International Conference on Advances in Communication and Computing Technologies (ICACACT) 2012
Proceedings published by International Journal of Computer Applications® (IJCA)

Organic Light Emitting Diodes: Future of Displays

Makarand Nikam
Department of Electronics & Telecommunication Engineering.

Rohit Singh
Department of Electronics & Telecommunication Engineering.

Suvarna Bhise
Department of Electronics & Telecommunication Engineering.

ABSTRACT

The Organic light-emitting diodes (OLEDs) are a new promising technology with high expected profitability on the display market, which is currently dominated by liquid crystals. In principle, organic light-emitting diodes (OLEDs) satisfy key requirements for this applications- low driving voltages in combination with unrestricted viewing angles, optically transparent, mechanically flexible displays, high color-brilliance, light weight, small film-thickness, low production costs and low-temperature fabrication.

However, The aim of this work is to perform the review of the recent most important results of experimental and theoretical investigations connected with the organic light emitting devices (OLEDs).The recent achievements in the field of designing, fabricating and clarification of the OLEDs operation have been presented. The possibilities of numerous, present and future applications of these devices have been pointed out through this paper.

Keywords

Transparent OLED, Hole Transporting Layer, Emissive Layer.

1. INTRODUCION

OLEDs, theirs structure and operation

OLED (organic light emitting diode) is a monolithic, thin-film, semi conductive device that emits light when a voltage is applied to it. Various ways of light are generated by applying an electric to organic materials, without involving any intermediate energy forms - the phenomenon known as organic electroluminescence (EL). EL is the result of the electric field– imposed formation of emissive states without recourse of any intermediate energy forms, such as heat. In its most basic form, an OLED consists of a series of vacuum-deposited, small-molecule organic thin films that are sandwiched between two thin-film conductors. The following figures show most often met constructions of this device.

In Fig.1 is presented one of the possible simple structures of OLED. Here emission of EL occurs in the electron and hole transmission layers. However, in more complicated but also more efficient OLED is shown in Fig. 2, the emission takes place in a separate layer. Sometimes the application requirements force to construct the different configurations of OLEDs, examples of these are shown schematically in Fig. 3. The output of the EL light can go through the anode, cathode or through the both electrodes as well. The ETL has the function of assisting the injection of electrons from a metal cathode and their transport throughout the bulk lm.

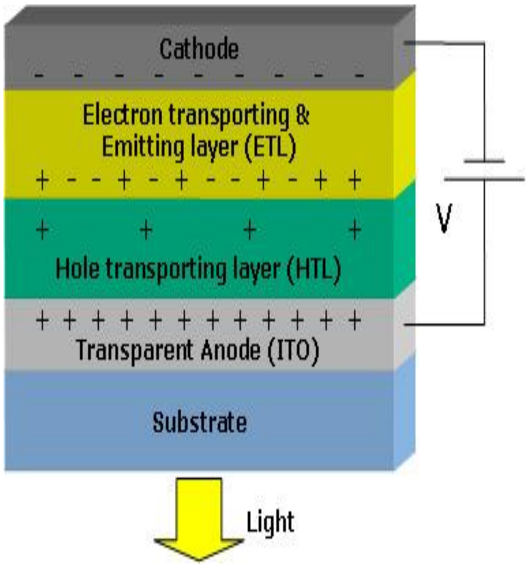

Figure. 1. An OLED is a monolithic, thin-film, solid-state device. Schematic of a simple real OLED structure. ETL – electron-transport layer, HTL – hole-transport layer.

Recombination of holes and electrons occurs at the boundary regions between two organic layers. When the recombination region is located within an ETL, the ETL behaves as an emissive layer (EML). When the recombination occurs within the HTL, on the other hand, the HTL can behave as an EML. Thus these devices are classified into two types: ITO/HTL/ETL (EML)/Metal and ITO/HTL (EML)/ETL/Metal. In three-layer structure shown in Fig. 2, an independent thin EML is sandwiched between HTL and ETL (ITO/HTL/EML/ETL/Metal), in case bipolar materials (which have ability to transport both electrons and holes) are available. Figure depicts this typical device structure. In its most basic form, an OLED is a monolithic, solid-state electronic device consisting of a series of vacuum-deposited organic thin films sandwiched between two transparent thin film conductors. When voltage is applied across the device, these organic thin films emit light. This light emission is based upon a luminescence phenomenon wherein electrons and holes are injected and migrate from the contacts toward the organic hetero-junction. When these carriers meet, they form excitons (electron-hole pairs) that recombine radiatively to emit light of a certain wavelength (e.g., red, green or blue for flat panel displays) according to the specific organic materials employed.

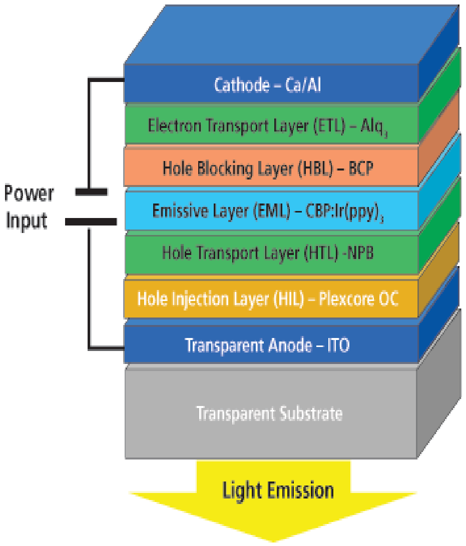

Fig. 2. A typical OLED multilayer device. ETL – electron-transport layer, HTL – hole-transport layer, HIL – hole-injection layer.

In its most common structure, known as a "single heterostructure", an OLED device consists of a hole transporting layer (HTL) and an electron transporting and light emitting layer (ETL/EL) sandwiched between two transparent electrodes. Transparent OLEDs (TOLEDs) enable new features: transparency, directed top emission, enhanced contrast ratio, and multi-stacked devices.

Transparency paves the way for displays to be used in new places in the automobile. In applications where maintaining vision area is important, TOLEDs have the potential to be integrated with the windshield for navigation and warning systems, and with the other windows for entertainment and telecommunication. TOLEDs can also be designed into a novel rear-view mirror and head-up information systems, and also be used as transmitters with the other display systems or backgrounds. In addition, because TOLEDs are transparent, they may be built on opaque as well as transparent surfaces. This means that a display may be built on metal roll stock, for example, for potential use in exterior automotive parts. Moreover, it also creates a number of new, and as yet, unimagined product opportunities.

Good HTL materials should satisfy one or more of the general requirements given below.

- Materials are morphologically stable and form uniform vacuum-sublimed thin films
- Materials have small solid state ionization potential.
- Materials have high hole mobility.
- Materials have small solid state electron affinity.

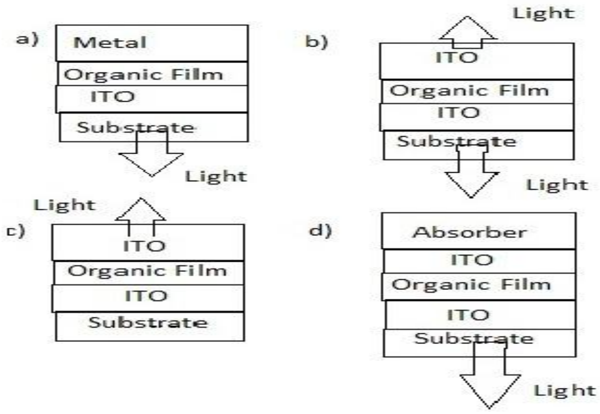

Fig. 3. Schematic of (a) Standard OLED with a reflective top cathode,
(b) TOLED with a transparent both, the top cathode and the substrate,
(c) TOLED built on an opaque substrate,
(d) TOLED with an absorber on top (T – transparent).

2. APPLICATIONS

Screens made from Organic Light Emitting Diode have a wonderful impact on the market and it has many wonderful applications. OLEDs that have such merits in addition to their temporal stability are expected to have many applications. Devices that are very thin and lightweight and have low power consumption are especially suitable for portable equipment (e.g., wireless phones, PDAs, view finders for digital cameras) and other portable imaging devices. Monochrome, multiple-colour, and full-colour display technologies using OLEDs, as are future directions relating to applications based on the needs in the multimedia era. Two of applications of OLED are listed below:

- A transparent screen can serve you as a windows screen as well as computer screen when needed.
- Screen of a car can help you with active Maps and Navigations while driving your vehicle by using OLED.

3. ADVANTAGES & DISADVANTAGES

3.1 Advantages

1. **Slimmer:**
   The biggest advantage of OLED screen is that it is slimmer than LCD display. While LCD and Plasma displays could be few inches thick, OLED advantage is that it is only few millimeters thick.
2. **Faster:**
   Another advantage of OLED is that it has much better response time than other displays. So these screens often provide better user experience. This advantage will lead great use of OLED screens in mobile phones and other handheld devices where fast response time is usually required.
3. **Efficient in Energy:**
   OLED displays consume less energy as compared to LCD displays and other display screens. No backlit is required in these screens which is the biggest OLED advantage for use in portable gadgets.
4. **Good for Eyes:**
   Another great advantage of OLED is that it pts less stains on eyes and hence are eye smoothening. These

screens provide better viewing experience because they have better contrast, brightness and colour aspects.

5. **Large Viewing Angle:**
   Viewing angle is always an issue in flat screens. But with the advent of OLED displays, viewing angle could be as large as 170 degree because they produce their own light which increases their viewing angle.
6. **Flexible:**
   Now you get displays which you can bend. This is possible only through the advent of OLED screens.
7. **Durability:**
   Another great advantage of OLED is that it is more durable than traditional screens. There chance of getting broken is comparatively less to LCD screens and other displays.
8. **Low Cost:**
   The price of OLED screens may be much higher now but it will come down as the technology becomes popular. OLED screens could become cheaper than LCD screens in coming time.

3.2 Disadvantages

1. **Lifespan:**
   The biggest technical problem for OLEDs was the limited lifetime of the organic materials. In particular, blue OLEDs have had a lifetime of around 14,000 hours to half original brightness (five years at 8 hours a day) when used for flat-panel displays. This is lower than the typical lifetime of LCD, LED or PDP technology-each currently rated for about 25,000–40,000 hours to half brightness, depending on manufacturer and model. However, some manufacturers' displays aim to increase the lifespan of OLED displays, pushing their expected life past that of LCD displays by improving light out coupling, thus achieving the same brightness at a lower drive current. In 2007, experimental OLEDs were created which can sustain 400 cd/m^2 of luminance for over 198,000 hours for green OLEDs and 62,000 hours for blue OLEDs.
2. **Color balance issues:**
   Additionally, as the OLED material used to produce blue light degrades significantly more rapidly than the materials that produce other colors; blue light output will decrease relative to the other colors of light. This variation in the differential colour output will change the colour balance of the display and is much more noticeable than a decrease in overall luminance. This can be partially avoided by adjusting colour balance but this may require advanced control circuits and interaction with the user, which is unacceptable for some users. In order to delay the problem, manufacturer's bias the colour balance towards blue so that the display initially has an artificially blue tint, leading to complaints of artificial-looking, over-saturated colors. More commonly, though, manufacturers optimize the size of the R, G and B sub pixels to reduce the current density through the sub pixel in order to equalize lifetime at full luminance. For example, a blue sub pixel may be 100% larger than the green sub pixel. The red sub pixel may be 10% smaller than the green.
3. **Efficiency of blue OLEDs:**
   Improvements to the efficiency and lifetime of blue OLEDs is vital to the success of OLEDs as replacements for LCD technology. Considerable research has been invested in developing blue OLEDs with high external quantum efficiency as well as a deeper blue colour. External quantum efficiency values of 20% and 19% have been reported for red (625 nm) and green (530 nm) diodes, respectively. However, blue diodes (430 nm) have only been able to achieve maximum external quantum efficiencies in the range of 4% to 6%.
4. **Water damage:**
   Water can damage the organic materials of the displays. Therefore, improved sealing processes are important for practical manufacturing. Water damage may especially limit the longevity of more flexible display.
5. **Outdoor performance:**
   As an emissive display technology, OLEDs rely completely upon converting electricity to light, unlike most LCDs which are to some extent reflective; e-ink leads the way in efficiency with ~33% ambient light reflectivity, enabling the display to be used without any internal light source. The metallic cathode in OLED acts as a mirror, with reflectance approaching 80%, leading to poor readability in bright ambient light such as outdoors. However, with the proper application of a circular polarizer and anti-reflective coatings, the diffuse reflectance can be reduced to less than 0.1%. With 10,000 'fc' incident illumination (typical test condition for simulating outdoor illumination), that yields an approximate photopic contrast of 5:1.

6. **Power consumption:**
   While an OLED will consume around 40% of the power of an LCD displaying an image which is primarily black, for the majority of images it will consume 60–80% of the power of an LCD: however it can use over three times as much power to display an image with a white background such as a document or website. This can lead to reduced real-world battery life in mobile devices when white backgrounds are used.

4. CONCLUSION

For future, further improvement of Lifetime will be necessary while improving power efficiency. If a device of longer Lifetime is realized, the foot of the application spreads out greatly.

We hope that the development discussed in this paper opens up a course to practical use of OLED as lighting sources for illumination use, backlights and others.

5. REFERENCES

Since this is a latest concept and OLED's are still under research we do not have much references.

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