Organic Light Emitting Technology - An Overview

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Abstract: *The preponderance of light for the very existence of mankind is indispensible, therefore on this account the light emitting devices are the most insurmountable amongst diverse electronic devices. The phenomenon of light emission be it spontaneous or stimulated depends upon the structure, fabrication of the light emitting device and in particularly upon the semiconductor material used. Most important point of concern is that organic electronics offers astounding advantages over their peas and pod and thus have become an apple of the eye of today's world technocrats. It is therefore vital and paramount to study about the organic light emitting technologies and for this cause the most prominent devices that fall under the roof of this technology are concisely discussed in this paper.*

Keywords: *Organic semiconductors, OLED, OLET, excitons, electroluminescence, organic electronics, electronic textiles.*

I. INTRODUCTION:

The origin of organic electronics dates back to 1960's however it then emerged as a technological paradigm due to the development of organic materials that offered conducting and semiconducting properties.

Organic semiconductors are those non metallic organic materials that exhibit semiconductor properties. They offer several advantages over their counterpart ie; the silicon based semiconductors (inorganic). They are less expensive thus affording inexpensive fabrication methods, soluble in most common solvents, possess a low annealing temperature which allows flexibility in substrate choice of substrates leading to ease in manufacture of transparent plastics. However it also suffers from a drawback that it is liable to environmental degradation. Few of their properties are bulleted below:

1. High thermal conductivity
2. Flexibility of electrical conductivity based on dopant concentration
3. Mechanically flexible
4. Less expensive

II. ORGANIC LIGHT EMITTING DIODE:

Novelty in the field of electronics is undeniably contemplated every day and one such marvel is the organic light emitting diode, abbreviated as the OLED. It finds its application in Flat Panel Displays and White light Sources. Their luminous efficiencies are greater than that of incandescent lamps and as a light source, the OLEDs have the capability to be tuned to any desired colour and intensity with a Colour Rendition Index (CRI) greater than 100. They are current controlled devices whose brightness could be varied widely over a dynamic range and they portray uniformity in operation eliminating flicker. Unlike the other television display technologies the OLED is a self laminating one, which adds another pearl to its crown.

i. STRUCTURE:

The OLED is structured into five layers and they unfold in the order below. It consists of a substrate that is either made of glass or plastic upon which is placed an anode. This electrode is usually transparent in nature. Upon this is present the organic layer comprising of two sub layers namely, the conducting layer and the emissive layer. This organic layer is made out of small molecules or polymers. The uppermost is the cathode, which can either be transparent or not.

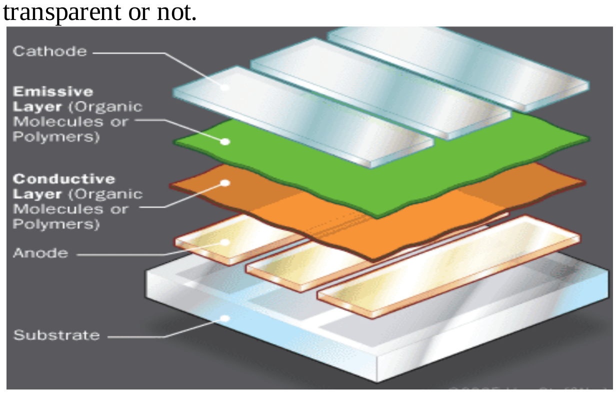

Fig 1.2: OLED layers

ii. WORKING:

Light emission is achieved by the phenomenon of electroluminescence. Upon application of a potential across the electrodes a current is said to flow through the device causing injection of electrons and ejection of the same by the mechanism explained. As in conventional LEDs, the OLED too has energy levels namely the HOMO abbreviated as Highest Unoccupied molecular orbit and LUMO which is Lowest Unoccupied Molecular Orbit. As electrons are injected into the emissive layer, the conductive layer removes these electrons leaving back holes. These carriers combine at the emissive layer forming an exciton which is a bound state of energy. The excess energy after exciton formation is released as a light photon.

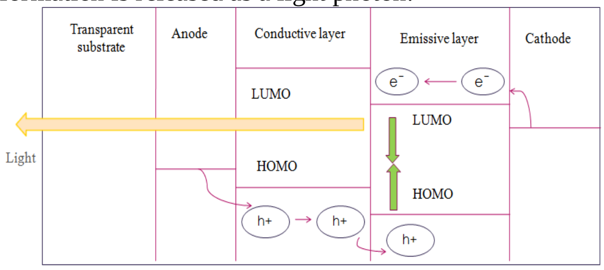

Fig 1.1: Exciton formation and light emission

iii. CLASSIFICATION:

The types of OLEDs and the bases of classification are shown below;

(a) On Transparency basis
(i) Bottom/Top emissive OLEDs
(ii) Transparent OLEDs
(b) On Flexibility basis
(i) Flexible OLEDs
(ii) Rigid OLEDs
(c) On Pixel formation basis
(i) Active matrix OLEDs (AMOLEDs)
(ii) Passive matrix OLEDs (PMOLEDs)
(d) On Whiteness basis
(i) White OLEDs

iv. ADVANTAGES:

a) Light weight, flexible substrates
b) OLED TVs have better picture quality
c) Devices have better power efficiency
d) Sleek in size
e) Greater response time
f) OLED devices will be available at much affordable prices in the near future

v. LIMITATIONS:

a) Lifespan is not promising due to environmental degradation
b) Prone to water damage
c) Poorer colour balance
d) Outdoor performance is prone to recede

vi. APPLICATIONS:

a) OLED televisions
b) Computer, portable device displays
c) Keyboard (Optimus Maximus)
d) Flexible smart phones
e) Foldable laptops (Rolltops)
f) Lighting
g) Wallpaper lighting

III. ORGANIC LIGHT EMITTING TRANSISTOR:

The organic light emitting transistors are fondly known as the light Emitting Organic FETs. They are said to integrate the phenomena of light emission and current modulation. They are abbreviated as the OLETs and are said to possess the switching properties of Thin Film Transistors (TFTs) and the light emitting property of OLED all in one floor. The first invented OLET had gold (Au) as its source and drain and polycrystalline tetracene thin film as an organic semiconductor layer. The recombination of electrons and holes from gold electrodes causes electroluminescence at tetracene as in the OLED.

IV. WHY TO MOVE FROM OLED TO OLET?

In OLEDs the nearness of contacts to the emissive layer accounts for loss of emitted photons due to its absorption within the device thus preventing it to leave the surface causing a glow. Also there exists another problem due to convergence of electron and hole currents at the emissive layer where the excitons are formed but spatially coexist there itself thereby leading to an issue called the exciton quenching which is worse than any other quenching mechanisms found in other semiconductor devices. These two drawbacks are said to greatly affect the device’s efficiency, brightness and stability. This gave rise to the inception of the new display technology, namely the OLET.

V. ORGANIC LIGHT EMITTING NANOFIBERS:

Organic electronics has laid its hands on fabric technology and has blended it with the conventional display technologies leading to the formation of electronic textiles. Organic optoelectronic devices having fiber form factor have come up to the extent of fabricating OLEDs in fiber form by the process called electrospinning and thereby enabling the fabric industry to come out with glowing textile made out of either edge emitting fibers or end emitting fibers. The next step in this era would be a day when man would wear his smart phone as or upon his T- shirt. Use of organic materials for the fabrication of electronic textiles offers the following advantages like ease of fabrication, less expensive, chemical and compositional flexibility and greater throughput in terms of fabrication methods.

VI. CONCLUSION:

The vitality of light emitting technologies and its efficacy when blended with organic electronics is cleanly described in this paper. The most prominent organic light emitting device ie; the OLED which serves the requirements of achieving both high efficiency lighting and effective electron to photon conversion is described with clarity and the reasons why it has donned the technological era and still continues to remain at the top in the market is mentioned. The OLET which is a transistor form of OLED, a device that overcomes the limitations of the profound OLED is given an overview in this paper. On a concluding note, the light emitting nanofibers that promises a great future to the textile industry giving rise to electronic textile were mentioned.

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