Applications of OLEDs for flexible electronics, Biophotonic, Chronic, Optogenetic applications & Different sensors.

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Abstract

Organiclight-emittingdiodes(OLEDs)areusedrecentlyinmostflexibleelectronic devices due to their manifold flexibility, less complexity, and lightweight. Due to these properties, it is attached with or bends easily to construct bendable devices, wearable flexible devices, and different types of sensors, microdisplays& antennas in 5G. This paper presents a review on OLED used in different flexible electronics devices as well as sensors in the last decade. OLEDs are used in biophotonics applications to diagnose and treat various neurological and phycactric diseases also used dynamic voltage scaling to reduce power consumption during video streaming applications in mobiledevices..

Keywords

OLED,5G, Antenna, Microdisplays, IoT, Sensors.

1. Introduction

Organic light-emitting diodes (OLEDs) are solid-state monolithic structures made up of a sequence of organic thin films sandwiched between two thin-film conductive electrodes LEDsandOLEDsareequivalenttoeachotherhoweverinOLEDthelightisemittedbythe emissiveelectroluminescentfilmformedbyorganicmaterial.Whenanelectricalcurrentpass throughitemitslight.OLEDprovidesawiderviewinganglewithself-emittingcharacteristics. Itisbrighter,thinner ,lighterwithafastresponsetime,highrefreshrate,lowpower [8, 16-20].As electricity is applied to OLED, charge carriers (holes and electrons) journey from the electrodes into the organic thin films until they recombine in the emissive region to form excitons under the effect of an electrical field. These excitons, relax to a lower energy level by emitting light (electroluminescence) and/or excessive heat after they've been created [1-3,8].

OLED layered structure is fabricated by two plates conducting anode and conducting cathode. In between these two layers, organic material is placed.OLEDs is basically of five types

1. AMOLED
2. PMOLED

International Conference on Emerging Technologies: AI, IoT, and CPS for Science & Technology Applications, September 06–07, 2021, NITTTR Chandigarh, India
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CEUR Workshop Proceedings (CEUR-WS.org)

CEUR-WS.org/Vol-3058/Paper-013.pdf

3. FOLEDs
4. TOLEDs
5. WOLEDs

2. Flexible OLEDs(FOLEDs)

Sung-Min Lee (2017) et.al [9] proposed that FOLEDs are OLEDs that are fabricated on flexible substrates, non-rigid substrates like plastic or metal foil. This boosts sturdiness and permits conformity to certain figures and even repetitive bending, rolling, or flexing. FOLEDs, still in their infancy, will user in a range of new design prospects for the display and lighting industries. Imaginehavingamobilephonethatlookslikeapenbuthasabright,full-Color display that rolls in and out for use. Open your imagination to what consumer and lighting products can be, including a foldable smartphone that could open up into a tablet display, a television that could roll up in your pocket, and confortable transparent interior lighting panels that could be unbreakable[15, 20-25]. These ideas offer, we believe, a mere glimpse into the phenomena and opportunities that FOLEDs provoke [10].

2.1 Transparent OLEDs(TOLEDs)

SreckoKunic (2012) et. al. [10] proposed that the first OLED devices were constructed with a metallic cathode, so the light generated in the device exited throughtheglasssubstrate(i.e.theanodesideofthedevice).Withtheinvention and development of a transparent cathode, the light can exit through both sides of the device. Besides, when the device is turned off, the device can be transparent [10-11].
Three key features are available for Transparent OLED (TOLED) technology. By using these features it can create new products.

- Topemission
- Transparency
- Stacking

TOLED technology is based on a patented optically translucent top contact or cathode. Standard OLED with a clear metal oxide layer on the bottom contact (anode)andatranslucentmetalonthetopcontact(cathode).Asaconsequence, when the OLED emits light, it does so from the bottom translucent surface. TOLEDs have an optically translucent top cathode, which allows light to pass through both the top and bottomcontacts.
TOLED technology can be used in top-emitting OLEDs with the same trademarked cathode that is used in transparent OLEDs. In a top emission OLED,anopticalcavityisformedinbetweenananodeandacathode,andemits the light from the substrate and the backplane, growing the aperture ratio of the display. This is very good for mobile devices and screens where you can turn thedisplaytoconfirmthebestviewingangle,asitincreasesthelightoutputand increases display efficiency at normal viewing angles. For various applications such as

architectural windows for home entertainment, retail advertising, illumination, warning displays navigation, windshields helmet face shields TOLEDs can be used efficiently by the following characteristics ofTOLEDs

- Bi-directional emission: TOLED emits light from both surfaces but it emits more light from one direction as compared to other by using enhancement films and opticaltreatment
- Stacking: Fabricating one OLED on top of another OLED can be advantageous in terms of improving overall lifetime and also providing a broader range of output Colorspectrum.
- Transparency: when turned off it provides 70% to 85% transparency. TOLED is built by using glass and plastic substrates and they are clear as likeglass
- Performance: it also provides better spectral color emission, luminous efficiency, and life as compared with bottom emissionOLED.

2.2 White OLEDs(WOLEDs)

Chang-WookHan(2009) et.al [11] proposed that White OLEDs have the potentialtooffersignificantperformanceadvancestothegenerallightingarena. Since Edison's development in 1879, its energy efficiency of the incandescent light bulb has not improved. Consequently, incandescent light bulbs are losing favor. Plans are underway to ban and/or phase them out altogether. Fluorescent tubes offer Color qualities that are undesirable for many applications. But they are not environmentally friendly nature and not disposed of easily because of mercury content in it. WOLED OLED lighting has the potential to reach more than150lm/W. WebelievethatOLEDsreduceenergyconsumptionandprovide environmental benefits to end-users around the world. It reduces global electricity consumption up to 15% and worldwide greenhouse gas emission up to 5% and so it achieves the best impression of reducing energy consumption [12-14].In solid-state lighting, OLEDs and LEDs are complementary. OLEDs are excellent surface lights, while LEDs are bright point light sources. OLEDs can be constituted as larger-area, extra diffuse light sources, to get lenient light it is costly to use in ambient lighting with less need of hades diffusers lenses and parabolic shells. Since OLEDs can be very thin, they are more appealing, and caneasilyattachtowallsurfacesandceilings.OLEDscanalsobemanufactured invirtuallyanyform,depositedonflexiblesubstrates,andtranslucent,allowing lighttobeemittedfromallsidesofthedevice—allofwhichsignificantlyextend the design possibilities and make for a whole new lightingexperience.

Numerous Semiconductor Materials Used for OLED with distinct wavelength and voltage drop to produce different colour

Table 1
Numerous Semiconductor Materials

Sr No	Semiconductor Material	wavelength	Voltage drop	Colour
1	Gallium Arsenide	> 760	< 1.9	Infrared
2	Aluminium Gallium Arsenide			
3	Aluminium Gallium Arsenide	610 - 760	1.6 - 2.0	Red
4	Gallium Arsenide Phosphide			

5	Aluminium Gallium Indium Phosphide			
6	Gallium Phosphide			
7	Gallium Arsenide Phosphide	590 - 610	2.0 - 2.1	Orange
8	Aluminium Gallium Indium Phosphide			
9	Gallium Phosphide			
10	Gallium Arsenide Phosphide	570 - 590	2.1 - 2.2	Yellow
11	Aluminium Gallium Indium Phosphide			
12	Gallium Phosphide			
13	Gallium Indium Phosphide	500 - 570	1.9 - 4.0	Green

14	Aluminium GalliumIndium Phosphide			
15	Aluminium GalliumPhosphide			
16	Indium GalliumNitride			
17	ZincSelenide	450 - 500	2.5 - 3.7	Blue
18	Indium GalliumNitride			
19	SiliconCarbide			
20	Silicon			
21	Indium galliumNitride	400 - 450	2.8 - 4.0	Violet
22	Dual Blue/RedLEDs	multiple types	2.4 - 3.7	Purple
23	Blue with RedPhosphor			
24	White with PurplePlastic			
25	Diamond	< 400	3.1 - 4.4	ultraviolet
26	Boron Nitride			
27	Aluminium Nitride			
28	Aluminium GalliumNitride			
29	Aluminium gallium IndiumNitride			
30	Blue withphosphor	multiple types	3.3	Pink
31	Yellow with Red, Orange orPink phospor			
32	White with Pinkpigment			
33	Blue/UV diode withYellow Phosphor	Broad spectrum	3.5	White

3. RESEARCH DISCUSSION-

Mustapha El Halaou (2020) et.al [1] proposed that the OLED can be used as a light source and a local wireless data emitter for the 5G network. Achievement of 20 Gbps in 5G over 100Mbps in 4G to increase the amount of data for users and also used in the concept of smart city, artificial intelligence, IoT, wireless technologies to find smart urban solutions for energy saving, operation of streetlights, better communication, etc. This creates a new evolution in mobile communication. Designing of radiating elements and ground plane of an optically transparent antenna is self-possessed of micrometric hexagonal cells integrated into OLEDfor 5G mobile applications and mm-Wave 5G applications optically transparent antenna is a network formed by micrometric hexagonal cells put on to a glass substrate. The antenna coversa28Ghzbandwithawidthof1.45GHzfrequencyrangefrom27.43GHzto28.88GHz achieving gain and directivity of 5.07db,6.27dbi at 28.27 GHzrespectively.

Tsu-Wu Hu(2018) et. al[2] proposed that using OLED technology for product engineering in conjunction with human design technology to verify the design of drinking water appliances.

UweVogel(2018)et.al[3]proposedthatOLEDsareusedtodevelopsmartglassesNeartoeye flexible displays which creates an image by using OLED the advantage of OLED displays are low power, the high resolution so they are used in tiny mobile phones. In the future, OLED- on-silicon is preferred. This paperwork is carried out on large-area OLED display WUXGA (1920 × 1200, 2300ppi) 120Hz OLED-on silicon micro display, Ultra-low power OLED micro displays with power consumption <1mw and Bi-directional OLED

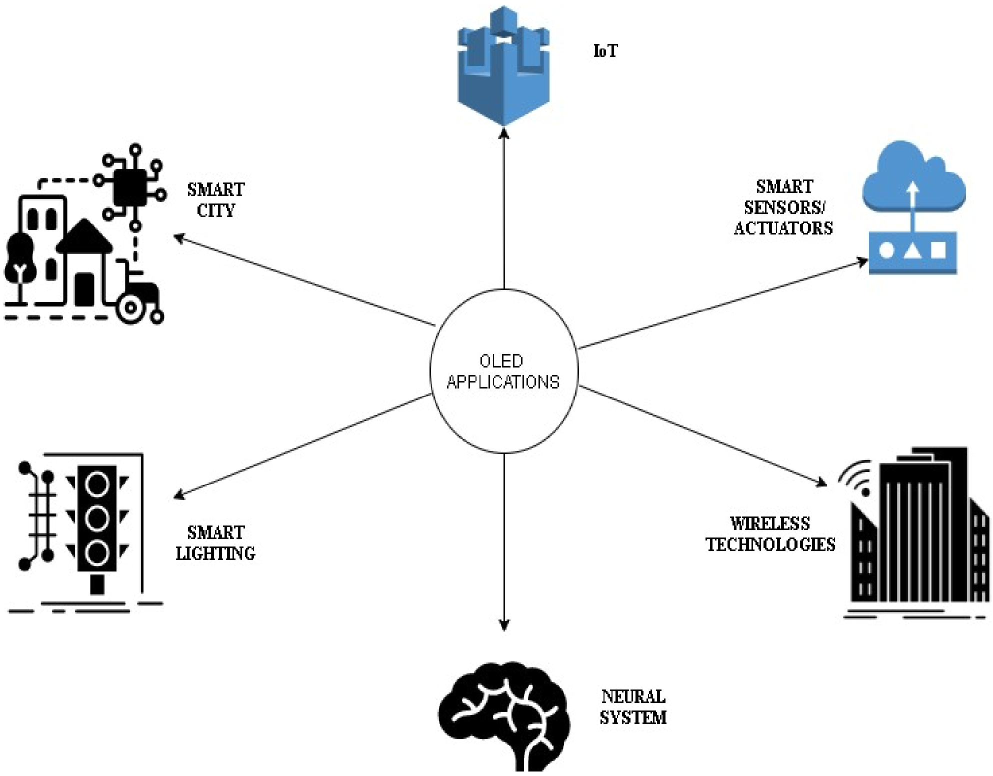

Figure 1.1: Broad assortments of applications of OLED

microdisplays each pixelconsistof5subpixelsoutof5subpixels4subpixelsareusedforcolorRBGWandone for image sensor pixel. OLED on silicon technology is appropriate for Bidirectional OLED microdisplay.

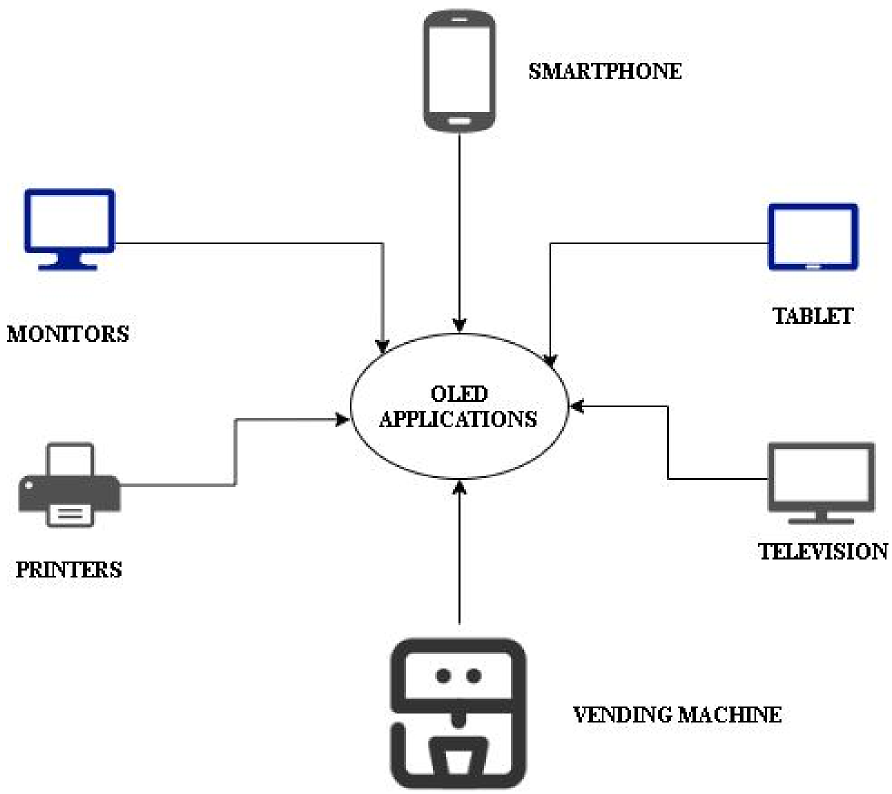

Figure 2.2: Applications of OLED

Norton D. Barth (2017) et.al[4] proposed that OLEDs are used in different lighting applications by providing a large area with a high emission of light with better thermal dissipation.

Joseph T. Smith (2014) et. al [5] proposed that OLED are used for high resolution, large area, low-cost flexible display technology to develop color flexible displays on a plastic substrate for biophotonic and chronic optogenetic applications. light stimulation to control inhibition, excitation of neural tissues to diagnose and treat various neurological and psychiatric diseases and disorders.

MengyingZhao(2013)et.al[6]proposedthatinmobiledevicesLCDsareinterchangedbyOLEDs for dynamic voltage scaling schemes for mobile video applications to reduce power consumption in videostreaming.

Bernd Richter (2011)et. al [7] proposed the development of bidirectional micro displays for different sensors such as image sensors and near to eye application using OLED on CMOS. The direct evaporation method is used for the fabrication of OLED on CMOS.

4. CONCLUSIONS:

ThispaperpresentstheOLEDforadvancementinthedesignofflexibleelectronics. The concentration of this work is focused on evolution parameters reported in different previous research papers. The comparative statement is developed based on numerous semiconductorsmaterialwithavarietyofwavelengthstoproduceseveraldistinctcolours. The various applications of OLEDs in the field of medical, communication, to reduce power consumption in mobile during video streaming applications, vending machine, sensors and flexible electronics devices are also discussed in thispaper.

5. Acknowledgements

TheauthorsarethankfultotheDirector,DTEMaharashtra,Principal,Government Polytechnic,Jintur.Dist.ParbhaniMaharashtra,HeadofDepartmentElectronicsand Communication Engineering and all faculty members of Electronics and Communication Engineering Department and supporting staff of NIITTTR Chandigarh, India who guide and help during the preparation of this reviewpaper.

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