Seminar
Assignment 2
22 October 2020

# OLED Technology
## Organic Light Emitting Diodes

## Abstract

OLED is a solid-state device composed of thin films of organic molecules that generate light with the use of electricity. OLED's can provide brighter, crisper displays on electronic devices and utilize less power than conventional light Emitting diodes (LEDs)used today. Alike an LED, an OLED is a solid state semiconductor device that comprises of 100-500 nms thick or nearly 200 times smaller than a human hair .OLEDs can have either two or three layers of organic material which plays an important role. An OLED consist of the following parts:

- Substrate
- Anode
- Organic layers
- Cathode

OLEDS radiate light through a process called electrophosphorescence.Various types of OLEDs in our field are : Passive-matrix OLED, Active-matrix OLED, Transparent OLED, Foldable OLED, Top-emitting OLED, White OLED Applications etc. At present , OLEDs are utilized in small-screen devices for eg. mobile phones ,PDAs and digital Cameras.Research and advancement in the field of OLEDs is going on rapidly now and may result in future applications in heads-up displays, automotive dash boards and so forth.

## History

In the early 1950s , André Bernanose and their co-workers at the Nancy-Université in France made their first observations of electroluminescence in organic materials. In early 1960s great scientist Pope's gathering additionally first observed direct current (DC) electroluminescence under vacuum on an unadulterated single crystal of anthracene and on anthracene crystals doped with tetracene in 1963 with the help of a small area silver electrode at 400V which was quite unique. The anticipated mechanism was field-accelerated electron excitation of molecular fluorescence. In 1965 Pope's group informed that lack of presence of an external electric field, the electroluminescence in anthracene crystals is carried about by the process of recombination of a thermalized electron and holeand that the conducting level of anthracene is greater in energy than the exciton energy level.

## OLED vs LED

Electronically, OLED is like old LEDs , put a low voltage across them and they glow. In any case, that is the extent that the comparability goes: rather than being made out of semiconducting metals, OLEDs are produced using polymers, plastics or other carbon-containing mixes. These can be made cheaply and transformed into gadgets without all the expensive palaver that goes with semiconductor fabrication.

Light-producing diodes, in view of semiconductors, are generally used in indicator lamps, in spite of the fact that they were used in calculator before liquid crystals, and are utilized in huge advertising signs, where they are esteemed for long life and high brightness. Such crystalline LEDs are not economical, and it is hard to integrate them them into small high-resolution displays.Since light-producing diodes, as their name proposes, really produce their own light while utilizing almost no battery power, they have long been viewed as an obviously better way to create displays. Shockingly, while regular L.E.D's. function admirably in giant screens and advertising displays like those in Times Square, cannot easily be used to make little, high-resolution screens for portable PCs.

OLED is an emissive display innovation dependent on slim organic light-emitting films. Like conventional inorganic light radiating diodes (LED), OLED requires a low-drive voltage to emit visible light. Since OLEDs are self-glowing, backdrop lights are not needed as in liquid crystal displays (LCDs). OLEDs needs low power requirements (still high performance) and are thin, bright.

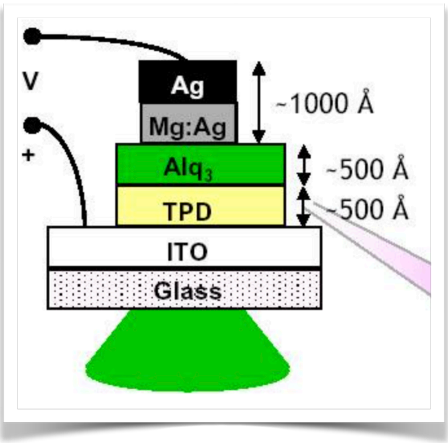
Since crystalline order isn't needed, organic materials, both molecular and polymeric, can be deposited far more cheaply than the inorganic semiconductors of conventional LED's. Designing is additionally simpler, and may even be cultivated by techniques obtained from the printing industry. Displays can be be prepared on flexible, transparent substrates such as plastic. These characteristics form the reason for display technology that can eventually supplant even paper, providing a similar resolution and perusing comfort in an enduring, completely reusable (and in the long run recyclable) digital medium.also OLEDs are significantly more effective than todays sections concerning power utilization and created light. Normal light producers today, Light Emitting Diodes (LEDs) and normal light bulbs consume more power, To tell something about the efficiency of components, the idea of Quantum Efficiency (QE) is used, which is characterized as the connection between photons produced and electrons injected. It has been commonly seen that organic gadgets can and will deliver high quantum efficiencies then organic diodes do.

The fundamental theory remains the same. Via the conduction of electricity to the organic materials sandwiched between the electrodes, OLED emits light. On the other side, by conducting electricity to inorganic materials sandwiched between electrodes, the LED emits light. The following are the characteristics of each lighting form :

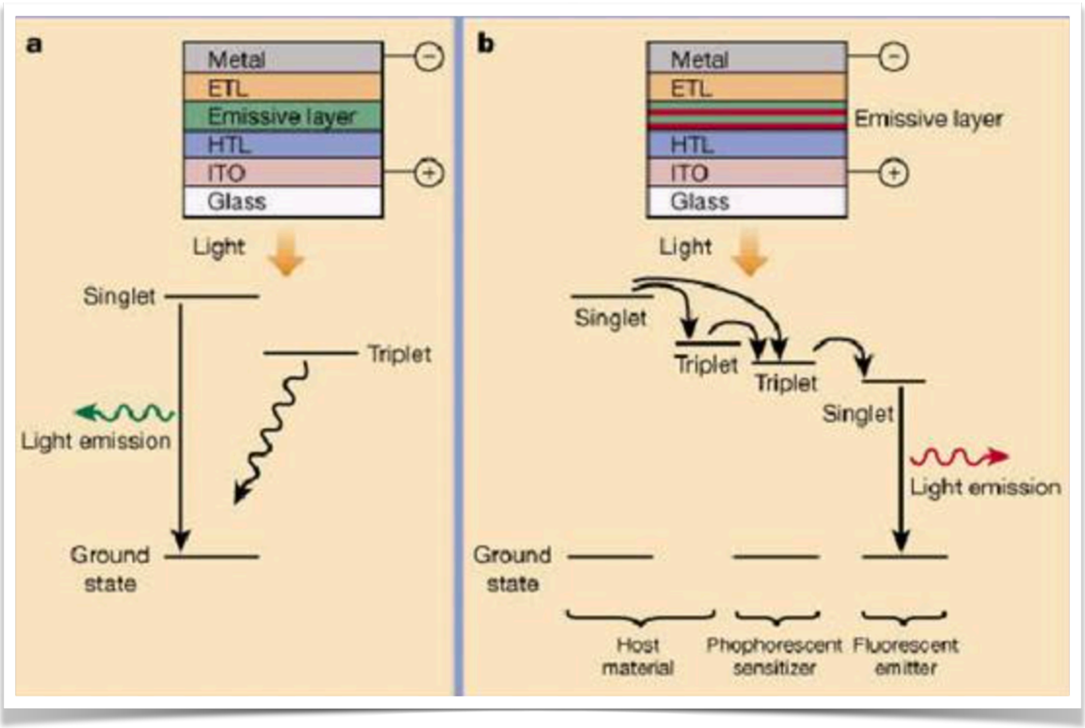
| **OLED lighting** | **LED lighting** |
|---|---|
| Thin and light weight | Easy downsizing |
| Low intensity | High intensity |
| Surface light source, diffused light | Point light source, light with high directivity |
| Easy to dissipate heat | Hard to dissipate heat |

## The operation of an OLED

The Organic Light Emitting Diode (OLED) is a p-n diode that recombines charge-carriers (e-h pairs) into an organic layer to emit photons. This layer's thickness is approximately 100 nm (experiments have shown that the optimum thickness is 70 nm). An excited state called an exciton is created when an electron and a hole recombine. The arousal is either a singlet or a triplet, depending on the spin of the e-h pair. Two separate spins, spin up and spin down, can be made by an electron. When the spin of two particles is the same, they are said to be in a spin-pair or triplet state, and they are in a spin-paired singlet state when the spin is opposite.



On average, for every four electron-hole pairs, one singlet and three triplets are created, and this is a major inefficiency in diode activity. Within a few nanoseconds, a singlet state decays very rapidly and thus emits a photon in a process called fluorescence. However, a triplet state is much longer-lived (1 ms-1 s), and usually only generates heat. One way of improving the efficiency is to connect one of the layers in the OLED to a phosphorescent material. Through adding a heavy metal, such as iridium or platinum, this is achieved. Then, the exciton will transfer its energy to a phosphorescent molecule that emits a photon in response. However, it is a problem that few phosphorescent materials at room temperature are effective emitters.




Devices have been developed that convert both singlet and triplet states in the fluorescent dye into a singlet state in a host. This is accomplished by using a phosphorescent compound that transfers its energy to both the singlets and triplets, in which the compound transfers its energy to a fluorescent material that then emits light.

There are several issues associated with using one organic layer. The energy levels of the electrodes need to be very precisely matched, otherwise the electron and hole currents would not be balanced properly. This results in a loss of energy because, without recombining, charges will then move through the entire structure and this decreases the device's efficiency. The situation improves significantly with two organic layers. For electrons and holes, respectively, the various layers can now be optimised. At the interface of the materials, the charges are blocked and "wait" for a "partner there.”

## OLED Advantages and Disadvantages

**Advantages :**

- The plastic, organic layers of an OLED are thinner, less heavier and more flexible unlike the crystalline layers in an LED or LCD.
- OLEDs are brighter than LEDs. As the organic layers of an OLED are not much thicker than the equivalent inorganic crystal layers of an LED, the conductive and emissive layers of an OLED can be single or multi-layered. Also, LEDs and LCDs require glass support, which absorbs some light and reduces brightness. OLEDs do not require glass.
- OLEDs generate light themselves that's why they don't require backlit like LCDs. This makes them way more power efficient. This is specially important for battery-operated devices such as cell phones, laptops.
- Production of OLEDs are much more easier than LCDs.
- OLED screens have more viewing angle than LCDS or normal LEDs.

**Disadvantages :**

- Red and Green OLED films have significant lifetime but blue films have very short lifetime comparatively.
- Manufacturing of OLEDs is costly.
- OLEDs can be easily damaged by water.

## Current and future OLED applications

As of now, OLEDs are utilized small screen gadgets, for example, mobile phones, PDAs and digital cameras. Innovations in the field of OLEDs is proceeding way crazier and may lead proceeding rapidly future applications in heads-up displays, automotive dashboards ,bill- board type display , home and office lighting and adaptable displays.. Since OLEDs has higher refresh rate than LCDs ,right around thousand times higher, a gadget with an OLED display could change data in nearly zero time. Videos could be substantially more practical and continually refreshed.