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Mini Review

Organic Light Emitting Diode (OLED) Technology and its Applications: Literature Review

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Abstract

An Organic Light Emitting Diode (OLED) was one of the growing leading semiconductor device technologies. This technology has several advantages over other technology such as eco-friendly lighting sources with superior color quality, wide viewing angle, mercury-free manufacture, fascinating flexibility etc. In an OLED a conducting an emissive layer was sandwiched between two electrodes to emits light in response to an electrical current. A various device structure, materials as well as deposition techniques have been investigated to achieve the better and improved performance of OLED. In this review we summarized the device architectures, materials and advantage and disadvantages of Organic Light Emitting Diode (OLED) has been discussed.

Keywords: Organic light emitting diode; Display; Liquid crystal display and organic LED; Hole transport layer; Hole block layer; Electron transport layer

Introduction

Organic Light-Emitting Diodes (OLEDs) have found applications in flat panel displays technologies suitable for information-display applications in the next generation of displays and solid-state lighting applications [1,2]. In Tang et al. [3] shows the performance of OLED as full-color display panels and eco-friendly lighting sources [3]. For a high-performance OLED device required a high opto-electrical property of Transparent Conducting Oxide (TCO) layer as an anode [4]. Development has been made through last few decades on luminance efficiency, color gamut, device stability, and fabrication techniques to achieve better performance of OLED [5-7]. Recent past OLEDs are used as indoor lighting and also in various display devices such as TV screens, pc monitor and transparent display in mobile phones, handheld game console, digital cameras, and ultra-high-definition televisions [8,9]. Still need some improvement the performance of OLED for competitive lighting sources and displays with desirable standards.

Design and working of device structures

Organic Light Emitting Diodes (OLEDs) are thin-film multi-layer device structure as shown in Figure 1a&b. Basically the structure consists of few layers like anode, Hole Injection Layer (HIL), Hole Transport Layer (HTL), Light-Emitting Layer (LEL), Electron Transport Layer (ETL), Electron Injection Layer (EIL) and cathode. Light was comes out when electrons and holes are injected into the light emitting layer from the two electrodes and recombined. The colour of the emitted light was depends on the emitter molecules. To obtain the high efficiency of the OLED design and optimization was one of the key factors.

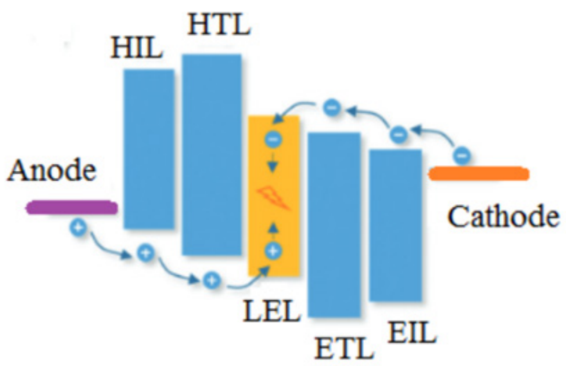

Figure 1a: Working mechanism of OLEDs.

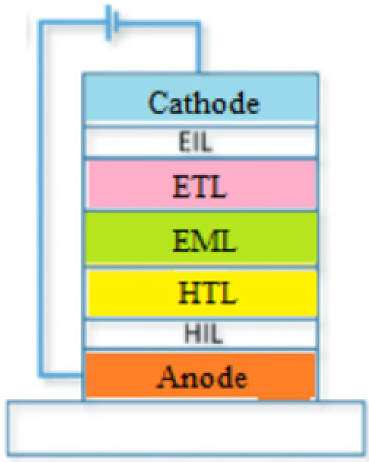

Figure 1b: Multilayer structure of Organic Light Emitting Diodes (OLEDs).

Fabrication Methods for OLEDS

In general, dry and wet process both are used to fabricate OLEDs. The commonly used dry process is vacuum evaporation. Also, OLEDs can be fabricated by the other process also like vacuum deposition or vacuum thermal evaporation, organic vapor phase deposition, inkjet printing, transfer-printing, lamination, spray coating and spin coating [10-15].

Based on the structure of OLEDs, they are classified into different types:

A. Passive OLED: In passive OLED the organic layer run perpendicularly between the strips of the anode and the cathode.

B. Active-matrix OLED: In case of active-matrix OLED an active component such as thin film transistor place on the top of the anode layer.

C. Transparent OLED: A transparent layer used as a substrate in this configuration with anode and cathode.

D. Top emitting OLED: The substrate layer in this OLED may be reflective/ non- reflective and the cathode layer is transparent.

E. White OLED: These types of OLEDs emit only white light and are used in the making of larger and efficient lighting systems.

F. Foldable OLED: Basically, such types of OLED made up of flexible metallic foil or plastic substrate.

G. Phosphorescent OLED: This OLED works on the principle of electroluminescence used to convert 100 % of the electrical energy into light (Table 1).

Table 1: Materials used for different layers in OLEDs [16,17].

Layer	Materials
Anode	ITO, ZnO
Hole Injection Layer (HIL)	Hexa-azatriphenylene Hexa-carbonitrile (HATCN).
Hole Transport Layer (HTL)	poly(3,4-ethylenedioxythiophene): poly(styrenesulfonate) (PEDOT: PSS), N, N-diphenyl-N, N-bis(3-methylphenyl)-1,10-biphenyl-4,4-amine (TPD), and N, N-Bis(naphthalen-1-yl)-N, N-bis(phenyl)benzidine (NPB). N′-bis(phenyl) benzidine (NPB) etc.
Light-Emitting Layer (LEL)	Polyfluorene (PFO), GGH1, Alq_3
Electron Transport Layer (ETL)	Polyethyleneimine ethoxylated (PEIE), 2-(4-Biphenyl)-5-(4-tert-butylphenyl)-1,3,4-oxadiazole (PBD), tris(8-quinolinolato) aluminium (Alq_3), and 2,9-Dimethyl-4,7-diphenyl-1,10-phenanthroline (BCP) etc.
Electron Injection Layer (EIL)	LiF, Liq, Py-hpp_2, LiF, NaF, or CsF, Li, Ca, or Ba,
Cathode	Barium, Calcium and Aluminium
Substrate	Glass, Plastic and foil.

Advantages

a) Low cost and manufacturing process of OLEDs leads itself several advantages over than TFT, LCD and plasma display.

b) OLED can fabricate on light weight and flexible plastic substrate.

c) Power efficiency of OLED better than other display technology.

d) OLEDs shows better response time rather than LCD.

Disadvantages

A. Power consumption was high compared to LCD.

B. Outdoor performance of OLEDs less reflective than LCD.

C. In case of OLED display image can persistent cause a discrepancy due to lifespan of the organic dyes.

D. UV light exposure can be damaged OLEDs.

E. Water environment can easily damage OLEDs.

Conclusion

High contrast ratio and fast response time makes OLED most promising technology than LCDs. Development of OLEDs makes it advanced technology application like dashboards and in flexible displays. Few years ago, OLEDs are suffering due to limited lifetime for display applications still need OLEDs to overcome such challenges like heavy production costs and sensitivity to water vapor also its emissive nature suffers due to direct sunlight.

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