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Organic Light Emitting Diodes : The Need of future

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Abstract- These new generation fluorescent materials may now challenge the domination by inorganic semiconductor materials of the commercial market in light-emitting devices such as light-emitting diodes (LED) and polymer laser devices. This review provides information on unique properties of LEDs and how they have been optimized to generate these properties. The review is organized in three sections focusing on the major advances in light emitting materials, OLEDs, polymer light emitting diodes and understanding the desirable properties as well as modern solid state lighting and displays. it is clear to motivate these organic light-emitting devices (OLEDs) and organic lasers for modern lighting in terms of energy saving ability. In addition, future aspects of conjugated polymers in LEDs were also highlighted in this review.
Keywords: Organic light emitting diodes; polymer laser devices; semiconductor.

Introduction-

Today LED (Light Emitting Diode) lights have taken place of most of the light bulbs. LED is a semiconductor diode which emits lights with the help of electric current. LED bulbs are used for many purposes such as indicator lights in various electronic device, flashlights and area lighting device. LED bulbs can be found in various shapes and colors. The color of emitting lights depends on the composition and condition of the semi conducting materials used. It can be green, red, yellow, infrared or ultraviolet. There are interesting applications also which uses LED bulbs such as UV-LEDs for the sterilization of water and disinfection of devices and to enhance the photosynthesis in plants as a grow light.

A light-emitting diode (LED) is a two-lead semiconductor light source that resembles a basic pn-junction diode, except that an LED also emits light.[2]When an LED's anode lead has a voltage that is more positive than its cathode lead by at least the LED's forward voltage drop, current flows. Electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. An LED is often small in area (less than 1 mm^2), and integrated optical components may be used to shape its radiation pattern.[1]

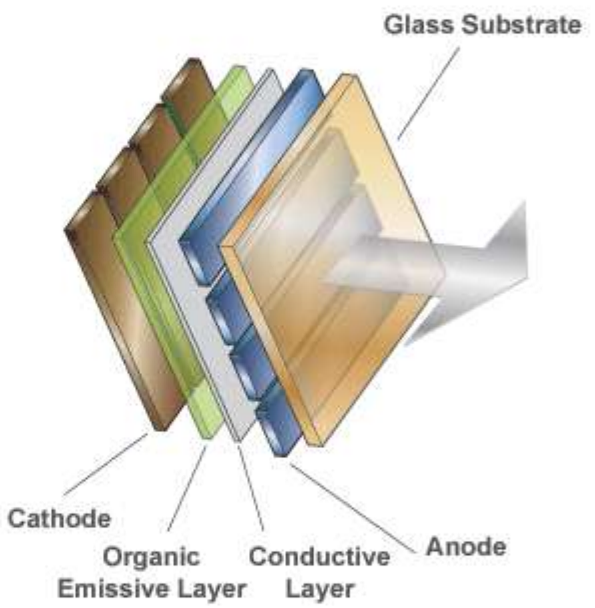
How prepare white LEDs

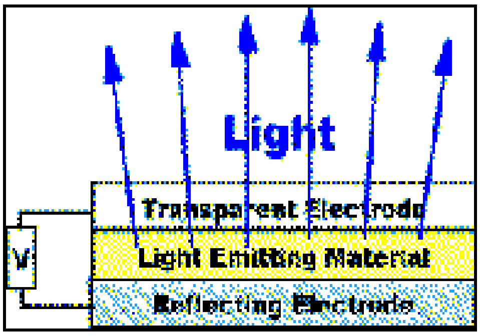
There are two primary ways of producing white light-emitting diodes (WLEDs), LEDs that generate high-intensity white light. (a)One is to use individual LEDs that emit three primary colors [4]—red, green, and blue—and then mix all the colors to form white light. (b)The other is to use a phosphor material to convert monochromatic light from a blue or UV LED to broad-spectrum white light, much in the same way a fluorescent light bulb works.

There are three main methods of mixing colors to produce white light from an LED:

- blue LED + green LED + red LED (color mixing; can be used as backlighting for displays)
- near-UV or UV LED + RGB phosphor (an LED producing light with a wavelength shorter than blue's is used to excite an RGB phosphor.
- blue LED + yellow phosphor (two complementary colors combine to form white light; more efficient than first two methods and more commonly used.
- White LEDs can also be made by coating near-ultraviolet (NUV) LEDs with a mixture of high-efficiency europium-based phosphors that emit red and blue, plus copper and aluminium-doped zinc sulfide (ZnS:Cu, Al) .[3]

What is Organic Light Emitting Diodes (OLED)?

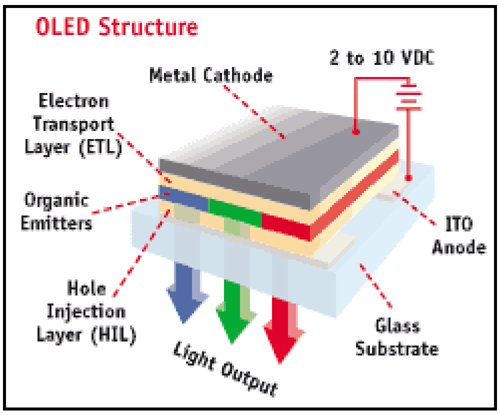




The latest innovative organic light emitting diodes (OLED) operates on the principle of *electro*-luminescence, converting electrical energy into light. Organic Light Emitting Diode technology, can produces full color, full-motion flat panel displays with a level of brightness and sharpness not possible with the use of other technologies.

OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. OLEDs can be used to make displays and lighting. Because OLEDs emit light they do not require a backlight and so are thinner and more efficient than LCD displays(which do require a white backlight).

How It Works:



The basic OLED cell structure consists of a stack of thin organic layers sandwiched between a transparent anode and a metallic cathode. The organic layers comprise a hole-injection layer, a hole-transport layer, an emissive layer, and an electron-transport layer. When an appropriate voltage (typically between 2 and 10 volts) is applied to the cell, the injected positive and negative charges recombine in the emissive layer to produce light (electro luminescence). The structure of the organic layers and the choice of anode and cathode are designed to maximize the recombination process in the emissive layer, thus maximizing the light output from the OLED device. [18,22]

Factors Affecting Brightness and Performance

Why a Green LED appears brighter than a Red LED even though both use same current? The answer being that a human eye has maximum sensitivity to light near 550 nm region of yellow – green part of the visible spectrum. There are some important parameters of LED responsible for its performance and brightness, which are as follows:

Luminous Flux (different materials)

It indicates the light energy radiating from LED. It is measured in terms of Lumen (lm) or Milli lumen (mlm) [27]

• **Luminous Intensity**

Luminous intensity is an expression of the amount of light power emanating from a point source per unit solid angle. It is measured as Candela (cd) or milli candela (mcd) Brightness of LED is directly related to its luminous intensity.

• **Luminous Efficacy**

It is the emitted light energy relative to the input power. It is measured in terms of lumen per watt (lm w). [29]

• **Forward current**

Forward current (If) is the current flowing through the LED when it is forward biased and it should be restricted to 10 to 30 Milli Amperes otherwise LED will be destroyed. [26]

• **Viewing Angle**

Viewing angle is the off – axis angle at which the luminous intensity fall to half its axial value. This is why LED shows more brightness in full on condition. This justifies high bright LED having narrow viewing angle so as to focus the light into a beam. [1]

• **Forward Voltage**

Forward voltage (Vf) is the voltage drop across the LED when it conducts. In ordinary LEDs the forward voltage drop range from 1.8 V to 2.6 Volt. However in Blue and White ones, it goes up to 5 volts. The table shown below, the forward voltage drop of common LEDs.[4]

Table 1: Voltage drop across LEDs

Colour	**Voltage drop**
Red	1.8 V
Orange	2 V
Yellow	2.1 V
Blue	3.6 V
Green	2.2 V
White	3.6 V

Forms of OLED Display -There are two forms of OLED displays: Passive-matrix and Active-matrix.

Polymer light emitting diodes

Polymer light-emitting diodes (PLED), also light-emitting polymers (LEP), involve an electroluminescent conductive polymer that emits light when connected to an external voltage. They are used as a thin film for full-spectrum colour displays. Polymer OLEDs are quite efficient and require a relatively small amount of power for the amount of light produced.[5]poly(*p*-phenylene vinylene), used in the first PLED.[9]

Wavelength conversion

Some blue or ultraviolet light from one OLEDs is used to exited several phosphors, each of which emits a different colour and these different colours are mixed to make a white ligh with the broadest and richest wavelength spectrum and is called down conversion by phosphores.A difficult of colour stability due to different ageing of various species occurs in several methods used for white emission from organic LEDs white emission by down conversion phosphors may be an alternative method in which a blue emitting OLED is coupled with one or more down conversion phosphor layers .The mixing of unabsorbed emission from the blue OLED and the emission from the phosphors produces white light.[7]

White emission from down conversion can also be obtained by coupling UV light with red, green and blue phosphors which excites several phosphors, each of which emits a different colour, as a result of mixing these colours white light emission is obtained. The technique has colour stability but the losses associated with wavelength conversion are the main drawbacks of this technique.[11]

Photo physics of OLEDs

The modification of emission properties upon doping is due to efficient energy transfer process from the host molecule to the guest molecule(dopants) and with careful balancing of the doping it is possible to obtain white light emission. The dopants can be fluorescent or phosphorescent in nature. The dopant site can be excited directly or by energy/ charge transfer from the host molecule.[26]

Why LEDs need of future

Recent developments in LEDs permit them to be used in environmental and task lighting. LEDs have many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. Light-emitting diodes are now used in applications as diverse as aviation lighting, automotive headlamps, advertising, general lighting, traffic signals, and camera flashes. However, LEDs powerful enough for room lighting are still relatively expensive, and require more precise current and heat management than compact fluorescent lamp sources of comparable output.[27] following are the factors which shows importance of LEDs -

• Carbon emissions:

LEDs deliver significant reductions in carbon emissions.[9]

• Efficiency:

LEDs emit more lumens per watt than incandescent light bulbs. The efficiency of LED lighting fixtures is not affected by shape and size, unlike fluorescent light bulbs or tubes.[10]

•Color:

LEDs can emit light of an intended color without using any color filters as traditional lighting methods need. This is more efficient and can lower initial costs.[25]

•Size:

LEDs can be very small (smaller than 2 mm^2) and are easily attached to printed circuit boards.[11]

On/Off time:

LEDs light up very quickly. A typical red indicator LED will achieve full brightness in under a microsecond. LEDs used in communications devices can have even faster response times.[12]

• Cycling:

LEDs are ideal for uses subject to frequent on-off cycling, unlike fluorescent lamps that fail faster when cycled often, or HID lamps that require a long time before restarting.[32]

• Dimming:

LEDs can very easily be dimmed either by pulse-width modulation or lowering the forward current. This pulse-width modulation is why LED lights viewed on camera, particularly headlights on cars, appear to be flashing or flickering. This is a type of stroboscopic effect.[13]

Video Capabilities:

They hold the ability to handle streamlined video, which could revolutionize the PDA and cellular phone market.[32]

- ***Robust Design*****:** OLED's are tough enough to use in portable devices such as cellular phones, digital video cameras, DVD players, car audio equipment and PDA's.[32]
- ***Power Usage:*** Takes less power to run (2 to 10 volts).[16]
- **Production Advantages:** Up to 20% to 50% cheaper than LCD processes. Plastics will make the OLED tougher and more rugged. The future quite possibly could consist of these OLED's being produced like newspapers, rather than computer "chips".[15]
- **Lifetime:** LEDs can have a relatively long useful life. One report estimates 35,000 to 50,000 hours of useful life, though time to complete failure may be longer. Fluorescent tubes typically are rated at about 10,000 to 15,000 hours, depending partly on the conditions of use, and incandescent light bulbs at 1,000 to 2,000 hours.[14,27]
- **Shock resistance:** LEDs, being solid-state components, are difficult to damage with external shock, unlike fluorescent and incandescent bulbs, which are fragile. e basic OLED cell structure consists of a stack of thin organic layers sandwiched between a transparent anode and a metallic cathode. The organic layers comprise a hole-injection layer, a hole-transport layer, an emissive layer, and an electron-transport layer. When an appropriate voltage (typically between 2 and 10 volts) is applied to the cell, the injected positive and negative charges recombine in the emissive layer to produce light (electro luminescence). The structure of the organic layers and the choice of anode and cathode are designed to maximize the recombination process in the emissive layer, thus maximizing the light output from the OLED device. [17]
- ***"Electronic Paper":*** OLED's are paper-thin. Due to the exclusion of certain hardware goods that normal LCD's require, OLED's are as thin as a dime.[7]
- **Optical fiber-**The light from LEDs can be modulated very quickly so they are used extensively in optical fiber and free space optics communications. This includes remote controls, such as for TVs, VCRs, and LED Computers, where infrared LEDs are often used. Opto-isolators use an LED combined with a photodiode or phototransistor to provide a signal path with electrical isolation between two circuits.[24]
- • **Sensors-**Many sensor systems rely on light as the signal source. LEDs are often ideal as a light source due to the requirements of the sensors. LEDs are used as movement sensors, for example in optical computer mice.[25]

Future prospects of OLEDs

The prospects of organic OLEDs are very good. In the R & D scenario,new efficient emitters are being reported everyday which are far more efficient than those which are in present use. New organic deposition techniques as well as roll to roll processing of OLEDs are also showing encouraging results. The efficiency of the best OLEDs has surpassed that of fluorescent discharge lamps and one can expect that in the coming years we see more efficient devices which replaces the existing lighting concepts. One of its applications can be "transparent window." By day, it would work like a common transparent plastic window.[12]

The conjugated polymers' contribution in the area of plastic electronics is leading to a variety of products with high energy efficiency and reduced environmental impact. Already a variety of advanced optical and electronic products based on conjugated polymers are in the market place such as light-emitting diodes, thin film transistors, photovoltaic cells, sensors, plastic lasers, and nonlinear optical systems. Yet the future of the conjugated polymer based devices holds even greater promise for an entirely new generation of ultra low cost, light-weight and flexible electronic devices, moreover, these are expected to supersede many of the existing inorganic semiconductor based devices.

Conclusion

LEDs are efficient and clean and have the potential to replace the existing lighting system based on incandescent lamp and discharge tubes. Even though the technology has developed to a stage where it can be commercialized, there are many basic issues which are not clearly understood and very intense research is required in this direction. Thus, as demonstrated in this review, it can be inferred that LEDs have evolved since their invention and this trend will continue. It has given a new direction to innovations in the field of electronics and continues to unravel more. The technical potential is still not exhausted by any means and that is why OLED represents the future of lighting.

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