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Light Emitting Polymers

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***Abstract*-This paper proposes the new display technology using the Light Emitting polymers. Organic light emitting diode (OLED) display technology has been grabbing headlines in recent years.LEP technology promises thin, light weight emissive displays with low drive voltage, low power consumption, high contrast, wide viewing angle, and fast switching times. One of the main attractions of this technology is the compatibility of this technology with plastic-substrates and with a number of printer based fabrication techniques, which offer the possibility of roll-to-roll processing for cost-effective manufacturing.LEPs are inexpensive and consume much less power than any other flat panel display. Their thin form and flexibility allows devices to be made in any shape. One interesting application of these displays is electronic paper that can be rolled up like newspaper.**

***Keywords*: Light Emitting Polymers (LEP), Organic light emitting diode (OLED), Light Emitting diode (LED)**

I. INTRODUCTION

An OLED (organic light-emitting diode) is a light-emitting diode (LED) in which the emissive electroluminescent layer is a film of organic compound which emits light in response to an electric current. This layer of organic semiconductor is situated between two electrodes; typically, at least one of these electrodes is transparent. A major area of research is the development of white OLED devices for use in solid-state lighting applications. There are two main families of OLED: those based on small molecules and those employing polymers. Adding mobile ions to an OLED creates a light-emitting electrochemical cell (LEC) which has a slightly different mode of operation. OLED displays can use either passive-matrix (PMOLED) or active-matrix addressing schemes. Active-matrix OLEDs (AMOLED) require a thin-film transistor backplane to switch each individual pixel on or off, but allow for higher resolution and larger display sizes.

Fig 1:LEP

II .STRUCTURE

The structure comprises of a thin film of semiconducting polymer sandwiched between two electrodes (cathode and anode).When electrons and holes are injected from the electrodes, the recombination of these charge carriers takes place, which leads to emission of light .The band gap, i.e. The energy difference between valence band and conduction band determines the wavelength (colour) of the emitted light. Indium-tin oxides typically used for the anode and aluminum or calcium for the cathode.

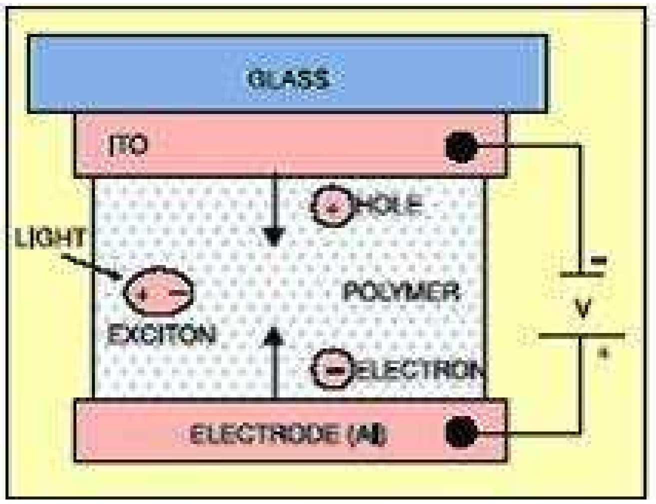

Fig 2: Structure of the LEP

III. WORKING

A typical OLED is composed of a layer of organic materials situated between two electrodes, the anode and cathode, all deposited on a substrate. The organic molecules are electrically conductive as a result of delocalization of pi electrons caused by conjugation over part or the entire molecule. These materials have conductivity levels ranging from insulators to conductors, and are therefore considered organic semiconductors. The highest occupied and lowest unoccupied molecular orbital of organic semiconductors are analogous to the valence and conduction bands of inorganic semiconductors.

Multilayer OLEDs are fabricated with two or more layers in order to improve device efficiency. As well as conductive properties, different materials may be chosen to aid charge

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injection at electrodes by providing a more gradual electronic profile, or block a charge from reaching the opposite electrode and being wasted. Many modern OLEDs incorporate a simple bilayer structure, consisting of a conductive layer and an emissive layer. More recent developments in OLED architecture improve quantum efficiency (up to 19%) by using a graded heterojunction. In the graded heterojunction architecture, the composition of hole and electron-transport materials varies continuously within the emissive layer with a dopant emitter. The graded heterojunction architecture combines the benefits of both conventional architectures by improving charge injection while simultaneously balancing charge transport within the emissive region.

During operation, a voltage is applied across the OLED such that the anode is positive with respect to the cathode. Anodes are picked based upon the quality of their optical transparency, electrical conductivity, and chemical stability. A current of electrons flows through the device from cathode to anode, as electrons are injected into the LUMO (lower unoccupied molecular orbital) of the organic layer at the cathode and withdrawn from the HOMO(highest occupied molecular orbital) at the anode. This latter process may also be described as the injection of electron holes into the HOMO. Electrostatic forces bring the electrons and the holes towards each other and they recombine forming an exciton, a bound state of the electron and hole. This happens closer to the emissive layer, because in organic semiconductors holes are generally more mobile than electrons. The decay of this excited state results in a relaxation of the energy levels of the electron, accompanied by emission of radiation whose frequency is in the visible region. The frequency of this radiation depends on the band gap of the material, in this case the difference in energy between the HOMO and LUMO.

As electrons and holes are fermions with half integer spin, an exciton may either be in a singlet state or a triplet state depending on how the spins of the electron and hole have been combined. Statistically three triplet excitons will be formed for each singlet exciton. Decay from triplet states (phosphorescence) is spin forbidden, increasing the timescale of the transition and limiting the internal efficiency of fluorescent devices. Phosphorescent organic light-emitting diodes make use of spin–orbit interactions to facilitate intersystem crossing between singlet and triplet states, thus obtaining emission from both singlet and triplet states and improving the internal efficiency.

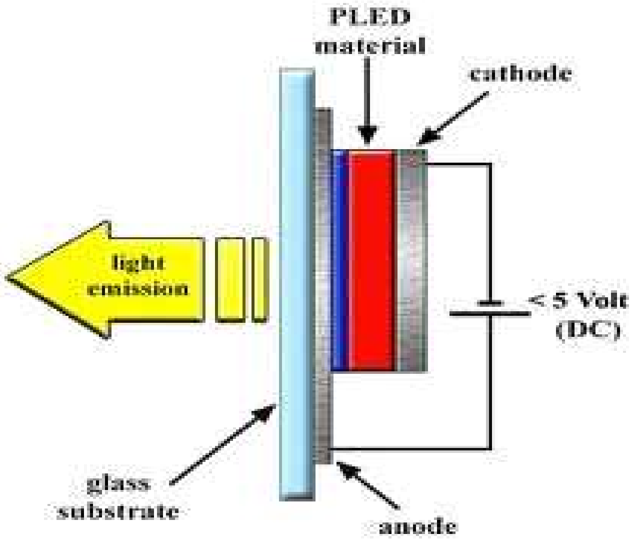

Fig 3: Working of the LEP

\IV.TYPES OF LEP

The types of LEPs available in the market include flexible, stacked and transparent.

1. FLEXIBLE ORGANIC LEPS

They are built on flexible substrates instead of glass substrates. These materials provide the ability to conform, bend or roll a display into any shape. So these find application on helmet face shields, military uniforms, shirtsleeves and automotive windshields. FOLEDs are built on flexible substrates. Flat-panel displays have traditionally been fabricated on glass substrates, in part because these have intrinsic structural and/or processing constraints that preclude the use of non-rigid substrates. Nonetheless, flexible materials are highly desired substrates because these have significant performance and cost advantages.

Fig 4: Fexible organic LEP

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2. STACKED ORGANIC LEPS

They are built on flexible substrates instead of glass substrates. These materials provide the ability to conform, bend or roll a display into any shape. So these find application on helmet face shields, military uniforms, shirtsleeves and automotive windshields. They use pixel architecture and offers high-definition display resolution and true-color quality for the next generations display applications. With this type, each pixel emits the desired color and thus is perceived correctly, no matter what size it is and from where it is viewed.

Fig 5: Structure of Stacked organic LEP

3. TRANSPARENT ORGANIC LEPS

The employ an innovative transparent contact to achieve an enhanced display. They can be top, bottom or both top and bottom emitting (transparent). Bi-directional LEPs will provide two independent displays emitting from opposite faces of the display. With portable products shrinking and desired information content expanding, transparent LEPs are a great way to double the display area for the same display size.This option creates a host of exciting new display opportunities. In its most basic form, the TOLED is a monolithic solid state device consisting of a series of small-molecule organic thin films sandwiched between two transparent, conductive layers.

V ADVANTAGES

1. Lower cost in the future

OLEDs can be printed onto any suitable substrate by an inkjet printer or even by screen printing, theoretically making them cheaper to produce than LCD or plasma displays. Lightweight and flexible plastic substrates OLED displays can be fabricated on flexible plastic substrates leading to the possible fabrication of flexible organic light-emitting diodes for other new applications, such as roll-up displays embedded in fabrics or clothing. As the substrate used can be flexible such as polyethylene terephthalate (PET), the displays may be produced inexpensively.

2. Response time

OLEDs also can have a faster response time than standard LCD screens. Whereas LCD displays are capable of between 1 and 16 ms response time offering a refresh rate of 60 to 480 Hz, an OLED theoretically can have a response time less than 0.01 ms, enabling a refresh rate up to 100,000 Hz . OLEDs also can be run as a flicker display, similar to a CRT, in order to eliminate the sample-and-hold effect that creates motion blur on OLEDs.

Few more advantages

- Require only 3.3 volts and have lifetime of more than 30,000hours
- Greater power efficiency than all other flat panel displays
- No directional or blurring effects
- Can be viewed at any angle
- Glare free view up to 160 degree
- Cost much less to manufacture and run than CRTs, because the active material used is plastic
- Can scale from tiny devices millimeters in dimension t high definition device upto 5.1 meters in diameter.
- Fast switching speed that is 1000 times faster than LCDs.
- Higher luminescence efficiency. Due to high refractive index of the polymer, only a small fraction of the light generated in the polymer layer escapes the film.

VI DISADVANTAGES

1. Lifespan

The biggest technical problem for OLEDs is the limited lifetime of the organic materials. In particular, blue OLEDs historically 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, which is lower than the typical lifetime of LCD, LED or PDP technology each currently rated for about 60,000 hours to half brightness, depending on manufacturer and model. However, some manufacturer's 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.

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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 differential color output change will change the color balance of the display and is much more noticeable than a decrease in overall luminance.
3. 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 displays.
4. 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 disappointing real-world battery life in mobile devices.

VII APPLICATIONS

- Multi or full color cell phone displays
- Full color high-resolution personal digital assistants(PDAs)
- Heads-up instrumentation for cars
- Lightweight wrist watches
- High definition televisions
- Roll-up daily refreshable electronic newspapers
- Automobile light systems without bulbs
- Poly LED TV

Windows/wall/partitions that double as computer screens
- Military uniforms
- Aircraft cockpit instrumentation panel a lot of others
- Manufactures like DuPont Displays, OSRAM, Philips. Seiko-Epson, Retek and many others have already started producing LEP displays and these displays will replace the active matrix LCDs as the market-dominant display by 2010.

VIII CONCLUSION

Using organic light emitting diodes, organic full colour displays may eventually replace LCDs in laptop and even desktop computers. Such displays can be deposited on flexible plastic coils, eliminating fragile and heavy glass substrate used in LCDs and can emit light without the directionality inherent in LCD viewing with efficiencies higher than that can be obtained with incandescent light bulbs.

IX FUTURE SCOPE

As the LEP can be made in the form of thin films or sheets, they offer a huge range of applications. These include television or computer screens that can be rolled up and tossed in a briefcase, and cheap videophones. A fully integrated analytical chip that contains an integrated light source and detector could provide powerful point-of-care technology. This would greatly extend the tools available to a doctor and would allow on-the-spot quantitative analysis, eliminating the need for patients to make repeat visits. This would bring forward the start of treatment, lower treatment costs and free up clinician time.

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