O.L.E.D.. (Organic light-emitting diode)

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ABSTRACT

Flat-panel displays are basically of two types: light valve (needs an external source of light) and emissive type (generates light at the display surface). The light emitting diode (LED) display is of the emissive type. The inorganic LED displays have been in use for more than 25 years in one form or the other. Because of certain limitations of inorganic materials (such as luminous efficiency and color), LED applications have been limited. The recent discovery (over the past 15 years) of polymer and organic materials has changed LED prospects. It now may become possible to make LED displays that are inexpensive, bright, low-power, large size, and at the same time provide full color. If present research objectives are met, LEDs, especially organic LEDs (OLEDs), may have the potential to revolutionize a certain segment of flat-panel display market. A comprehensive list of various research efforts in OLED technology all over the world will be presented with their differentiating features. The strength of the underlying technology and the challenges facing these types of displays will be discussed.

KEYWORDS

electric current organic compounds engineering flexibility electroluminescent polysilicon.

INTRODUCTION TO TOPIC

An organic light-emitting diode (OLED) is a special type of light-emitting diode (LED) in which the emissive layer comprises a thin-film of certain organic compounds. The emissive electroluminescent layer can include a polymeric substance that allows the deposition of very suitable organic compounds, for example, in rows and columns on a flat carrier by using a simple “printing” method to create a matrix of pixels which can emit different colored light. Such systems can be used in television screens, computer displays, portable system screens, advertising and information, and indication applications etc. OLEDs can also be used in light sources for general space illumination. OLEDs lend themselves for the implementation of large areal light-emitting elements. OLEDs typically emit less light per area than inorganic solid-state based LEDs which are usually designed for use as point light sources.

One of the great benefits of an OLED display over the traditional LCD displays is that OLEDs do not require a backlight to function. This means that they draw far less power and, when powered from a battery, can operate longer on the same charge. It is also known that OLED based display devices can be more effectively manufactured than liquid-crystal and plasma displays.
HISTORY

OLED technology was invented by Eastman Kodak in the early 1980s. It is beginning to replace LCD technology in handheld devices such as PDAs and cellular phones because the technology is brighter, thinner, faster and lighter than LCDs, use less power, offer higher contrast and are cheaper to manufacture.

Kodak scientists discovered organic materials with light-emitting properties in 1979 and received the first patent for OLED in 1987. In 1999 Kodak co-developed the first active-matrix, full-color 2.4-inch OLED display with Sanyo. Less than a year later, they developed a 5.5-inch AM OLED. No other camera companies are currently using OLED technology on digital cameras. However, Saumsung recently licensed the Kodak/Sanyo OLED technology, and apparently plans to implement it on mobile phones.

OLED COMPONENTS AND WORKING

Like an LED, an OLED is a solid-state semiconductor device that is 100 to 500 nanometers thick or about 200 times smaller than a human hair. OLEDs can have either two layers or three layers of organic material; the third layer helps transport electrons from the cathode to the emissive layer.

An OLED consists of the following parts:

- **Substrate** (clear plastic, glass, foil) - The substrate supports the OLED.
- **Anode** (transparent) - The anode removes electrons (adds electron "holes") when a current flows through the device.
- **Organic layers** - These layers are made of organic molecules or polymers.
  - **Conducting layer** - This layer is made of organic plastic molecules that transport "holes" from the anode. One conducting polymer used in OLEDs is polyaniline.
  - **Emissive layer** - This layer is made of organic plastic molecules (different ones from the conducting layer) that transport electrons from the cathode; this is where light is made. One polymer used in the emissive layer is polyfluorene.
- **Cathode** - (may or may not be transparent depending on the type of OLED) - The cathode injects electrons when a current flows through the device.

An organic light-emitting diode is a solid-state semiconductor device. It is usually 100 to 500 nanometers thick.

The five main parts of OLED are substrate, anode, cathode and two organic layers. The substrate should support the OLED and can consist of glass, foil or clear plastic. The anode is usually transparent and removes electrons, the cathode does exactly the opposite, it injects electrons. The cathode can be transparent or not - depending on the type of OLED used.
The organic layers are a conducting layer and an emissive layer. The conductive layer is made of organic plastic molecules, the emissive layer is different to those molecules from the conducting layer. These molecules transport electrons from the cathode. This is the part where light is emitted.

OLED display panel with the desired electrical isolation for the cathode lines. A major advantage of this method is that all patterning steps are conventional, so the entire panel fabrication process can easily be adapted to large-area, high-throughput manufacturing.

The process that is emitting light is called electrophosphorescence, it is similar to the process to traditional LEDs. Current is flowing from the cathode to the anode through the organic layers. By this, electrons are removed from the conducting layer and are given to the emissive layer. Holes are left to the conductive layer at the removing process. The holes are jumping over to the emissive layer and recombine with the electrons. While the electrons drop into the holes they release extra energy as light.

To get a passive-matrix OLED to work, electrical current is passed through selected pixels by applying a voltage to the corresponding rows and columns from drivers attached to each row and column. An external controller circuit provides the necessary input power, video data signal and multiplex switches. Data signal is generally supplied to the column lines and synchronized to the scanning of the row lines. When a particular row is selected, the column and row data lines determine which pixels are lit. A video output is thus displayed on the panel by scanning through all the rows successively in a frame time, which is typically 1/60 of a second.

TYPES OF OLED

There are two forms of OLED displays: Passive-matrix and Active-matrix.

Passive Displays:- The passive-matrix OLED display has a simple structure and is well suited for low-cost and low-information content applications such as alphanumeric displays. It is formed by providing an array of OLED pixels connected by intersecting anode and cathode conductors.

Organic materials and cathode metal are deposited into a “rib” structure (base and pillar), in which the rib structure automatically produces an

Active Displays:-

In contrast to the passive-matrix OLED display, active-matrix OLED has an integrated electronic back plane as its substrate and lends itself to high-resolution, high-information content applications including videos and graphics. This
The basic OLED cell structure consists of a stack of thin organic layers sandwiched between a transparent anode and a metallic cathode. The organic layers comprise a hole-injection layer, a hole-transport layer, an emissive layer, and an electron-transport layer. When an appropriate voltage (typically between 2 and 10 volts) is applied to the cell, the injected positive and negative charges recombine in the emissive layer to produce light (electro luminescence). The structure of the organic layers and the choice of anode and cathode are designed to maximize the recombination process in the emissive layer, thus maximizing the light output from the OLED device.

**ADVANTAGES**

1. **Robust Design** - OLED’s are tough enough to use in portable devices such as cellular phones, digital video cameras, DVD players, car audio equipment and PDA’s.

2. **Viewing Angles** – Can be viewed up to 160 degrees, OLED screens provide a clear and distinct image, even in bright light.

3. **High Resolution** – High information applications including videos and graphics, active-matrix OLED provides the solution. Each pixel can be turned on or off independently to create multiple colors in a fluid and smooth edged display.

4. **Electronic Paper** – OLED’s are paper-thin. Due to the exclusion of certain hardware goods that normal LCD’s require, OLED’s are as thin as a dime.

5. **Production Advantages** – Up to 20% to 50% cheaper than LCD processes. Plastics will make the OLED tougher and more rugged. The future quite possibly could consist of these OLED’s being produced like newspapers, rather than computer “chips”.

6. **Power Usage** – Takes less power to run (2 to 10 volts).

7. **Hardware Content** – Lighter and faster than LCD’s. Can be produced out of plastic and is
bendable. Also, OLED’s do not need lamps, polarizers, or diffusers.

8 Video Capabilities – They hold the ability to handle streamlined video, which could revolutionize the PDA and cellular phone market.

DISADVANTAGES

1 Engineering Hurdles – OLED’s are still in the development phases of production. Although they have been introduced commercially for alphanumeric devices like cellular phones and car audio equipment, production still faces many obstacles before production.

2 Color – The reliability of the OLED is still not up to par. After a month of use, the screen becomes nonuniform. Reds, and blues die first, leaving a very green display. 100,000 hours for red, 30,000 for green and 1,000 for blue. Good enough for cell phones, but not laptop or desktop displays

3 Overcoming LCD’s – LCD’s have predominately been the preferred form of display for the last few decades. Tapping into the multi-billion dollar industry will require a great product and continually innovative research and development. Furthermore, LCD manufacturers will not likely fold up and roll over to LCD’s. They will also continue to improve displays and search for new ways to reduce production costs.

4 Intrusion - Also, the intrusion of water into displays can damage or destroy the organic materials. For the above reason efforts are being made such that water cannot reach the diodes and hence effect them.

CONCLUSION

The Organic Light Emitting Diode forms of display still have many obstacles to overcome before it’s popularity and even more importantly, its reliability are up to par with standards expected by consumers. Although the technology presents itself as a major player in the field of displays, overcoming these obstacles will prove to be a difficult task. However, the OLED’s advantages over LCD’s and future outlook have many in the industry goggle-eyed at the realm of possibilities. For all we know and can hope for…OLED’s could change the ways in which we see things.

FUTURE SCOPE

The OLED technology faces a bright future in the display market, as the ever-changing market environment appears to be a global race to achieve new success. Eventually, the technology could be used to make screens large enough for laptop and desktop computers. Because production is more akin to chemical processing than semiconductor manufacturing, OLED materials could someday be applied to plastic and other materials to create wall-size video panels, roll-up screens for laptops, and even head wearable displays.

OLEDs have also been found in models of the Sony Walkman and of some of the Sony Ericsson phones, notably the Z610i, as well as most Motorola color cell phones.

OLEDs could also be used as solid state light sources. As by now the OLED efficacies and lifetime already go beyond those of tungsten bulbs, white OLEDs are under worldwide investigation as source for general illumination. There are enormous opportunities for to replace a large proportion of conventional lighting in the long term because of cost, power, weight, space and other potential benefits of OLEDs. Up to 5% of conventional lights in advanced countries may be replaced by 2016-2020. Most of the world’s major lighting manufacturers are working on this because it could
wipe them out if they do not. Many small companies and newcomers to lighting are also working in this area.

OLED lighting and signage will really take off when it has long life, is cheaper up front than conventional lighting, less power hungry, thin and flexible. Environmental, ease of installation and replacement, optical transparency and low cost of ownership are important but secondary benefits that will be realized.

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