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Research Paper

OLED and QLED TV Comparative Analysis

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ABSTRACT: *QLED TV is a new television technology that is taking many of its cues from OLED TV technology. It consists of extremely small light-emitting crystals called quantum dots. Most TVs today including all of those made by companies and just about every other TV brand are based on decades-old LCD, or liquid crystal display, technology. In the past few years' Better technology and more advanced manufactured, called OLED or organic light-emitting diode. OLED TVs have the best picture quality we've ever tested, keeping LCD-only companies from achieving the coveted top positions on certain lists. At the moment a new TV display technology on the horizon called QLED, and it might be even better than OLED and LED. Short for "quantum dot light emitting devices," QLED has the potential to match the infinite contrast ratio of OLED, with better power efficiency, better color and more*

KEYWORDS: *QLED, OLED, Quantum Dot, LED, LCD*

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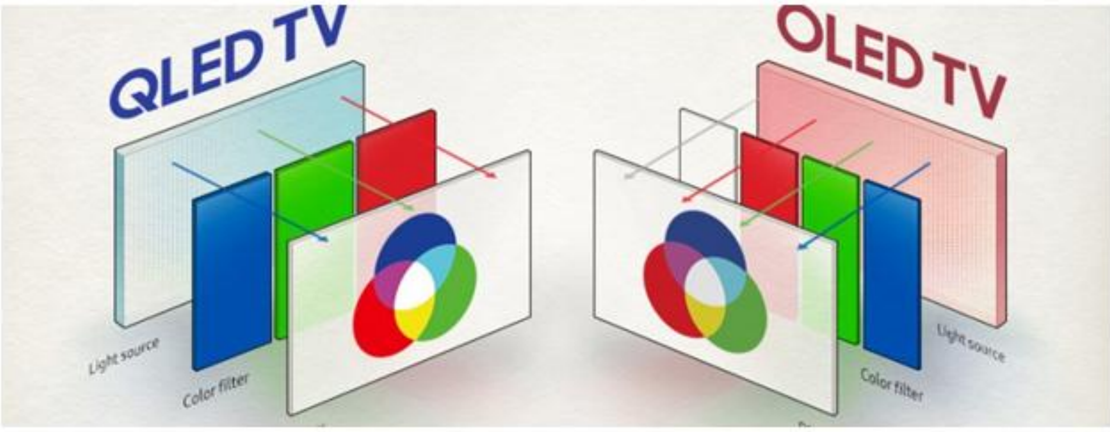
I. INTRODUCTION

Quantum Dot is composed of semiconductor materials which look like a nanocrystal sphere. These nanocrystals emit light with absorbing light due to flow of electric current. The lightning wavelength differs depending on the dot size. LCD alone is not capable of emitting its own light. There should be a light source or backlight. A LED backlight used the three basic colors-blue, green, and red in order to come up with a white color light. Recently, one of the popular LED LCD colors is blue coated with a yellowish phosphor to achieve a white light color and QD LED TV is found as a more advanced version of this. The manufacturer no longer used the blue LED with yellowish phospor, but instead they use QD particles for achieving white color. The QDLED absorbs the emitted blue light then transfer it to red and green to creating the desired white color. This process is also known for achieving an accurate LED colors. OLED is composed of organic molecules made of thin films that create light with the use of electricity. This type of lightning technology is capable of creating crisper and brighter displays on electronic devices than the traditional liquid crystal displays (LCD) and light emitting diodes (LED). Meanwhile, the Organic Light-emitting Diode (OLED) display is made of organic compound which releases light with the presence of an electric current. The pixel is capable of emitting light on its own. It only means that this type of LED display have no issues regarding backlight leaking. Thus, Organic Light-emitting Diode is different from Quantum Dot Light-emitting Diode in terms of in expressing colors. QD LED uses LCD-based technology which is slightly difficult to consider as the next generation display. However, OLED is considered as the next generation display which is transparent, flexible and roll-able. It has relatively low processing temperature suited for a plastic substrate when you wish to make a flexible display and because it does not require a backlight as compared to QD, it can be optimized in creating a transparent generation display .

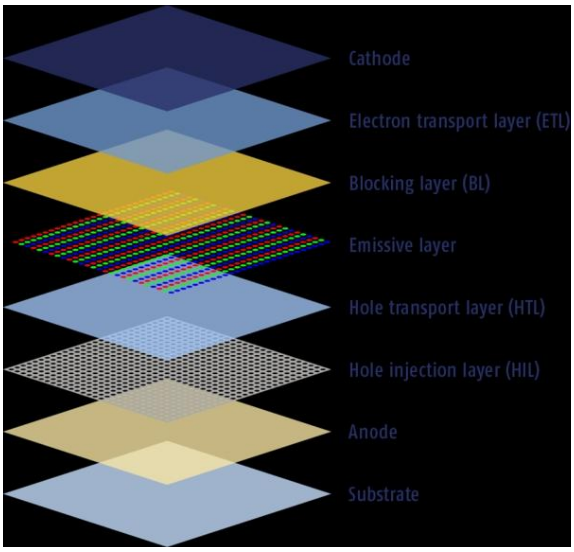


II. OLED

The acronym 'OLED' stands for Organic Light-Emitting Diode - a technology that uses LEDs in which the light is produced by organic molecules. These organic LEDs are used to create what are considered to be the world's best display panels.

OLED displays are made by placing a series of organic thin films between two conductors. When an electrical current is applied, a bright light is emitted. A simple design - which brings with it many advantages over other display technologies. OLEDs enable emissive displays - which means that each pixel is controlled individually and emits its own light (unlike LCDs in which the light comes from a backlighting unit). OLED displays feature great image quality - bright colors, fast motion and most importantly - very high contrast. Most notably, "real" blacks (that cannot be achieved in LCDs due to the backlighting). The simple OLED design also means that it is relatively easy to produce flexible and transparent displays.

OLED structure has many thin layers of organic material. These OLEDs compose of aggregates of Amorphous and crystalline molecules arranged in irregular pattern. When current passes through these thin layers, light gets emitted from their surface by a process of electro phosphorescence. OLEDs work on the principle of electro-luminescence, and this can be achieved by using multi-layered devices. In between these multi-layered devices, there are several thin and functional layers that are sandwiched between the electrodes.



When Direct Current is applied, charge carriers from the anode and cathode are injected into organic layers, due to electroluminescence visible light gets emitted.

The architecture of OLED display comprises several layers: two or three organic layers like conducting layer, emissive layer and other layers such as substrate, anode and cathode layers that are explained below in detail.

- Substrate Layer: This layer is a thin sheet of glass with a transparent conductive layer, which can also be made by a clear plastic layer or foil. This substrate supports the OLED structure.
- Anode Layer: This layer is an active layer and removes electrons. When current flows through this device, electrons are replaced by electron holes. Thin layers are deposited onto anode surface, and therefore, it is

also known as transparent layer. Indium tin oxide is the best example of this layer that serves as the bottom of the electrode or anode.

- Conductive Layer: Conductive layer is an important part in this structure that transports the holes from the anode layer. This layer is made up of organic plastic, and the polymers used include light-emitting polymers, polymer light-emitting diode, etc. The conductive polymer used in OLED are polyaniline, polyethylenedioxythiophene. This layer is an electroluminescent layer and uses the derivatives of p-phenylene vinylene and polystyrene.
- Emissive layer: This layer transports electrons from anode layers, and it is made of organic plastic molecules that are different from the conducting layers. There are multiple choices of materials and processing variables such that a wide range of wavelengths can be emitted during emission. In this layer, two polymers are used for emitting such as polyfluorene, poly para phenylene which normally emits green and blue lights. This layer is made of special organic molecules that conduct electricity.
- Cathode Layer: Cathode layer is responsible for injection of electrons when current flows through the device. Making of this layer is done by using calcium, barium, aluminum and magnesium. It may be either transparent or opaque depending on the type of OLED.

Operating principle of OLED

The conductive layer and emissive layers are made of special organic molecules that are helpful in conducting electricity. Anode and cathode are used for connecting OLEDs to the source of electricity.

When power is applied to an OLED, the emissive layer becomes negatively charged and the conductive layer becomes positively charged. Due to electrostatic forces applied, the electrons move from the positive conductive layer to a negative emissive layer. This may lead to a change in electrical levels and creates radiation that varies in frequency range of visible light.

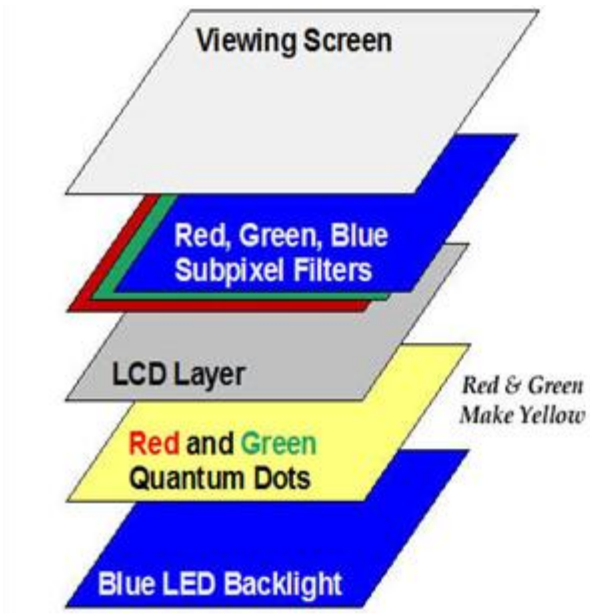
OLEDs also work as diodes if current flows through them in correct direction. The anode layer connected above the emissive layer is at a higher potential compared to the cathode connected to the conductive layer for the working of OLEDs.

III. QLED

QLED stands for Quantum Dot Light Emitting Diode. A quantum dot display is a display device that uses quantum dots (QD), semiconductor nanocrystals which can produce pure monochromatic[a] red, green, and blue light. The structure of a QLED is very similar to the OLED technology. But the difference is that the light emitting centers are cadmium selenide (CdSe) nanocrystals, or quantum dots. A layer of cadmium-selenium quantum dots is sandwiched between layers of electron-transporting and hole transporting organic materials. An applied electric field causes electrons and holes to move into the quantum dot layer, where they are captured in the quantum dot and recombine, and emitting photons. The spectrum of photon emission is narrow, characterized by its full width at half the maximum value. There are two major fabrication techniques for QD-LED, called phase separation and contact printing. QLEDs are a reliable, energy efficient, tunable color solution for display and lighting applications that reduce manufacturing costs, while employing ultra-thin, transparent or flexible materials

Quantum Dot (QD) displays are quite different as the technology is based on small conducting nanocrystals, usually in the range of 2 to 10 nanometers in diameter. The color of light produced or filtered by a dot is based on its diameter and using a few of these could produce all your necessary colors. Like OLED, light and colors could be supplied on demand and QD-LEDs can be very bright. However, current QD displays are based on a blue LED backlight which is then filtered to a white light before passing through the familiar LCD color producing layer.

Color gamut is seen as one of OLED’s big advantages over LCD, allowing for more vivid viewing experiences and accurate color reproduction, so long as the media also supports it. LCDs often fall short on color accuracy and gamut because of their reliance on a pseudo-white backlight (this is made from blue LEDs with a yellow phosphor coating). However, the highly accurate nature of Quantum Dots means that developers can use a pure blue back light and accurate red and green filters produce a true white light, which can then be filtered into better looking colors. As Quantum Dot displays don’t have to worry about inaccuracies in the white light, there is less compensation required in the LCD filtering layer, so manufacturers can drive up the color brightness and gamut of the display. As a result, QD LED TVs are able to match and sometimes even exceed the color accuracy of OLED panels . However, as QDs are currently reliant on a backlight, the deep black accuracy and contrast ratio will still suffer from similar drawbacks as existing LCD displays. Therefore, OLED should still win out when it comes to contrast and high dynamic range imagery, as it can switch off pixels for a pure black dot, but QD displays will still see a boost in brightness over traditional LCD. This leads us onto viewing angles, an area that OLED again boasts superiority over LCD displays and this is unlikely to change much with the introduction of Quantum Dot displays. Because backlight based displays require a filter layer rather than producing light directly on the surface, some light is blocked when you don't look at the display from head on. While perhaps not likely to be a major problem on your small mobile phone, Quantum Dot displays won't match OLED's viewing angles until designs come along that eliminate the need for a backlight.



IV. DIFFERENCE BETWEEN OLED AND QLED

Pros:
1. Even the base model QLED'S can become extremely bright if needed. Have a ton of natural light in your room? This may be the better option.
2. Low input lag. Gamer's rejoice, these QLED's have an excellent input lag time. The 2018 version has recorded lag-time of just 15.4ms. No excuse to lose a match on this TV.
3. 10 year no burn in guarantee. These QLED's are not susceptible to burn-in like other TV's. Great for not retaining that ESPN or CNN logo.
4. QLED's produce incredibly bright, vibrant and diverse colors.
5. Price. Generally you can find a QLED somewhat cheaper than an OLED.
Cons:
1. QLED's still require back lighting. Meaning light is emitted in sections as apposed to OLED's lighting individual diodes. This means blacks won't be as pure and contrast not as great in comparison.
2. QLED is more of a refinement of technology than the next-gem product Samsung is claiming it to be.

OLED

Pros:
1. Light is emitted on a pixel-by-pixel basis, so complete black can be right next to bright white with neither impacting each other. This gives you deep blacks and amazing contrast.
2. No light bleeding because there's no back light. Each diode can operate individually without effect the others because they light up themselves.
3. OLED's tend to be lighter and slimmer than a typical LED panel.
4. Significantly wider viewing angles. Great for bigger spaces. Don't worry about sitting directly in front of these TV's.
Cons:
1. Very expensive to produce. While the prices continue to lower, OLED panels don't come cheap.
2. Brightness isn't great. Comparative to QLED's, a lot of natural light will affect your enjoyment of these TV's.
3. Input lag and burn in. While both of these key points for gamer's are worse in comparison to QLED's, they continue to improve with every model release. Neither should be a deciding factor as burn in should only occur in extreme circumstances and input lag has been lowered significantly in the recent years.

V. APPLICATIONS OF OLED AND QLED DISPLAY TECHNOLOGY

- In TVs
- Cellphone screens
- Computer screens
- Keyboards
- Lights
- Portable device displays
- Applications of QLED display technology

VI. CONCLUSION

Though the structure of QLED is quite similar to OLED, you can easily tell the difference between the two by checking its light emitting centers which is made of cadmium selenide nanocrystals or simply called quantum dots. QLEDS are known for having less manufacturing costs and lower power consumption. QLED's manufacturers claim that QLED TVs are more power efficient than OLEDS with same color purity. When OLED hit the market, it was the absolute, most perfect TV technology ever. The type of picture quality that it produced was simply not seen with any previous technology. It can produce a wide range of colors, deep blacks, and superb contrasts that render brilliant pictures. QLED, as an improvement over OLED, significantly improves the picture quality. QLED can produce an even wider range of colors than OLED, which says something about this new tech. QLED is also known to produce up to 40% higher luminance efficiency than OLED technology. Further, many tests conclude that QLED is far more efficient in terms of power consumption than its predecessor, OLED.

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