ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 3, Issue 9, September 2014**

# Development of New Hybrid Polymer for Efficient OLED

Ravi Kumar[1], Rakesh Rajan[2], Ravi Baweja[3]

Student, Department of ECE, Dronacharya College of Engineering, Gurgaon, Haryana, India[1]

Student, Department of ECE, Dronacharya College of Engineering, Gurgaon, Haryana, India[2]

Student, Department of ECE, Dronacharya College of Engineering, Gurgaon, Haryana, India[3]

**ABSTRACT:** In this research paper we are trying to introduce new hybrid polymer which is a combination of organic and inorganic substance to improve the efficiency, life time of Oleds. This paper reviews the technical issues and recent progress in light extraction technologies and discusses ways of enhancing the out-coupling efficiency of OLEDs. This paper discusses our recent progress in development of new polymer systems that are highly solvent-resistant but maintaining their photo physical properties and new polymer quantum-dots (QDs)-polymer nano composites for their use in multicolor and multilayer OLEDs pixels through solution-processing.

**KEYWORDS:** Semi-interpenetrating polymer networks, Emissive polymers, Quantum Dot conjugatedoligomer/ polymersnanocomposites, OLEDs

## I.INTRODUCTION

There are two main families of OLED: those based on small molecules and those employing polymers. Adding mobile ions to an OLED creates a light-emitting electrochemical cell (LEC) which has a slightly different mode of operation. OLED displays can use either passive matrix (PMOLED) or active matrix addressing schemes. Active-matrix OLEDs require a thin-film transistor backplane to switch each individual pixel on or off, but allow for higher resolution and larger display sizes. Metals such as arsenic, gallium, indium, and the rare-earth elements (REEs) cerium, europium, gadolinium, lanthanum, terbium, and yttrium are important mineral materials used in LED semiconductor technology. Most of the world's supply of these materials is produced as byproducts from the production of aluminium, copper, lead, and zinc. Most of the rare earths required for LED production in 2011 came from China, and most LED production facilities were located in Asia. Our new polymer systems are named conductive semi-interpenetrating polymer networks (C-Semi-IPNs) served in different layers of OLEDs devices, containing an inert polymer network and conducting polymer(s) including hole transport and emissive materials. Since these do not require complicated chemical modification or introduction of reactive moieties to OLED materials, many state-of-the-arts emissive polymer scan be utilized to achieve RGB and white OLEDs. The research findings on hybrid QDoligomernanocomposite as a good analogue lead to the successful design and synthesis of QDpolymernanocomposites which were used to build proof-of-the-concept devices showing a good promise in providing excellent color purity and stability as well as device robustness.

## II.POLYMER LIGHT-EMITTING DIODE

Organic materials are of great interest for electronics applications, as they have many advantages over their inorganic counterparts**.** They may often be solution-processed, allowing the fabrication of devices such as circuits**,** displays and radio-frequency identification devices on plastic substrates, and deposition by unconventional means, such as screen and inkjet printing**.** The most attractive prospect, however, is the incorporation of functionality by design. The versatility of organic synthetic techniques and the wide spectrum of commercially available building blocks allow seemingly finite flexibility in tuning molecular structure, and therefore the corresponding molecular packing and microscopic properties. Already, organic solids such as pentaceneandrubrene have surpassed amorphous Si in performance, of thin film transistors (TFT) and light emitting devices creating organic light emitting diodes which are

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 3, Issue 9, September 2014**

used by the former. An OLED is a thin-film solid state device, which makes it easier to apply to flexible displays because of relatively simple fabrication process and reduced distortion according to the geometric form of display.

Originally, the most basic polymer OLEDs consisted of a single organic layer. One example was the first light-emitting device synthesized by J. H. Burrougheset al., which involved a single layer of poly (p-phenylenevinylene) However multilayer OLEDs can be fabricated with two or more layers in order to improve device efficiency.

Organic light emitting diodes (OLEDs) have rapidly progressed in recent years due to their potential applications in flat panel displays and solid-state lighting. In spite of the commercialization of OLEDs, they still have a low out-coupling efficiency of about 35% due to factors such as the total internal reflection, absorption, and surface Plasmon coupling. This light out-coupling efficiency is a major limitation on the high efficiency levels of OLEDs. Hence, enhancing the light out-coupling efficiency of OLEDs offers the greatest potential for achieving a substantial increase in the external quantum efficiency and power efficiency of OLEDs. Accordingly, significant advancements in OLEDs have driven the development of light extraction technologies as well as highly transparent conducting electrode materials. Recent efforts to combine photon of light extraction structures with the improved out-coupling efficiency of OLEDs have produced OLEDs with an efficiency level that matches the efficiency of a fluorescent tube (＞150 lm/W). This paper reviews the technical issues and recent progress in light extraction technologies and discusses ways of enhancing the out-coupling efficiencyof OLEDs.

## III.EXPERIMENTS RESULTS

**Organic and Inorganic Conducting Layers**

Indium tin oxide is the typical conducting layer used in display technology because ofits excellent sheet resistance and optical clarity. However, the process temperature required for ITO on glass is incompatible with plastic substrates. Therefore lower temperature processes have to be developed for ITO in order for it to be considered for flexible display applications. When ITO is deposited on polymeric substrate, it could crack under tensile strain and cause catastrophic failure. Conducting polymers are also being considered for flexible display applications.

Although their sheet resistance and optical properties are not as attractive as ITO, they do have exceptional mechanical properties and low temperatures. ITO and conducting polymer technology compete for the conducting substrate solution, there is a new conducting substrate technology based on nanotechnology. Flexible and transparent electrodes have been formed from carbon nano tube dispersions in the combination with wet coating processes and printing technique. Where injected charge carriers recombine and generate light(photon). All OLEDs have four basic components: substrate, anode, organic layers, and cathode. Flexible substrate materials are usually plastic, thin glass or metal foils. The anode is a transparent layer of metal of low work function which serves to remove electrons when a current flows through the device. The cathode is a metal layer of high work function which injects electrons when a current flows through the device. In between the cathode and the anode are the organic layer(s) where transport and recombination of the electrons and holes occur. Depending on the device, the OLED could have one, two or multiple organic layers.

Conventional semiconductor electronics is almost exclusively comprised of inorganic materials, the most common being silicon. Elemental semiconductors such as silicon, however, have indirect band gaps making it hard to use these materials to generate photon without heat. In contrast, many compound semiconductors have direct band gaps, making photon production far more efficient. Early work on visible light emission from a compound semiconductor used the three component system gallium arsenide phosphide (GaAsP). The most efficient visible light- emitting materials today are drawn from three-and-four component systems such as aluminium indium gallium phosphide or nitride (AlInGaP or AlInGaN). Light-emitting devices (most commonly diodes) made from these and other inorganic materials are known as light-emitting diodes, or LEDsZnO can crystallize with other materials, Ga2O3, and SnO2, to form binary or ternary oxides that are transparent and offer high mobility. An example is singlecrystallineInGaO3(ZnO)5 (IGZO) films, which can be epitaxially grown on (111) single-crystal yttria- stabilized zirconia substrates, with mobilities as high as ca. 90 cm2V–1 s–1 reported for TFTs fabricated using them. Although such results are not directly relevant to the scope of this Review, recent reports indicate that amorphous IGZO films with good properties can be formed on plastic substrates at room temperature. In these systems, as well as for other amorphous oxide semiconductors containing post-

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

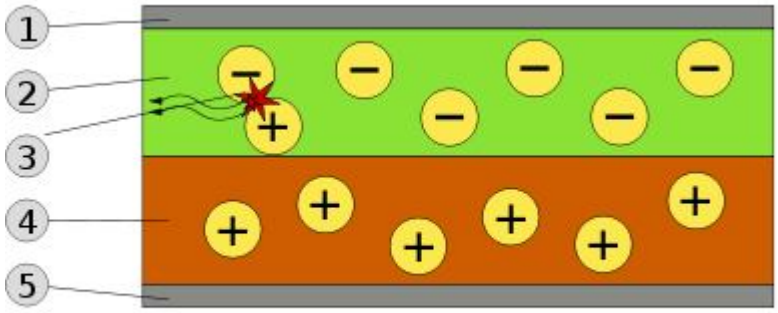
International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 3, Issue 9, September 2014**

transition-metal cations, degenerate band conduction and large mobility are possible. Such behaviour is different to that of amorphous covalent semiconductors, such as Si, in which carrier transport is controlled by hopping between localized tail states and band conduction is not achievable. The conduction band minimum (CBM) in typical wide-bandgap oxide semiconductors which can directly overlap neighbouring metal *n*s orbital to generate carrier-transport pathways. In addition, *n*s orbital with large principal quantum numbers (i.e., $n > 5$) lead to greatly dispersed CBM, which in turn leads to high electron mobility if the carrier relaxation times are not significantly different between the constituent materials. As a result, amorphous oxide semiconductors can exhibit Hall-effect mobilities similar to those of their corresponding crystalline phases, even when grown at low temperatures. the Hall mobility and carrier concentration (*N*e) for films of In2O3–Ga2O3–ZnO systems deposited by pulsed-laser deposition at room temperature. The results clearly show that high mobility (> 15 cm3V–2 s–1) can be achieved in amorphous oxide systems, i.e., In2O3–Ga2O3 (a-IGO), Ga2O3–ZnO (a-GZO), In2O3–ZnO (a-IZO), andIn2O3–Ga2O3-ZnO (a-IGZO). The devices also exhibit good electrical performance when operated at room temperature. Figure 4D shows a series of *I–V* curves from a TFT with the geometry shown in Figure 4B, recorded at various gate biases in air. The thicknesses of the layers of a-IGZO, Y2O3, and ITO are 34, 170, and 40 nm, respectively. [41a] the channel length and width of the transistors are 50 and 200 lm, respectively. The data indicate enhancement- mode, n-type behaviour. Both the linear and saturation values of mobility are ca. 13 cm2V–1 s–1. Devices on PET substrates continue to operate when bent to radii of curvature radius as small as 30 mm with only slight (11–18%) reductions in Mobility.

**Working principle**




Schematic of a bilayer OLED: 1. Cathode (−), 2. Emissive Layer, 3.Emission of radiation, 4.Conductive Layer, 5. Anode (+)

## IV.HYBRID QD-OLIGOMER/POLYMER NANOCOMPOSITE

As we discussed above, the inert polymer networks introduced in E-semi-IPN based OLED devices do not negatively impact device function but help improve the device performance with improved device robustness and solvent resistance. It is noteworthy that a similar scheme could be used to incorporate emissive species like, for example, semiconducting quantum dots (QDs) or their mixtures with the appropriate polymer agents to form a multilayer structure since QDs as emitters provide unique properties including narrow emission band which gives good color purity, great color tenability and differential stability. In this part of the paper, we describe our research findings in developing hybrid QDOLED pixels where QD-polymer hybrid nanocomposite. One critical challenge of the hybrid pixel development is to develop functionalized conjugated conducting polymers that can chemically bind or attach to QDs so as to achieve optimal distribution of emissive inorganic QDs within these polymers so as to enhance the efficiency of Föster energy transfer, thereby increasing device efficiency and improving color purity by quenching the remaining polymer emission. Our first design of these novel materials is to incorporate functional groups such as organo phosphine oxide to QDs surfaces into conducting oligomers or polymers in order to achieve direct attachment of QDs to oligomers or polymer matrix. A number of new organic building blocks have been designed and synthesized. These building blocks are used either as capping agents or monomers to build novel functionalized oligomers/polymer multi-step organic syntheses.

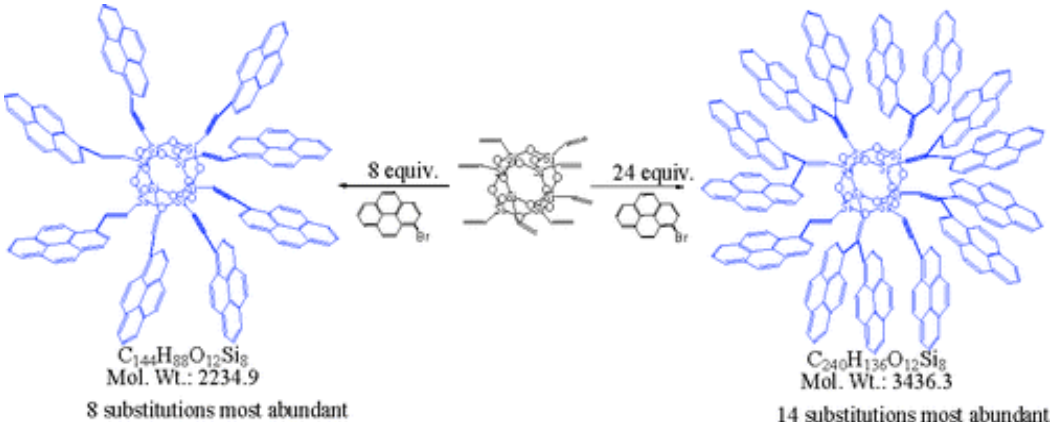
ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

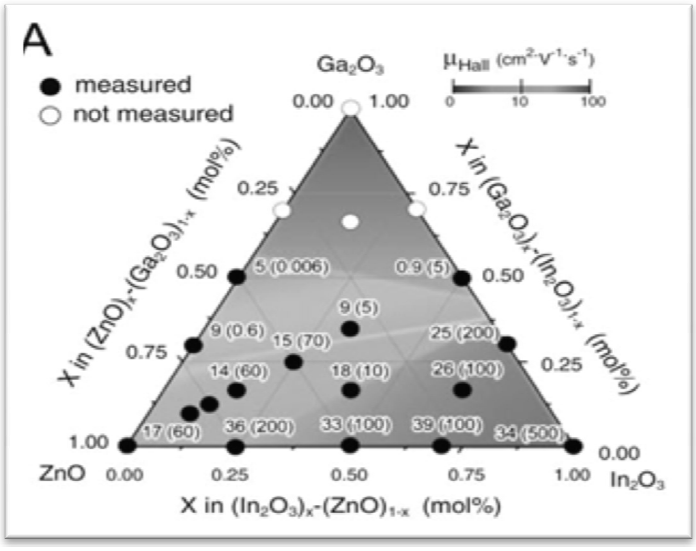
*(An ISO 3297: 2007 Certified Organization)*

**Vol. 3, Issue 9, September 2014**

## V.DIAGRAMMATICAL REPRESENTATION




These above diagram shows the main polymer which is divided into two equivalent polymer that is 8 equivalent and 24 equivalent polymer .




It represent the triangular representation of three different polymer element .In this dark dot represent the measured mol % and light dot represent not measured mol %.

## VI.CONCLUSION

In the last decade, tremendous strides have been made in the science and technology of OLEDs. In particular, the efficiency levels have increased by more than two orders of magnitude and the operating life span time has progressed from less than an hour to more than 100000 h. Much of the research in the area of inorganic synthesis has focused on improved materials for the emissive layer and phosphorescent dopant. Modern devices have also been enhanced by improvements to light extraction technologies and the out coupling efficiency. The dopant efficiency level in OLEDs has reached 50 lm/W, which is double the corresponding level of incandescent light bulbs (20 lm/W). White OLEDs with a power efficacy of 45 lm/W. As outlined in this Review, a variety of inorganic materials in the form of

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

*(An ISO 3297: 2007 Certified Organization)*

**Vol. 3, Issue 9, September 2014**

amorphous, nanocrystalline, microcrystalline, and polycrystalline thin films as well as assembled arrays of nanowires/nanoribbons and nano-/microstructures can yield transistors with high mobilities and simple circuit components\with good performance. Many of these materials have the potential to be grown and processed on low-temperature plastic substrates, and in several cases these capabilities have already been demonstrated. TFTs fabricated with inorganic materials on plastics can be operated at high frequencies into the ultrahigh frequency (UHF) and *S*-band regimes, allowing them, in principle, to be applied in demanding applications, such as radio frequency communications. We concluded that by adding extra organic and inorganic polymer to oled, we can increase the efficiency of oled and also their life time. We have also analyzed the two figures which we have already discussed in diagrammatical representation section.

## REFERENCES

1. J. A. Rogers, *Science* 2001, *291*, 1502.
2. D. B. Mitzi, *J. Mater. Chem.* 2004, *14*, 2355.
3. D. B. Mitzi, L. L. Kosbar, C. E. Murray, M. Copel, A. Afzali, *Nature*2004, *428*, 299.
4. X. Duan, C. M. Lieber, *Adv. Mater.* 2000, *12*, 298.
5. Y. Shan., K. Kalkan, C.-Y. Peng, S. J. Fonash, *Nano Lett.* 2004, *4*,2085
6. M. Ariu, M. Sima, M. D. Rahn, J. Hill, A. M. Fox, D. G. Lidzey, M. Oda, J. Cabanillas-Gonzalez, D. D. C. Bradley, Physics Review.B, 67,195333 (2003).
7. J. Peet, E. Brocker, Y. Xu, G. C. Bazan, Advanced Materials, 20, 1882, (2008).
8. H. H. Lu, C. Y. Liu, C. H. Chang, S. A. Chen, Advanced Materials, 19, 2574 (2007
9. Z. Guo, J. Pei, Z. L. Zhou, L. Zhao, G. Gibson, S. Lam, and J. Brug Polymer, 50(20), 4794-4800(2009).
10. Z. Guo, D. Liu, C. Wang, J. Pei, Z. L. Zhou, L. Zhao, G. Gibson, J. Brug, S. Lam, S. MaoScience China Chemistry, 54(4), 678-684 (2011).
11. Lihua Zhao, Zhang-Lin Zhou, ZengshanGuo, Jian Pei,Hewlett-Packard Labs, Hewlett-Packard Company, 1501 Page Mill Rd, Palo Alto, CA, 94304 U.S.A.
12. Engineering, Peking University, Beijing100871, China
13. Lawrence Berkeley National Laboratory and Department of Mechanical Engineering,University of California, Berkeley, Mail Code 1740, Berkeley, CA, 94720, U.S.A.
14. Jong-Lam Lee et al.: Recent Developments in Light Extraction Technologies of Organic Light Emitting Diodes
15. *J. Am. Chem. Soc.*, 2007, 129 (18), pp 5808–5809S
1999 jun physworld frinde review.pdf