International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 7 Issue 7 Ver IV || July 2018 || PP 39-45

Optimized Current Efficiency Using Different Anode Oxide Layers

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Abstract: *The Given paper propose the three layers of Oxide/Metals/Oxide to be used as anode, different material being used to differentiate their properties and compatibility with light emitting materials. Four structures are being experimented to find the better three layer structure having improved Current efficiency at the place of ITO using the setfos software. ITO being inflexible in nature therefore OMO layer is used as anode to increase the Output against the given input, has high transmission and is pliable in nature, therefore it is used. These layers have high Emission rate of different wavelength in the range 575 to 580nm with Luminance efficiency belongs to MoO3/Au/MoO3 of 473.8452 and highest current efficiency belongs to IZO/Ag/IZO of 64.9561 is obtained.*

Keywords*-Evolution, Indium tin oxide (ITO), organic light-emitting diodes (OLEDs), Recycling, Renewable resources, Transmittance.*

Date of Submission: 05-07-2018 Date of acceptance: 19-07-2018

I. Introduction

The increasing demand of greener methods and the gradual depletion of non-renewable sources, Organic LED has gained the spotlight of the global activities. Since the non-renewable resources are depleting inn a greater extend and one cannot acquire the benefits of these resources in future. Therefore it has become a necessity to get a new technology which is renewable. The main renewable resources are SOLAR energy, WIND energy, TIDAL energy, THERMAL energy etc; therefore the greater amount of research and work is being carried out in these areas. Main focus is on the solar energies. The category of research is carried out in SOLAR CELLS, and LED's. In these areas instead of using the p and n type semiconductors, the ORGANIC materials are implied. Organic gadgets made principally from carbon-based atomic mixes and other natural materials. The hardware configurations are drastically changing due to advancement in technology related to organic light-emitting diodes.

Organic optoelectronic devices are exploited in different applications that range from show and the lighting on account of natural light-radiating gadgets (OLEDs), to solar cells, sensors and wearable hardware. Regularly, the benefit of an about boundless assortment of materials is reduced by tedious and entangled trial streamlining methodology.To diagnose and heal various neurological diseases like epilepsy, stroke, seizures, paralysis, depression, schizophrenia, Opto-genetics is significantly effective tool. It controls the excitation, inhibition, or signaling pathways of optically excitable cells using light stimulation. Neurons are genetically modified and specifies light-gated ion channels in the cellular membrane that is sensitive to light incident on it by using a viral vector. Blue light activates cells expressing Channelrhodopsin-2 (ChR2). Yellow light silences cells expressing Halorhodospin. Then the nerve tissue,both surrounding and underneath the exposed tip, is illuminated using a laser or LED that is connected mechanically to the end of optical fiber[1]. Numerical recreations have turned out to be basic for picking up knowledge into the gadget material science, for removing physical parameters that administer electrical and optical qualities, and for enhancing device performance.

II. Oled

OLED were first announced in 1987 however are presently utilized wherever in business products[2], because of its quick reactions, wide survey points, extensive scale manufacture, simple to fabricate, low cost, and mechanical flexibility [3]. The source material purity and device encapsulationare improved to suppress metallic contamination, residual water, and other environmental contaminants. Various intrinsic methods like ionic migration [4-6], crystallization or decomposition of organic materials and charge accumulation[7] are analysed.

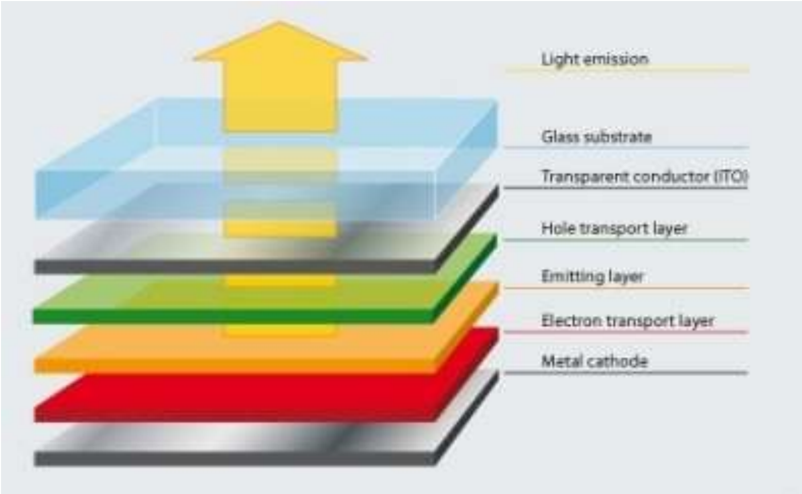

Fig 1: shows basic OLED structure

An OLED consists of the HTL layer, ETL layer, EMISSIVE LAYER, cathode and an anode. The top and bottom layers are mainly the cathode and anode. And in between these HTL, EMISSIVE LAYER and ETL is present. To develop unbelievable zone and adaptable light sources highly innovative advancements is used in OLED. Thin ITO layers are used as anode in commercial OLEDs. ITO is conductive, transparent and colorless. Inspite of it's great use in OLED displays, it has the disadvantage that indium is a rare element with steeply increasing cost. Also ITO deposition requires complex technologies and is expensive[8-10].Energy requirement of producing ITO electrodes is also very high nearly 90% of the total needed to make all materials used to fabricate representative thin-layer devices [11]. ITO has some problems like High temperature required in processing, flexibility limitation, low chemical and thermal Stability. A low refractive file electron transport layer (ETL) is very useful to suppress radiation loss in transient mode.Multilayer structures with high triplet charge blocking layers are formed to control radiative recombination. This causes the confinement of excitons in the emission layer. ETL is the intermediate layer between the EML and the cathode. So it can determine the light extraction efficiency [12]. Thus for better efficiency and device working, the HTL and ETL layers must be of compatible materials.

The software used for analysing the numerical stimulations is the semiconducting thin film optics Simulation software (setfos) provides the means to perform such numerical simulations. Setfos is powerful but easy-to-use simulation software customized to the development of novel optoelectronic thin-film-based technologies.Nowadays three layer structures are used as anode to check the increase and decrease in the current efficiency and to find a suitable structure to give more output in terms of efficiency and emission rate and the wavelength at which the OLED is highly emitting.

III. Experiment

3.1 Introduction

In this investigation Basic structure of the OLED was used and triple structures of anode are used and compared. Al(100nm), LiF(2nm), MEHPPV(30nm), NPB(60nm), and then the three layer anode is used Lithium Fluoride (LiF) is used as an Electron injection layer(EIL) having width 10nm, Alq3 acts as an Electron transport layer (ETL) width of Alq3 is 30nm, N,N'-Bis(naphthalen-1-yl)-N,N'-bis(phenyl)benzidine (NPB) (20 nm), NPB is a n HTL and Alq3 is an ETL. Alq3 behaves as the emitting layer and LiF acts as the electron injection layer[13].

3.1.1 Anode Layers

The three layer structure anode are used have same width used for all substances.In IZO(40nm)/Ag(12nm)/IZO(40nm), the electrical properties of devices are improved by using IZO contactthus reducing the operating voltage.Voltage drop decreases for the devices having IZO used in anodes. MoO_3(40nm)/Au(12nm)/MoO_3(40nm)/, has superior hole injection properties in comparison with other anodes. It has high transmittance. ZnO(40nm)/ Ag(12nm)/ZnO(40nm), has significantly improved transmittance and electrical properties at 550 nm. At this wavelength, the transmittance ismaximum and gradually decreases with increase in wavelength. TiO_2(40nm)/Ag(12nm)/ TiO_2(40nm) provides high carrier mobility.

3.2 IZO(40nm)/Ag(12nm)/IZO(40nm)

The encapsulation, the indium zinc oxide considered as better candidate in place of ITO in the OLED technology so that grade up could be done the device reliability. As of, the devices with the ITO faces with the optical degradation to an extended end than devices with IZO as contact Reduction in the operating voltage was allowed due to the use of IZO contact leading the improvement in the electrical properties of the devices. The voltage drops for the devices with IZO contact while being higher for the OLED devices with ITO contacts. Also, the thermal resistance is lower for devices with IZO to that of ITO resulting to the less self-heating during operation adding up to the device optical stability. Devices with IZO have high reliability under the stress conditions and guarantying vital enhancements [**14**]. Devices built upon glass substrate having ITO and IZO as anode brings out the study leading the comparison on the optical and electrical parameters. Improved reliability provided by the use of IZO as anode ensures the higher lifetime of the devices using IZO as a contact to that of having ITO.

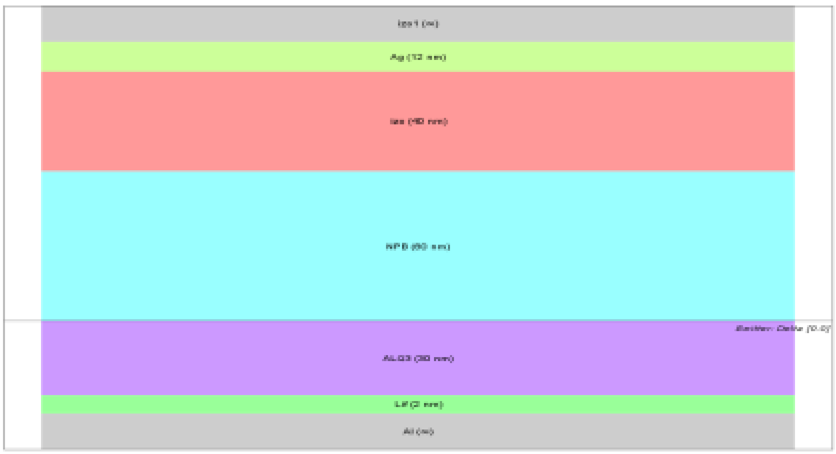

Fig 2: The structure of the OLED used IZO/Ag/IZO as anode

3.3 MoO_3(40nm)/Au(12nm)/MoO_3(40nm)

For the transparent electrode OLED use of multilayer MoO/Ag/MoO has been done. The whole viewing angle of devices using ITO is similar to that of dielectric/metal/dielectric multilayer devices emission intensities. The effectiveness of hole injection is by the insertion of MoO_3. Superior hole injection properties were shown with the uuse of dielectric/metal/dielectric to that of ITO. The MoO/Au/MoO_3 multilayer device having a glass substrate is prepared by vapour decomposition. Similar attainment of bright emission in both OLED's based on IZO and ITO. Barrier height in IZO is smaller in comparison to ITO.

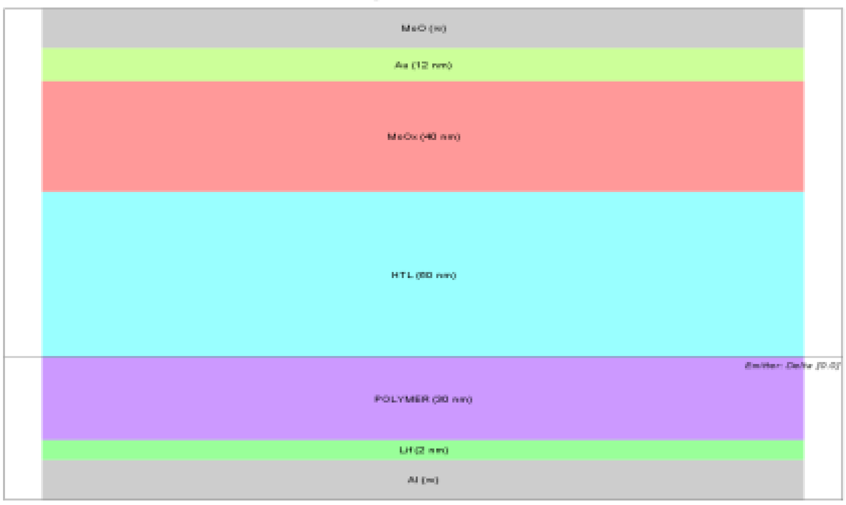

Fig 3: The structure of the OLED used MoO_3/Au/ MoO_3 as anode

TiO_2(40nm)/Ag(12nm)/TiO_2(40nm)

It is highly transparent conductive (ρ~9.5* 10^$^{-4}$) oxide having high carrier mobility of 10cm^{2}V^{-1} s^{-1}

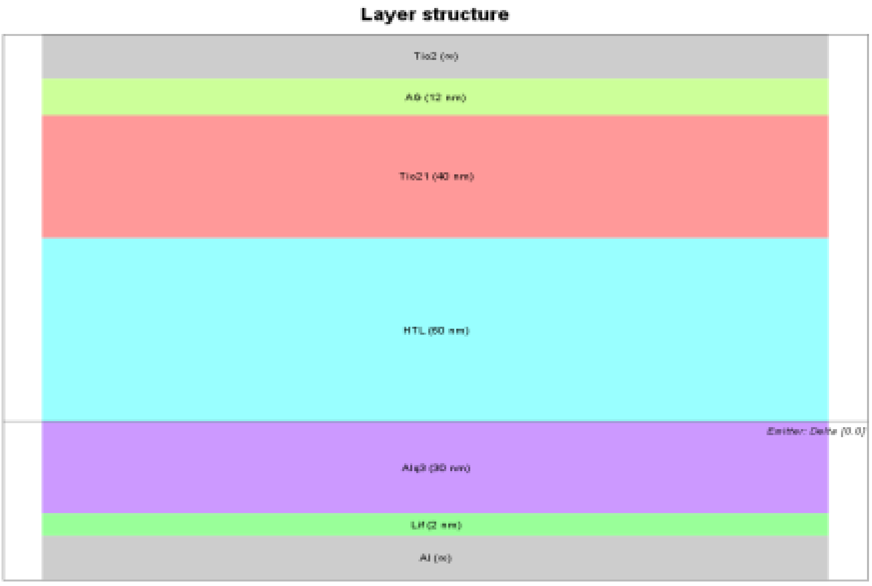

Fig 4: The structure of the OLED used TiO_2/Ag/ TiO_2 as anode

3.5ZnO(40nm)/Ag(12nm)/ZnO(40nm)

In the visible region, widening of transmittance window and the decrease in resistance sheet is led by the insertion of Ag between the ZnO layers. Reach to the maximum and the gradually decrease of transmittance of the multilayer film with the increase In the wavelength whereas the case scenario in ITO is that there is overall reach to maximum and then slightly decrease. In comparison to ITO, ZnO/Ag/ZnO yields higher optical transmittance and significant better electrical properties.

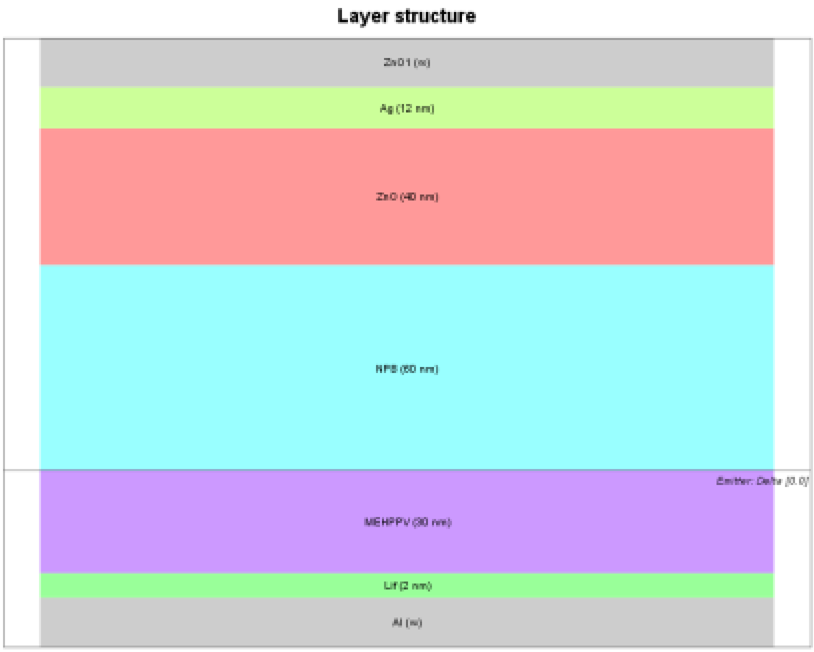

Fig 5: The structure of the OLED used ZnO/Ag/ZnO as anode

IV. Result

ZnO/Ag/ZnO and TiO_2/Ag/TiO_2 is having peak wavelength 580nm. IZO/Ag/IZO has maximum emission at 579nm MoO_3/Au/MoO_3 gives its high emission at 578nm.This may be conclude from thesevalues that maximum emission from all these layers is in the range of 575nm to 580nm. Current efficiency of IZO/Ag/IZO is maximum, luminance efficiency of MoO_3/Au/$MoO_3$is better.. Current efficiency of IZO/Ag/IZO is 1.16% higher than TiO2/Ag/ TiO2, 6.68% higher than MoO3/Au/ MoO3, 2.8% higher than ZnO/Ag/ZnO.
Given layers are anode triple structures for experimenting the better three layers or their compatible
Structure A composition of anode IZO(40nm)/ Ag (12nm)/ IZO (40nm),

Structure B composition of anode MoO_3(40nm)/ Au(12nm)/ MoO_3(40nm),
Structure C composition of anode ZnO(40nm)/ Ag(12nm)/ZnO(40nm),
Structure D composition of anode TiO_2(40nm)/Ag(12nm)/ TiO_2(40nm).

Table

Different composition of Anodes				
Structures	A	B	C	D
Luminance [cd/m2]	6495.6141	6088.1345	6713.9503	6420.4876
Luminance Efficiency [lm/W]	453.6569	473.8452	452.5836	452.6355
Current Efficiency [cd/A]	64.9561	60.8813	63.1795	64.2049
Wavelength[nm]	579	578	580	580

Table: Shows comparison of all anode layer results.

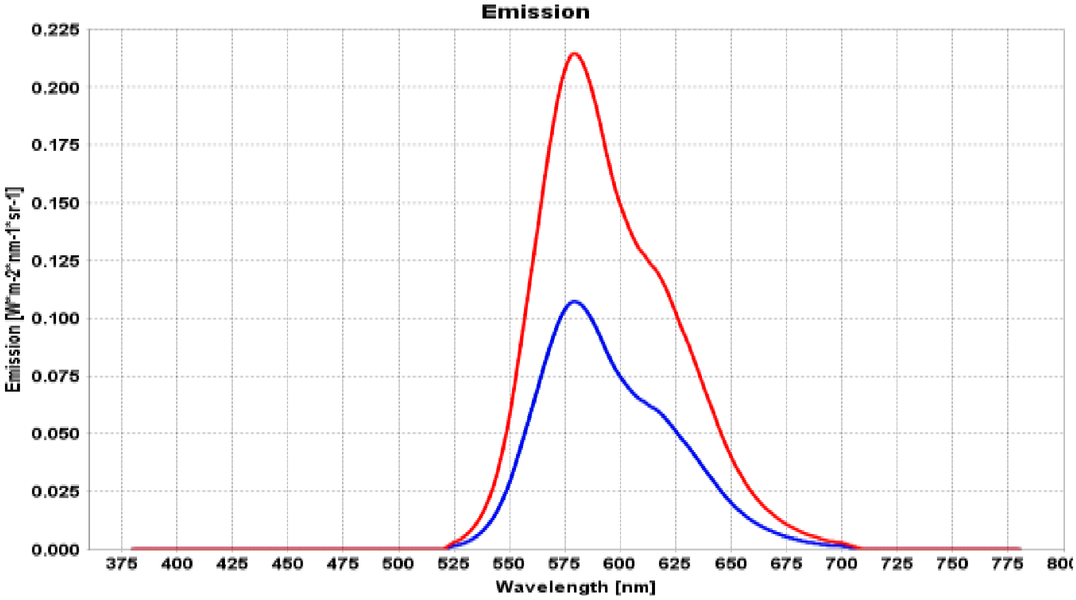

Fig 6:Emission of IZO/Ag/IZO anode structure at different wavelengths having maximum efficiency

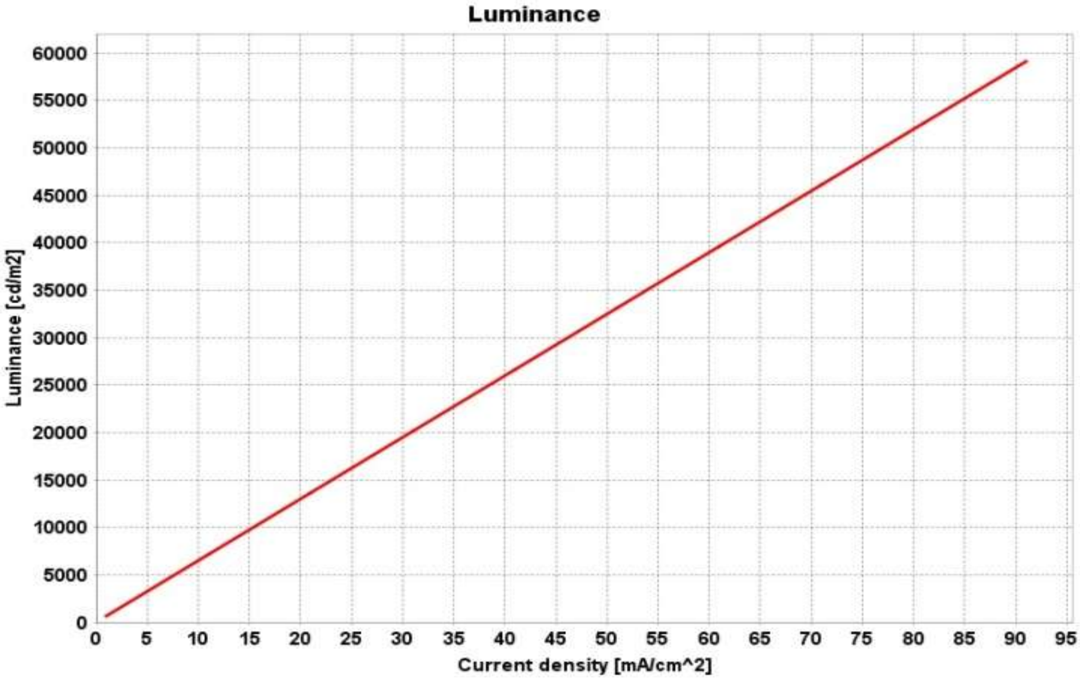

Fig 7: Luminance of IZO/Ag/IZO anode structure at different Current density having maximum efficiency

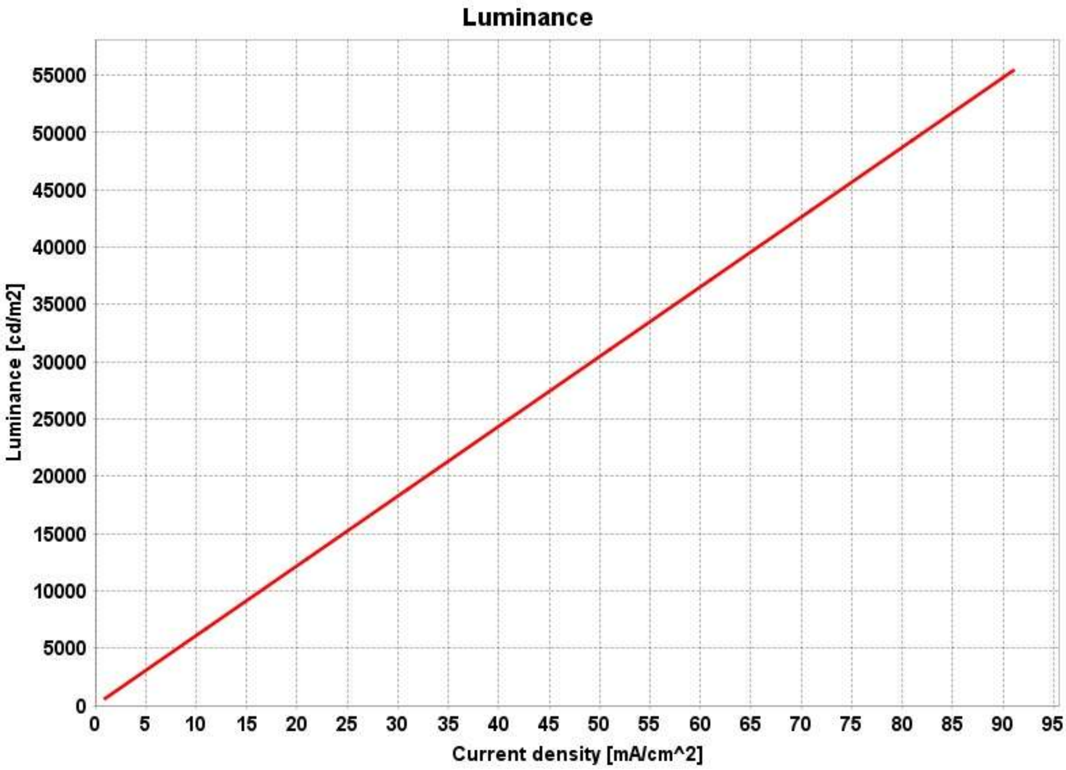

Fig 8: Luminance of anode structure at different Current density $MoO_3/Au/MoO_3$.

V. Conclusion

Current efficiency of IZO/Ag/IZO is higher among all the three layer structures of anode.Current efficiency ofIZO/Ag/IZO is 1.16% higher than $TiO_2/Ag/\ TiO_2$, 6.68% higher than $MoO_3/Au/\ MoO_3$, 2.8% higher than ZnO/Ag/ZnO. It is significantly higher than others because the use of IZO contact leads to improvement in the electrical properties of the devices.IZO has high reliability under the stress conditions and guarantee vital enhancement.It's maximum emission wavelength is 579nm, it gives high emission at this wavelength. However, it's luminance efficiency is lower than $MoO_3/Au/MoO_3$by 4.45%.

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Nisha Sharma"Optimized Current Efficiency Using Different Anode Oxide Layers "International Journal of Engineering Science Invention (IJESI), vol. 07, no. 07, 2018, pp 39-45