Organic Light Emitting Diode: "A New Era in Display Techniques"

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Abstract -This article is a study of various parameters of Organic Semiconductor light emitting device such as transmittance, reflectance, thickness, absorption, refractive index, extinction coefficient, life time and out coupling efficiency. We are fabricating an organic display device using Thin Film Spray Pyrolysis Deposition Method. ITO glass substrate, Alq$_3$ we are using for providing potential gradient to emissive layer.

Organic Light Emitting Diodes (OLED), a quantum leap in display technology in the field of organic display was achieved in 1987 by Tang and Van Slyke from Kodak where they developed an efficient OLED by using p-n heterostructure devices including thin film and organic material. Inside the OLED emissive electroluminescent layer is fully organic film and it emits light when current applied on it. Organic Light Emitting Diode devices are new rising technology with high convenience in display market. On the other hand, is a portable, reusable display medium, typically thin and flexible. An enormous amount of research effort into the field all around the globe has made it sufficient to compete with other display technology rather now it is ahead of any available display technique.

Keywords: OLED, ITO, Alq$_3$, Transmittance, Absorbance, Extinction Co-efficient, Spray Pyrolysis.

I. INTRODUCTION

The basic organic devices are formed in sheets where a layer located in between cathode and anode known as emissive organic layer and substrate deposited on it. The OLED substrate can be glass or metal or a polymer plastic. Organic light-emitting devices operate on the phenomenon known as electroluminescence in which the electrical energy is converted into light.

Passive Matrix OLED

In PMOLED's the strips are placed like rows and columns in between the organic layer in other side of the substrate. PMOLED's required more power as compared to the other OLED's.

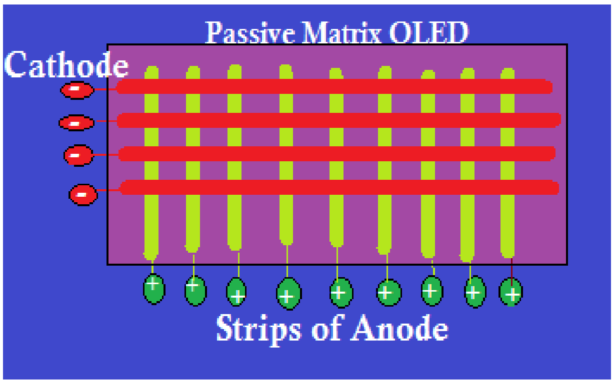


Fig 1. Structure of AMOLED

Active Matrix OLED

In AMOLED's the organic layer placed in between cathode and anode. Anode layer consist of black thin film transistor (TFT) which forms a matrix. It possess two TFT array per pixels one to start and second to stop the charge, so this device consumes less power than passive devices.

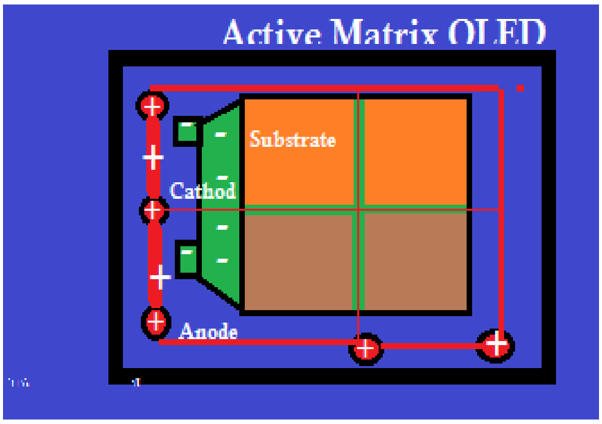


Fig 2. Structure of PMOLED

WORKING

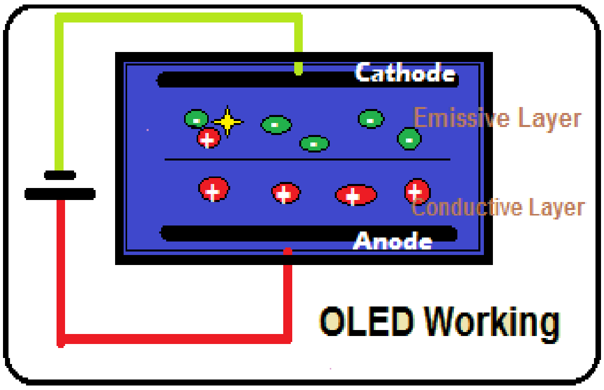


Fig 3. Working of OLED

OLED's are made using thin films of organic material which are sandwiched in between an anode and cathode. There are a variety of organic materials that can be used for such films. The general structure for an OLED consists of four thin film layers deposited on a substrate. The first layer is the cathode which is typically made of Mg:Ag. Under this layer is an electron transport layer, typically made of Alq_3. The third layer is the hole transport layer. Lastly, fourth layer is the anode, which is typically made of indium-tin-oxide (ITO). The substrate is made of either a glass or transparent plastic. When a voltage is applied across the two inner layers the holes and electrons combine forming excitons. When an exciton decays, a photon is emitted [4].

Layer Thickness

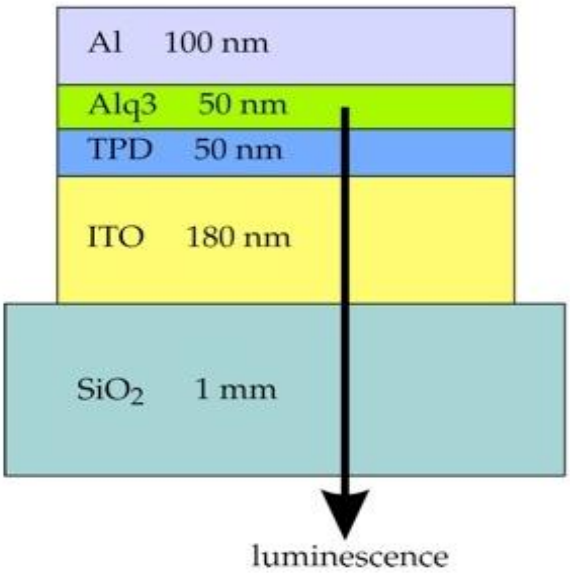


Fig 4.Thickness of OLED Layers

II. MATERIALS FOR FABRICATION

ITO (Indium tin oxide) is widely used in transparent display technology .It have two major property first is Electrical conductivity and second is Optical transparency so we use ITO as an anode in our project. As we increase it thickness the conductivity decreases and vice versa.

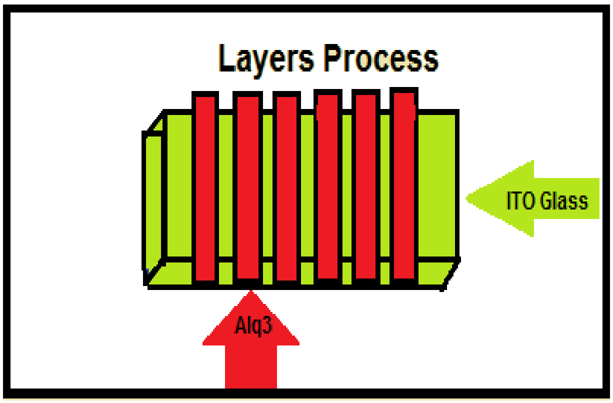
Hole Transporting layer- N, N'-bis (naphthalen-1-yl)-N,N'-bis (phenyl) benzidine.

Electron Transporting Layer / Emission Transporting Layer : Since the first report of efficient and stable OLEDs [1,2], tris (8- hydroxyquinoline) aluminum (Alq_3) –which is used as the emission and electron transport layer, the interest in this archetype material is persistent. Properties such as relative stability, easy synthesis, good electron transport, and emitting properties result in extensive application of Alq_3 in OLED design. Tang and coworkers discovered Alq_3-based multi-layer thin-film electroluminescent devices in 1987[1]. Alq_3 still continues to be the workhorse among the class of low molecular weight materials for OLEDs. Research into organic materials for use in OLEDs has mostly focused on conjugated polymers or low molecular weight materials [3].

Cathode- Aluminum is remarkable for the metal's low density. Aluminum is a relatively soft, durable, lightweight, ductile and malleable metal with appearance ranging from silvery to dull gray, depending on the surface roughness. Aluminum is a good thermal and electrical conductor, having 59% the conductivity of copper, both thermal and electrical, while having only 30% of copper's density.

III. SPRAY PYROLYSIS METHOD

Technique we considered for deposition of thin film layers of OLED. Unlike many other film deposition techniques, spray pyrolysis represents a very simple and relatively cost-effective processing method (especially with regard to equipment costs). It offers an extremely easy technique for preparing films of any composition. Spray pyrolysis does not require high-quality substrates or chemicals. The method has been employed for the deposition of dense films, porous films, and for powder production. Even multilayered films can be easily prepared using this versatile technique [5].



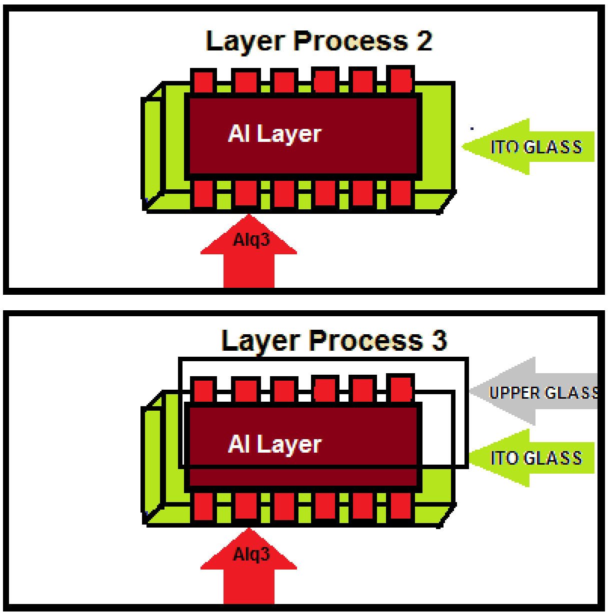


Fig 5. Thin Film Deposition Technique

IV. EFFECTIVE PARAMETERS

Transmittance & Absorption

Some compounds absorb light and some does not absorb the light. According to the spectroscopy the transmittance is the incident light passing through the sample.

In the above figure Light (**P_o**) entering the sample and absorption takes place and it comes out in after leaving the sample its value is **(P).**

According to Beer's Law,

Transmittance – T = P/P_o

Absorption – A = $\log_{10} P_o/P$

Thickness (cm)	0	0.2	0.4	0.6	1.0
%T	100	50	25	12.5	3.125
Absorbance	0	0.3	0.6	0.9	1.5

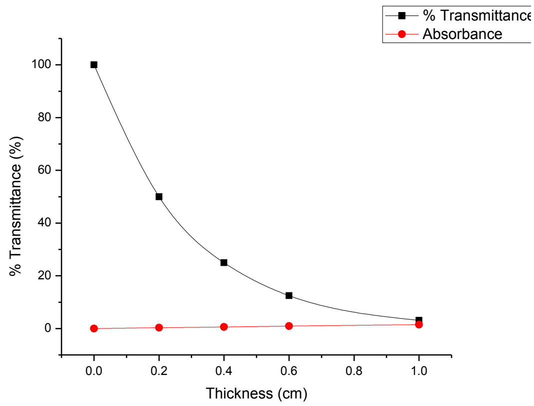


Fig 5. Plot Thickness v/s Transmittance & Absorbance

Extinction Coefficient

We are using Ellipsometry method for calculating the complex refractive index of thin film formed over the substrate. A measure of the rate of diminution of transmitted light via scattering and absorption for a medium. It is a parameter defining how strongly a substance absorbs light at a given wavelength as per mass density or per molar concentration.

Thickness

Again Ellipsometry method we are using for calculating the thickness of film. Typically, the measured signal is the change in polarization as the incident radiation (in a known state) interacts with the material structure of interest (reflected, absorbed, scattered, or transmitted). The polarization change is quantified by the amplitude ratio, Ψ, and the phase difference, Δ. Because the signal depends on the thickness as well as the materials properties. Ellipsometry can be a universal tool for contact free determination of thickness and optical constants of films of all kinds.

V. CONCLUSION

An entirely new era in display technology that offers improved performance as well as novel applications, is molded with the application of organic semiconductor for display application. Full color displays using OLEDs are in the position to replace LCDs in the small scale display market. OLEDs offer a decreased manufacturing cost, a brighter, more vibrant display, as well as a larger viewing angle. Lower power consumption makes OLED perfect for portable devices which rely on battery power. Current research all around the globe is focused in increasing its brightness, lifetime and out coupling efficiency.

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