and integrated design, and have advantages in brightness, contrast, very fast response, and long life (Zhang et al., 2023). Micro Light Emitting Diode still has many obstacles ranging from material growth, device design, display modules, assembly techniques, to system integration because many technical fields must be developed and improved and even revolutionized to meet the needs such as the level of accuracy and performance required by (Micro-LED) (Lin et al., 2023). Compared to LEDs or OLEDs, GaN-based Micro-LEDs promise superior brightness and color accuracy. This is due to the Micro-LED's ability to produce direct light emission without the need for a backlight or color filter, resulting in more saturated colors and higher contrast quality, GaN also provides thermal and chemical stability that enables consistent visual performance over the long term (Bandari & Schmidt, 2024).

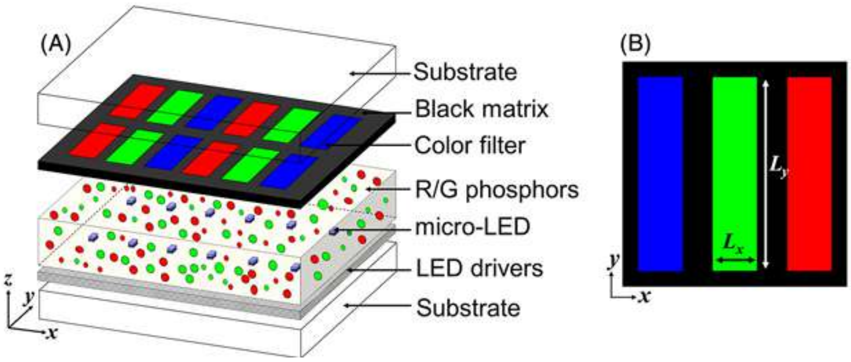

Figure 1. Micro-Light Emitting Diode
Source: (Gou et al., 2019)

3.2 Advantages and Disadvantages

Micro Light Emitting Diode The advantage of Micro Light Emitting Diode is that it has an expanded area. enables the development of direct displays from micro LEDs with illumination which is as high as 50,000,000 cd/m2 per LED because the micro LEDs are separated individually. special so that it produces lower lighting. With low measurement, the tile display becomes smaller and makes the display higher resolution. (V. W. Lee et al., 2016). These so-called micro LEDs have many potential benefits, including use in 2D arrays for high-resolution displays and micro LEDs can also be switched very quickly, providing a degree of tential modulation that can otherwise only be achieved with laser diodes (Parbrook et al., 2021). Here is a comparison table between OLD and also Micro LED.

Table 1. Comparison of LCD, OLED, and micro-LED metrics.

Display Technology	Micro-LED	OLED
Emission mechanism	*High (≈100 lm W−1)*	*Self-emissive*
Luminous efficacy	*Low (≈20 lm W–1)*	*Low (≈20 lm W–1)*
Color gamut	*>100%, NTSC*	*>100%, NTSC*
Luminance	*>1×10^5 nits (full color >1×10^6 nits (blue/green) ≈10^7 nits (blue)*	*≤2×10^3 nits (full color) ≈10^3 nits (yellow)*
Contrast ratio (CR)	*→10000:1 −CR=infinity*	*→10000:1 −CR=infinity with peak brightness of 600 nits for OLED TV*
Response time	*ns*	*ms*
MPRT(AMdisplay)b)		
Power consumption	*−Low (10% of LCD)*	*−Low (20% of LCD)*
Operating temperature	*−100–120 °C*	*−50–70 °C*
Resolution	*Max. 5000 PPI [174]*	*−3200 PPI*
(Commercial and/or research-based values)		*−5644 PPI for μOLED (CR: >100 000:1)*
Lifetime	*Long*	*Medium*
Cost	*High*	*Low*

Source: **(Parbrook et al., 2021)**

3.3 Micro-Light Emitting Diode components

Micro-light emitting diode (micro-LED) is a new generation display technology that uses inorganic semiconductor materials, mainly based on group III-nitride materials such as Gallium Nitride (GaN), Indium Gallium Nitride (InGaN), and Aluminum Gallium Nitride (AlGaN). GaN serves as the base material that enables high efficiency in the emission of blue and green light, while InGaN is used to tune the emission wavelength to precisely produce other colors (Mishra et al., 2024).

3.3.1 Gallium nitride (GaN)

Gallium Nitride (GaN) has driven high-performance optoelectronic devices, such as LEDs, laser diodes, and electronic devices such as radio frequency transistors and power devices since the 1990s (Zhao et al., 2023). Gallium Nitride (GaN) is a third-generation semiconductor material, this material has important applications in devices with high temperature, high frequency, and high power (Liang et al., 2025). GaN is known for its ability to conduct electricity with very high efficiency, and has resistance to extreme conditions. These advantages make GaN a superior material compared to conventional semiconductor materials such as (Si), especially in the field of electronic devices. This is because the characteristics of GaN which have higher penetration strength and good thermal conductivity allow GaN-based devices to operate faster, more efficiently, and last longer (Zhong et al., 2022)

3.3.2 Indium Gallium Nitride (InGaN)

Indium Gallium Nitride (InGaN) is a semiconductor composed of indium nitride (InN) and gallium nitride (GaN). According to research conducted in 2002, InN has a band gap energy of approximately 0.64 eV, which is significantly lower than the previously accepted value of around 1.9 eV. This discovery expands the direct band gap range of InGaN materials—from the ultraviolet region (about 3.42 eV for GaN) to the near-infrared region (about 0.64 eV for InN)—enabling nearly perfect matching with the full solar spectrum under air mass 1.5 conditions. InGaN also exhibits several other advantageous properties, including high thermal stability, radiation resistance, high saturation velocity and charge carrier mobility, and strong light absorption (Zhao et al., 2023). InGaN-based micro-LEDs (μLEDs) have garnered significant attention for next-generation high-performance display applications, such as large-area displays and smart wearable electronic devices (Zhuang et al., 2021).

3.3.3 Aluminium Gallium Nitride (AlGaN)

Aluminum Gallium Nitride (AlGaN) is a semiconductor material composed of aluminum (Al) and gallium nitride (GaN). AlGaN has crystal structures similar to those of GaN and aluminum nitride (AlN), namely the wurtzite (WZ), zinc blende (ZB), and rock-salt structures. At room temperature and atmospheric pressure, the WZ structure is the most stable form of AlGaN, as the metal atoms are tightly arranged in a hexagonal configuration and the nitrogen atoms are closely packed (Li et al., 2018). AlGaN-based micro-LEDs, with sizes ranging from 3 μm to 100 μm, were fabricated using commercial epitaxial wafers (TES) (Feng et al., 2024).

3.4 Applications

LEDs are widely used as light sources for liquid crystal displays (LCDs) of various sizes, ranging from 100-inch TVs to 0.5-inch microdisplays (V. W. Lee et al., 2016). Like Micro-LEDs, OLEDs are also used in LCDs, but due to limitations in material understanding and the ability to produce them in large quantities, OLEDs are not as popular as LCDs in the consumer electronics market (Chen et al., 2018). Since the emergence of Micro-LED display technology, many investors and companies have been keen to develop display technologies such as Micro-LED (Anwar et al., 2022). Around 2012, a Japanese smartphone brand introduced the first 55-inch full HD Micro-LED TV. In 2014, several well-known brands began developing Micro-LED-based displays that are well-suited for future products, which could significantly increase the popularity and influence of Micro-LED displays. Meanwhile, in

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Vol 1, No 2, December, 2025, pp. 26-40

2022, Seoul Viosys from South Korea showcased Micro-LED-based displays measuring 54 inches and 81.5 inches, with pixel pitches of 625 μm and 937.5 μm, respectively. Based on the stacked Micro-LED structure, these displays can be used to produce 4K displays ranging from 100 to 200 inches in size (Zhang et al., 2023).

According to market research firm Research and Markets, the global market value of Micro-LED-based displays is expected to surge from USD 0.6 billion in 2019 to USD 20.5 billion in 2025, with an average annual growth rate of around 80%. The rapid growth of this market is driven by the increasing need for display panels that have high brightness levels while remaining efficient in energy consumption. The demand mainly comes from modern devices such as smartwatches, mobile phones, televisions, laptops, and augmented reality (AR) and virtual reality (VR) based devices (Zhang et al., 2017). Based on Yole's optimistic projections, the market volume of micro-LED displays is expected to reach 330 million units by 2025 (Wu et al., 2018).

Figure 2. Predictions regarding the advancement of micro-LED display technology.
Source:(Wu et al., 2018)

3.5 Classification

Classification is carried out by grouping several key factors into categories, including how light emission works, pixel size and integration, and energy consumption efficiency.

3.5.1 How to Emit Light

The generation of light emission (photons) occurs through a recombination process between electrons and holes within the Micro-LED structure. This process primarily takes place in the quantum well-based structure, typically composed of InGaN or GaN, which plays a crucial role in facilitating efficient recombination. When an electric current is applied, electrons from the n-type layer and holes from the p-type layer are injected into the active layer, where their recombination releases energy in the form of photons (light). Quantum wells enhance this efficiency (Mishra et al., 2024).

The high operating current density in Micro-LEDs reduces the lifetime of charge carriers, allowing light emission to occur at high speeds. This characteristic supports the use of Micro-LEDs in visible light communication applications (Xie et al., 2017). During the emission period, current flows directly from the positive voltage source to the negative terminal, causing light to be emitted directly from the LED chip. Emission efficiency is further improved through engineering of the electron generation layer and optimization of the metal contact in p-type GaN (Jung Hun Choi et al., 2020).

3.5.2 Pixel Size and Integration

The pixel size and integration of Micro-LEDs are crucial in the development of high-resolution electronic displays. Typically, Micro-LEDs have an LED chip size of less than 100 µm. Recent studies have successfully achieved pixel densities of up to 5100 PPI (Zhang et al., 2023). Integration techniques such as flip-chip bonding and pick-and-place are commonly employed in Micro-LED fabrication. A recent innovation involves the successful combination of Micro-LED arrays with CMOS transistors using flip-chip technology, enabling a pixel pitch as small as 20 µm while maintaining high brightness and efficiency (V. W. Lee et al., 2016).

Despite their small size and high level of integration, micro-LEDs are well-suited for high-resolution displays. One of the key challenges in the pixel integration process is the precise transfer of micro-scale chips onto the target substrate. High accuracy is essential to ensure both speed and precision in chip placement, particularly when using carrier printhead and cartridge methods. For applications such as 4K high-resolution displays, precise placement of 1 µm chips at a transfer rate exceeding 100 million chips per hour, with a yield above 99.9999%, is required (Z. Chen et al., 2021)

3.5.3 Energy Efficiency and Consumption

Micro-LEDs have good efficiency and energy consumption compared to conventional displays. Measured through wall-plug efficiency (WPA), it is the ratio of the light power generated to the electric power used. This efficiency is affected by the chip's external quantum (EQ) and forward voltage (VF). Although the chip EQ value can be more than 80% for large size chips, Micro-LEDs below 50µm in size experience a decrease in efficiency due to the effects of chip-side emissions and its light limitation (Huang et al., 2020). The use of chips with certain settings can save power consumption up to 30-40% with an additional 12% efficiency. Achievement can be obtained by adjusting the size of the RGB chip differently. The use of PWM or Pulse width modulation can maintain operation at the optimal EOQ point, along with engineering the structure of the LED chip can also improve the power efficiency of Micro-LEDs (Hsiang et al., 2020).

The stability of brightness during device operation significantly affects the efficiency of Micro-LED displays. At high intensities, especially when current is flowing, fluctuations in brightness can occur due to internal voltage drops in the thin-film transistors. A SWEEP signal-based high-precision control system operating in a voltage range of 0 to 9 V and divided into 4096 steps represents an effective approach to address this issue. The high precision enables the system to maintain consistent color and brightness quality despite variations in temperature and current during operation (Y. Chen et al., 2023)

3.6 Mechanism of Action

E-ISSN XXXX-XXXX | P-ISSN XXXX-XXXX
Vol 1, No 2, December, 2025, pp. 26-40

The working principle of micro-LEDs is based on the electron-hole pair recombination process that occurs when an electric current is passed through the LED chip. This current flows from the voltage source (VDD) to the negative terminal (VCom), causing electrons and holes to be injected into the active layer of a semiconductor, such as InGaN/GaN, where they recombine and produce photons as a form of light emission (Jung Hun Choi et al., 2020). This mechanism belongs to the process of electroluminescence, and is highly relevant to the principle of charge and energy transport in semiconductor materials and due to the very small chip size and high current density, the life time of the charge carriers is very short, improving the modulation capability and temporal efficiency of the micro-LED element (Xie et al., 2017).

One of the advantages of Micro-LEDs is their structure, which allows high current density flow without significant temperature rise. This is due to their low series resistance and minimal self-heating effects, which contribute to the structural benefits of Micro-LEDs. Generally, Micro-LEDs have a basic structure that adopts a configuration consisting of an n-GaN layer, an InGaN/GaN-based multiple quantum well (MQWs) layer and a p-GaN layer (Tian et al., 2016).

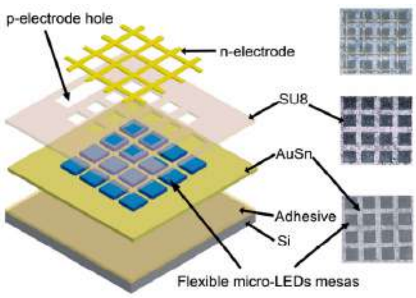

Figure 3. Flexible Micro-LED fabrication process flow.

Source:(Tian et al., 2016)

3.7 Micro-LED Technical Specifications

Micro-LEDs have person Driven sizes of less than 100 micrometers with amazingly tall pixel thickness, empowering show resolutions of up to 2K to 8K in a compact physical measurement. Its most extreme brightness level can surpass 1000 nits, indeed coming to 5000 nits in a few models, with a different proportion near to 1,000,000:1 due to its self-emitting nature. The control proficiency of Micro-LED is higher than that of OLED, because it does not require color filters or backlights, and includes a luminance effectiveness of almost 30-70 lm/W, depending on the fabric arrangement. It underpins revive rates over 120 Hz and exceptionally moo inactivity. In terms of lifetime, Micro-LED shows tall warm resistance and long-term stability with a lifetime of more than 100,000 hours. The burn-in resistance is additionally exceptionally great. Mechanically, Micro-LEDs can be created on adaptable substrates, but the manufacture process-especially the mass exchange and arrangement of millions of Driven chips-remains a major technical challenge. Micro-LEDs have working temperatures between -100 ◦C and 120 ◦C and have reaction times within the nanosecond (ns) extend (Zhang et al., 2023).

3.8 Micro LED Characteristics

E-ISSN XXXX-XXXX | P-ISSN XXXX-XXXX
Vol 1, No 2, December, 2025, pp. 26-40

Micro-LED is a cutting-edge display technology that offers several advantages over conventional display technologies such as OLED and LCD. One of its main advantages lies in its extremely small pixel size of around 35 μm, which enables ultra-high pixel densities of up to 10,000 PPI. This makes micro-LED ideal for high-resolution display applications such as augmented reality (AR) and virtual reality (VR) (Huang et al., 2020). In addition, micro-LED has an extraordinary brightness level of up to 100,000 cd/m² and an ultra-fast response time of around 0.2 nanoseconds, enabling extremely sharp and ghosting-free visual performance, especially in dynamic content. Its high power efficiency is an additional advantage, making it more energy efficient than other display technologies.

In addition, the operational life of micro-LEDs is very long, exceeding 10 years even under intensive use conditions (Liu et al., 2023). This technology also has infinite contrast and a wide color gamut, even approaching or exceeding the Rec.2020 standard, making it suitable for both professional display and immersive entertainment purposes. These advantages are made possible by the LED structure made of InGaN material and advanced optical engineering such as the use of distributed Bragg reflectors (DBR), as well as modern passivation techniques such as atomic layer deposition (ALD) that improve device efficiency and stability.

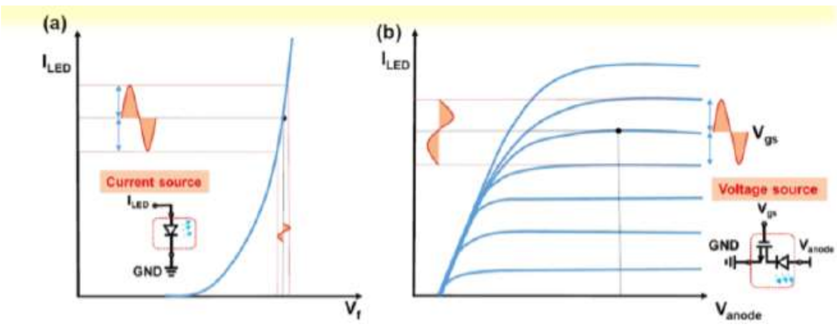

Figure 4. (a) Traditional voltage biasing technique used in LED operation and (b) the newly introduced biasing approach specifically designed for operating a single micro-LED.

Source: (Cai et al., 2021)

3.9 Characteristic Challenges

In spite of the fact that smaller scale light-emitting diodes (micro-LEDs) offer incredible potential in next-generation show advances, there are a number of critical characteristic challenges that ruin their far reaching selection. One of the major challenges is the diminish in outside quantum productivity (EQE) with diminishing chip measure. When the micro-LED chip estimate is decreased to underneath 10 μm, the circumference-to-area proportion increments, causing harm to the side dividers amid the plasma carving handle. This harm creates noteworthy non-radiative recombination centers, which definitely decrease the EQE of the gadget (Liu et al., 2025). For illustration, the greatest EQE can diminish from approximately 10% to 5% when the chip measure is diminished from 500 μm × 500 μm to 10 μm × 10 μm.

In addition, the complex and high-precision fabrication process of micro-LEDs, including plasma etching and chip mass transfer, presents additional challenges. Damage to the wall surface that occurs during the plasma etching process can cause distortion of the lattice structure and material contamination, which then become leakage paths and centers of non-radiative Shockley–Read–Hall (SRH) recombination. This impacts the device's efficiency. Additionally, the size effect plays a significant role in influencing the luminous efficiency and external quantum efficiency (EQE) of micro-LEDs.. For example, while conventional blue LEDs can achieve an EQE of up to 80%, reducing their size to 5–10 μm typically results in an EQE of less than 20% during practical operation. This reduction is primarily attributed to sidewall damage induced by dry plasma etching. Mitigation strategies include the use of passivation coatings such as atomic layer deposition (ALD) and the implementation of superlattice structures to stabilize the surface and suppress non-radiative recombination (S. L. Lee et al., 2021).

3.10 Micro-LED Fabrication Process

The creation of smaller scale light-emitting diodes (micro-LEDs) incorporates a few fundamental stages that are exceptionally complex and require tall accuracy to guarantee proficiency and quality of the ultimate result. The starting organize begins from epitaxial development, where a III-V semiconductor layer such as gallium nitride (GaN) is developed on a inflexible substrate such as sapphire, silicon (Si), or silicon carbide (SiC) utilizing the Metal-Organic Chemical Vapor Testimony (MOCVD) strategy. This strategy permits exact development control to create high-quality precious stones (Seo et al., 2025). Advancements such as farther epitaxy by embedding two-dimensional layers such as graphene have moreover been created to encourage the lift-off handle without relinquishing gem quality. After the Driven layer is shaped, a partition (lift-off) prepare is carried out from the substrate, which can be done by means of Laser Lift-Off (LLO), Chemical Lift-Off (CLO), or Mechanical Lift-Off (MLO), each with its claim points of interest and challenges in keeping up the keenness of the Driven structure.

Once effectively isolated, micro-LEDs are transferred onto a target substrate—either flexible or transparent—using various transfer techniques. The pick-and-place method offers high precision for individual LED placement, but is less efficient for mass production (Jung Hun Choi et al., 2020). In contrast, transfer printing uses an elastomer stamp to transfer multiple LEDs simultaneously, making it suitable for high-resolution displays. For large-scale applications such as electronic skin (e-skin) or medical devices, methods like roll-to-roll and self-assembly are preferred due to their efficiency in mass production. Each step in the process significantly contributes to external quantum efficiency (EQE), structural reliability, and compatibility with large-scale system integration (Ji et al., 2018).

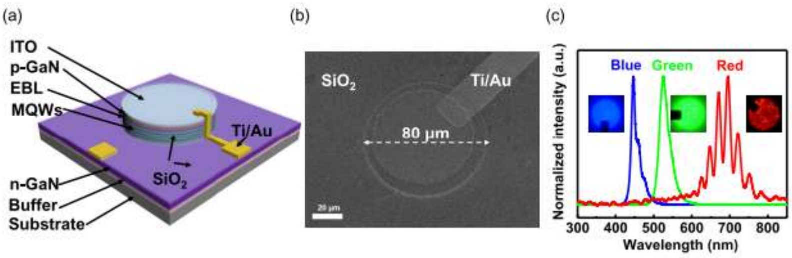

Figure 5. (a) A schematic diagram showing the structure of an RGB micro-LED chip. (b) FESEM image of a blue micro-LED with a pixel diameter of 80 μm. (c) Emission spectrum of the RGB micro-LED operated at a current density of 5 A/cm² and a temperature of 298 K. Inset: Optical microscope image displaying the light emission of the RGB micro-LED.

Source:(Wang et al., 2022)

3.11 Manufacturing Challenges

The fabrication process of micro-scale light-emitting diodes (micro-LEDs) faces significant technical challenges that hinder their mass production and commercialization. One of the primary issues is the complexity of the manufacturing process, which involves several critical stages, including epitaxial growth, chip dicing, mass transfer, bonding, and packaging. Each stage demands high precision and strict quality control to ensure optimal device performance. In particular, the mass transfer process—where millions of micro-LEDs are transferred from the wafer to the display substrate—presents a major obstacle due to the requirement for microscopic accuracy and high efficiency to enable large-scale production. Thermal control and heat management also pose challenges, especially in high-density and high-brightness displays, where heat accumulation can negatively impact performance and device longevity. Furthermore, production cost remains a significant bottleneck, given the need for high-quality materials such as Gallium Nitride (GaN) and the use of expensive, advanced manufacturing equipment (Zhu et al., 2023). Therefore, despite the promising potential of micro-LEDs in display technology, these technical and economic challenges must be addressed to enable cost-effective and scalable manufacturing.

4. DISCUSSION

Display technology continues to evolve rapidly, and Micro-LED is now emerging as a strong competitor to OLED. Both technologies have unique characteristics that make them superior in certain areas. Micro-LED also offers higher brightness, better energy efficiency, and longer durability because it does not use organic materials like OLED. Additionally, Micro-LED does not suffer from burn-in issues, making it more reliable for long-term use. Meanwhile, OLED remains the top choice for flexible and thin-screen devices due to its ability to display deep black colors and high contrast, as well as its ease in designing curved or foldable screens. However, OLED tends to have a shorter lifespan and is prone to burn-in. Over time, technological advancements have driven screen miniaturization, making display devices smaller, thinner, and lighter without compromising image quality. This opens up broader opportunities for screen applications across various fields, such as wearable devices, AR/VR, and holographic projection. Therefore, in the near future, Micro-LED is expected to be more widely used in small-sized displays with high pixel density, such as AR/VR glasses, as well as in large-scale displays like video walls for conferences, while OLED will remain dominant in portable devices and high-end televisions.

5. CONCLUSION

Micro Light Emitting Diode (Micro-LED) technology is an innovation in the field of visual displays that delivers exceptional performance in terms of brightness, contrast, color gamut, and response time, compared to traditional display technologies such as LCD (Liquid Crystal Display) and OLED (Organic Light Emitting Diode). This technology utilizes micro-sized light-emitting diodes as individual pixels, enabling the creation of high-resolution displays with optimal energy efficiency and extremely high brightness. Unlike OLED, which uses organic materials, Micro-LED is more durable because its components are less prone to degradation. Its extremely small size also provides high flexibility for application in various devices, from wearable technology to large-scale displays. These advantages make Micro-LED a strong candidate to replace LCD and OLED, and offer significant opportunities for the development of efficient and high-performance electronic devices in the future.

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