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IMPROVEMENTS EFFICIENCY IN ORGANIC LIGHT EMITTING DIODES (OLED) USING BUFFER AMPLIFIER AND REDUCE THE OPERATING VOLTAGE

Kaushik Nigam, Prof. Amrita Khera
Department of Electronics & Communication Engg. Trinity Institute of Technology & Research, Bhopal

ABSTRACT: **Organic light emitting diodes (OLEDs) are being commercialized in display applications, and will be potentially in lighting applications in the near future. This paper is about the design of high performance OLEDs, which includes both the electrical and optical design of OLEDs. In particular, the following work is included in this thesis Energy level alignment and charge injection at metal/organic interfaces has been systematically studied. ii) Transition metal oxide anodes have been developed to inject sufficient holes into the OLEDs due to their high work function. The oxide anodes have also been used to systematically study the transport properties in organic semiconductors. iii) Highly simplified OLED devices with unprecedentedly high efficiency have been realized using both fluorescent and phosphorescent emitters. The high performance was enabled by using a high work function metal oxide anode and a hole transport material with very a deep highest occupied molecular orbital (HOMO). iv) An optical model has been developed to describe the optical electric field across the OLED device. By using the model, a high performance flexible OLED using metal anode was designed and realized. OLED power management on mobile devices is very challenging due to the dynamic nature of human-screen interaction.**

Index Terms: Organic light emitting diodes (OLEDs), HD to Full HD, screen scrolling, 4K Ultra HD, low power.

I. INTRODUCTION

Organic light-emitting diodes (OLEDs) have been extensively developed over the past few decades owing to their potential application in digital displays and solid-state lighting. For an energy-saving illumination light source, phosphorescent OLEDs (PhOLEDs) have considerable advantages over fluorescent OLEDs because PhOLEDs can give unity internal quantum efficiencies through radiative recombination of both singlet and triplet excitons in a conventional device, ITO is used as anode while metal electrode acts as cathode. Compared with the conventional structure, the inverted OLEDs (IOLEDs) which use the air stable metals as anode and indium-tin-oxide (ITO) as the cathode However, there exist many technical challenges for the mass production of large OLED panels, such as significant efficiency roll-off and an undesired low efficiency at high luminance, which is unfavorable for their commercial realization for lighting. Meanwhile, the high cost and energy consumption restrict the development of OLEDs Recently, inverted organic light-emitting devices (IOLEDs) have received considerable attention because of their extremely-low efficiency roll-off and a significant lifetime improvement Nevertheless, IOLEDs still face some problems such as low efficiency and high operating voltage One of the key factors to reducing turn-on voltage is the efficient charge injection, which is generally achieved by matching work functions of the electrode of the anode and cathode to the highest occupied molecular orbital (HOMO) levels and lowest unoccupied molecular orbital (LUMO) levels of the organic semiconductors, respectively. Last several years, some metal oxides have been investigated for efficient electron injection, with some success, and efficient IOLEDs have been realized by employing zinc oxide or tin dioxide In addition, the use of high mobility hole -electron transportation materials will also reduce the high operating voltage and alleviate efficiency roll-off. However, some transportation materials have excellent charge transmission ability but very lower triplet level than the emitter, which may give rise to the excitons leaking from the EML. Therefore, it is necessary to insert an electron blocking layer (EBL) which has a high triplet level between the HTL and EML to confine the excitons in EML completely. Organic light-emitting diodes (OLEDs) have emerged as the most favorable alternative to liquid crystal displays (LCDs) in portable display devices like smartphones, smart watches, digital cameras, MP3/MP4 players, etc. This is because they offer numerous disruptive features, such as energy efficient, lightweight, ultra-thin, mercury free, diffuse surface emission, very high color rendering index (CRI), and potentially low cost Recently, some large size OLED televisions (TVs) have also commercialized and their efficiencies and lifetimes are sound at the comparatively low required luminance. In 2013, LG had commercialized 55″ curved OLED TVs. LG also introduced 65″ and 77″ ultrahigh definition (UHD) full-color OLED TVs in March Several large display companies, such as Sharp, AU Optronics, BOE Display, Panasonic, Skyworth, Changhong, and Konka are very close to launching similarly large TVs in the near future Although a noteworthy advancement has been made in OLED technology, there are still immense challenges to realize the high efficiency and long lifetime at high brightness, especially for illumination applications According to the International Energy Agency’s 2006 report, lighting consumes about 20% of total generated electric energy. It accounts for 30% to 40% of total energy consumption in residential buildings, industrial buildings, and offices. Especially in developing countries, a major amount of building light is consumed by energy-inefficient light sources such as incandescent bulbs Currently highly energy saving and long-lasting lighting sources are in demand to solve the energy crisis. In recent years, both academics and industries have made a considerable effort to devise novel display and lighting techniques like light-emitting diodes (LEDs) and OLEDs Nowadays, OLED has already reached fluorescent tube efficacy To realize even more efficient OLED devices, a large number of different approaches have been reported, such as thin device layer structures, low charge carrier injection barriers, high charge carriers (hole and electron) mobilities, balanced carrier injection, effective carrier confinement, effective host-to-guest energy transfer, a wider recombination zone, effective exciton generation on host, effective exciton confinement, p-i-n structures, and tandem structures Several of these are especially effective in improving device efficiency at high applied luminance. In past years, the employment of a nano carrier modulation layer (CML) has been recognized as being able to regulate the charge carriers into the available wider recombination zones, and hence obtain a higher device efficiency and reduce the efficiency roll-off at high brightness The incorporation of a high triplet energy CML between the emissive layers could effectively lead the carriers to recombine in a wider recombination zone, and exhibit a marked enhancement in brightness Different terminologies have been used by different research groups regarding the employed nano inter-layers, such as CML (as used in the present review article), carrier-regulating layer, spacer, inter-layer, mixed/blend inter-layer, hole modulation layer, and buffer layer.

The buffer consists of a biasing network, a rail-to-rail stacked-mirror differential amplifier and a push-pull output gain stage. In particular, both output branches of the stacked-mirror amplifier are profitably exploited to realize the two current comparators, which, unlike other antecedently proposed solutions, are therefore implemented without supplemental transistors and power consumption. Finally, in order to sanction the buffer amplifier to be capable of driving a wide range of load capacitance, phase emolument is performed by introducing a left half-plane zero, which is engendered by the load capacitance CL and the series resistor RC connected between the amplifier output and the load capacitor. As a minute-valued emolument resistance is required for the proposed buffer, stability is accomplished without any paramount degradation of slewing and settling performance. Organic light-emitting diode (OLED)-based display products have already emerged in the market and their efficiencies and lifetimes are sound at the comparatively low required luminance. To realize OLED for lighting application sooner, higher light quality and better power efficiency at elevated luminance are still demanded. This review reveals the advantages of incorporating a nano-scale carrier modulation layer (CML), also known as a spacer, carrier-regulating layer,

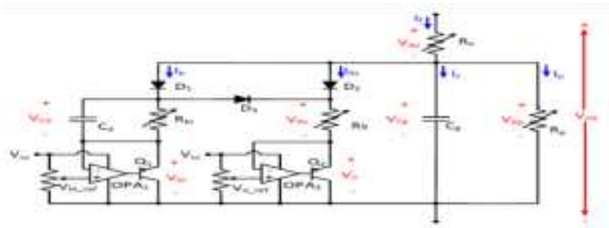


Fig. 1. Block diagram of implemented

presented a hardware emulator based on atheoretical equivalent model that can be used to emulate the static and dynamic behavior of OLEDs.Two OLED panels used in lighting applications have been evaluated. The experimental results of the OLEDs operating RGANIC Light-Emitting Diodes (OLEDs) are organic-material based surface light sources. The source of light is an emissive layer where electron-hole recombination produces light emission. Other layers such as, electron transport and electron injection layers, jointly with hole transport and hole injection layers are used to optimize the flow of electric current and enhance the device luminous efficacy [2]. The initial use of OLEDs was in display applications, such as, flat displays, smartphones and television screens [2], but their advantageous features, as lightness, thinness, broad emission surface and good color rendering index (CRI) have motivated the use of OLEDs also in general lighting systems, where they also are named OLED panels because of their large area. In addition, the availability of commercial devices with a luminous efficacy of 60 lm/W and a lifetime of 40,000 hours.

II. ORGANIC LIGHT EMITTING DIODES DISPLAY

Organic light emitting diodes or OLEDs originated from the class of LEDs as one of the major display technologies that differ with low power and combination of great colors. OLED technology uses the principle of electroluminescence which can be stated as the optical and electrical phenomenon wherein certain materials emit light in response to an electric current passing through it. These OLEDs are used to create digital displays in devices such as TV screens, computer monitors and portable systems like mobile phones, mp3 players and digital cameras, etc. These diodes are about 100 to 500 nanometers thick and 200 times smaller than human hair. OLED displays are very expensive than LCD displays because they use ink-jet printing technology and sprays conductive polymer substances instead of ink. OLED displays are advantageous as they are bright, clear, thin, light in weight, and possess an efficient viewing angle. Apart from this, they can be taken on various surfaces and can be printed on various surfaces. OLED lighting contains no mercury, and thus eliminates the disposal and pollution problems associated with the fluorescent lighting.

Fig.2. OLED Display

OLED displays are very expensive than LCD displays because they use ink-jet printing technology and sprays conductive polymer substances instead of ink. OLED displays are advantageous as they are bright, clear, thin, light in weight, and possess an efficient viewing angle. Apart from this, they can be taken on various surfaces and can be printed on various surfaces. OLED lighting contains no mercury, and thus eliminates the disposal and pollution problems associated with the fluorescent lighting.

Architecture of OLED Technology

OLED structure has many thin layers of organic material. These OLEDs compose of aggregates of Amorphous and crystalline molecules arranged in irregular pattern. When current passes through these thin layers, light gets emitted from their surface by a process of electro phosphorescence. OLEDs work on the principle of electro-luminescence, and this can be achieved by using multi-layered devices. In between these multi-layered devices, there are several thin and functional layers that are sandwiched between the electrodes. When Direct Current is applied, charge carriers from the anode and cathode are injected into organic layers, due to electroluminescence visible light gets emitted. The architecture of OLED display comprises several layers: two or three organic layers like conducting layer, emissive layer and other layers such as substrate, anode and cathode layers that are explained below in detail. Substrate Layer: This layer is a thin sheet of glass with a transparent conductive layer, which can also be made by a clear plastic layer or foil. This substrate supports the OLED structure.

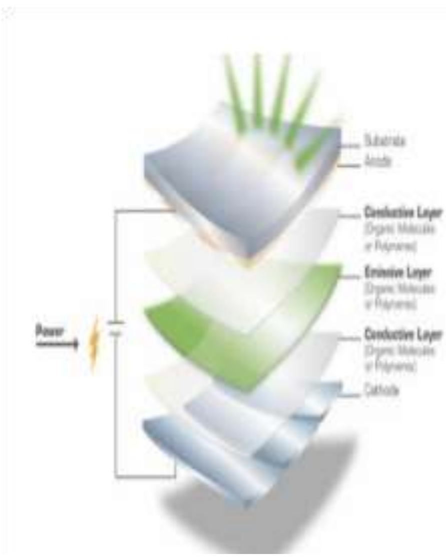


Fig. 3. Architecture of OLED Technology

Anode Layer: This layer is an active layer and removes electrons. When current flows through this device, electrons are replaced by electron holes. Thin layers are deposited onto anode surface, and therefore, it is also known as transparent layer. Indium tin oxide is the best example of this layer that serves as the bottom of the electrode or anode. Conductive Layer: Conductive layer is an important part in this structure that transports the holes from the anode layer. This layer is made up of organic plastic, and the polymers used include light-emitting polymers, polymer light-emitting diode, etc. The conductive polymer used in OLED are polyaniline, polyethylenedioxythiophene. This layer is an electroluminescent layer and uses the derivatives of p-phenylene vinylene and polystyrene.Emissive layer: This layer transports electrons from anode layers, and it is made of organic plastic molecules that are different from the conducting layers. There are multiple choices of materials and processing variables such that a wide range of wavelengths can be emitted during emission. In this layer, two polymers are used for emitting such as polyfluorene, poly para phenylene which normally emits green and blue lights. This layer is made of special organic molecules that conduct electricity. Cathode Layer: Cathode layer is responsible for injection of electrons when current flows through the device. Making of this layer is done by using calcium, barium, aluminum and magnesium. It may be either transparent or opaque depending on the type of OLED.

III. RESULTS

Simulation and results are obtained using MICROWIND software’s. Results illustrate the tracking behavior of the proposed output OLED buffer driven by a 50-kHz large-swing triangular wave and loaded with a large-size capacitance of 23000pF. As can be inspected, the output voltage basically follows the input voltage for a full dynamic range. To show the output driving performance of the discussed buffer, results depicts the simulated transient response to a 50-kHz full-swing input step for the same capacitive load. Slew-rate values are found to be 12V/µs and 14V/µs for the rising and falling edges, respectively, whereas positive and negative settling time values within 90% of the final output voltage are only .6µs and .78µs, respectively.. As can be observed, the output waveform follows the input waveform. The major performance parameters of the analyzed buffer are summarized and compared to other conventional topologies in which shows a remarkable improvement of the proposed amplifier over other previously reported OLED buffers.

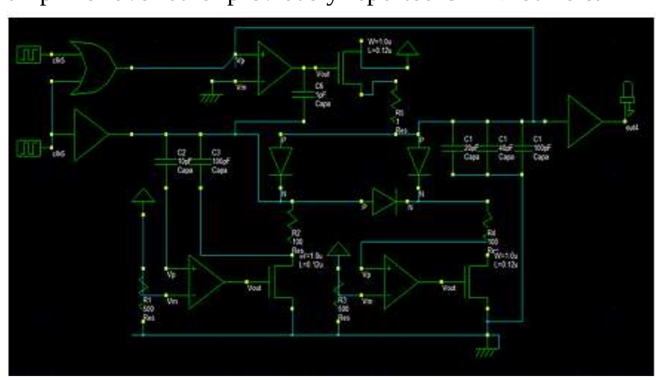


Fig.4. Circuit diagram of the OLED buffer

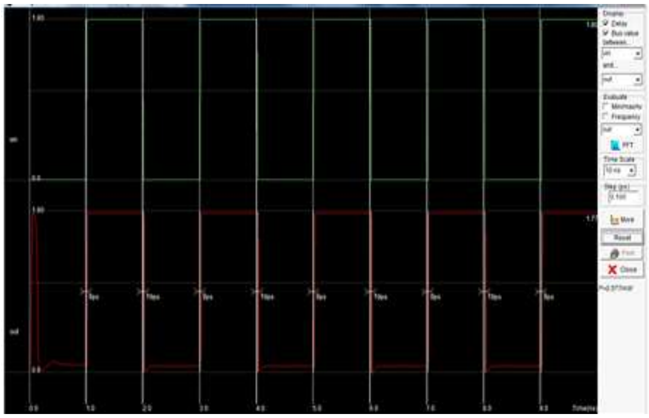


Fig.5. Output waveforms of the voltage at OLED buffer

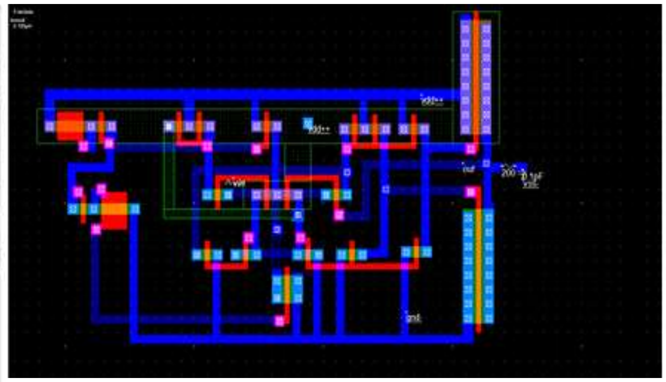


Fig.7. Layout of the implemented buffer

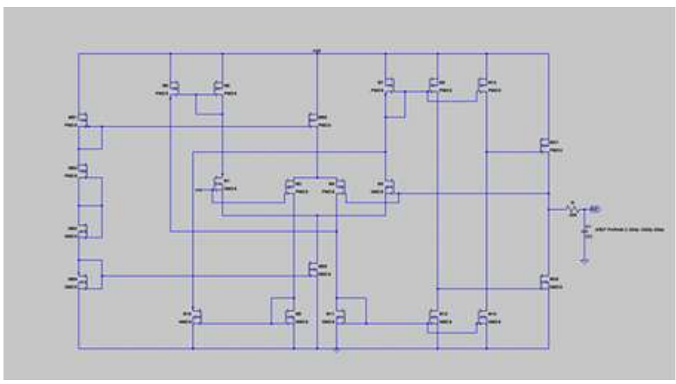
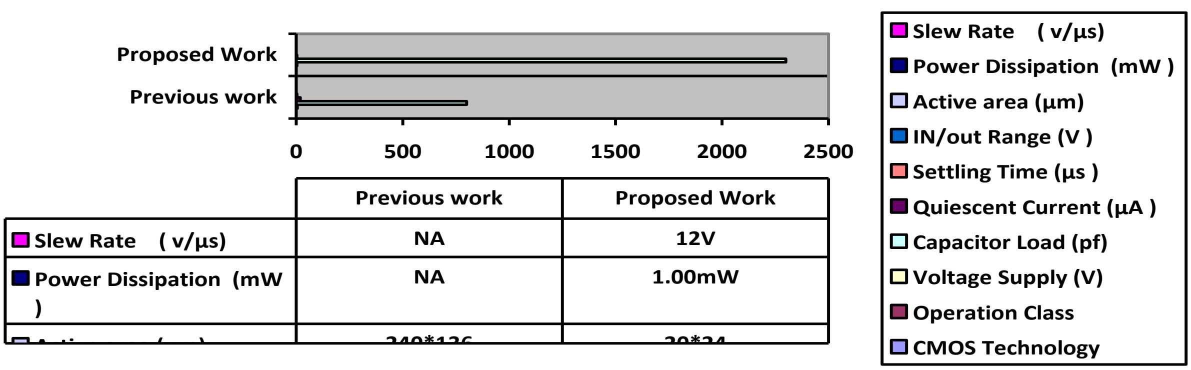


Fig.6. Circuit diagram of OLED buffer oscillator



	Previous work	Proposed Work
Slew Rate (v/µs)	NA	12V
Power Dissipation (mW)	NA	1.00mW

Comparison of OLED buffer previous work & Proposed Work

IV. CONCLUSION

A great progress has been made in the field of organic electronics and devices in terms of synthesis, development and applications of electron transport materials to improve the performance of OLED's. The effectiveness of the OLED device is governed by three important processes: charge injection, charge transport and emission. Light emission through phosphorescent dyes has been utilized in OLEDs and gives good results. OLEDs have achieved long operational stability. The performance of OLEDs meets many of the targets necessary for applications in displays. Research and development in the field of OLEDs is proceeding rapidly and may lead to future applications in heads-up displays, automotive dashboards, billboardtype displays, home and office lighting and flexible displays. OLEDs refresh faster than LCDs (almost 1,000 times faster). A device with an OLED display changes information almost in real time. Video images could be much more realistic and constantly updated. The newspaper of the future might be an OLED display that refreshes with breaking news and like a regular newspaper, you could fold it up when you're done reading it and stick it in your backpack or briefcase It is limpidly visually perceived in the results that the output waveform follows the input waveform. Withal the comparison table depicts a remarkable amelioration of the proposed amplifier over other antecedently reported buffers. Hence the high speed self-inequitable low power rail-to-rail class-AB buffer amplifier is implemented prosperously.

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