Are Polymer Electronics the Future of Television Screens?

Until recently all televisions used to contain a Cathode Ray Tube (CRT). This was the basis of the TV screen, and without it, we would have no picture on the screen. As Marshall Brain stated the CRT is a vacuum tube containing 3 electron guns, and a phosphor-coated screen. The electron guns give out a red, green and blue beam of light. The mix of the light can then be altered to give you any colour you want on the TV screen. These beams were then bent by magnetic deflection, which gave you a picture all over the screen. Because every TV contained a CRT they had to be fairly large and thick.

As this technology got old and inefficient, and people wanted to have thinner TV screens. Plasma and LCD screens were developed. These are much thinner, and according to Tom Harris, they draw much less power than CRTs which mean they are cheaper to run. Plasma screens work by having 1000s of tiny pixels all over the screen, and each individual pixel has its own supply of red, green and blue fluorescent light. Each pixel is then lit up in slightly different colours to create a picture.

This technology is now starting to become obsolete, as the public are wanting thinner more efficient TVs, that don't have to be the centre piece of a room, but placed on a wall like a picture, and go reasonable unnoticed. People are also seeking a better quality picture, which is like real life. The picture quality of TVs has change hugely since the CRT screens, but people still demand a better picture.

The most recent advance in TV screens is the development of polymer electronics, producing TV screens known as OLEDs. These tend to create a brighter, crisper picture, while drawing less power. Hans-Jorg Bullinger says that polymer electronics is an emerging technology the concentrates on the development of electronics devices incorporating electrically conductive and semi-conductive materials, especially organic polymers. Polymer conductors and semiconductors open up prospects for microelectronic systems that go beyond the scope of conventional TVs and electronics based on silicon as the semiconductor.

According to Richard S. Muller a semiconductor is an element which is neither a good conductor nor a good insulator, but rather lies somewhere between the two. They are characterized by a valence shell containing four electrons. Semiconductors are now used as a preference in most electronic devices for 2 main reasons; they are smaller to use than other alternatives, which make the device using it smaller. They are also easy to manipulate, so the electronic properties that are needed for a certain job, for example

conductivity can be easily obtained, this process is known as doping, which is a process by which electrons are either added or taken away

Properties of Polymers

Plastic materials are organic polymers, which mean that they consist of large molecules with long repeating chains of smaller organic units. Depending on the structure of the materials, they are electrically insulating, conducting or semiconducting.

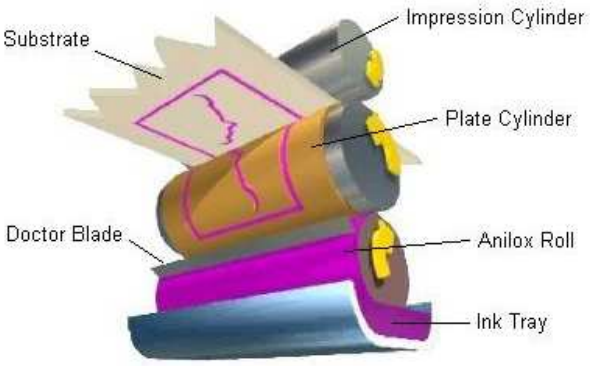
Special polymers, such as conductive polyacetylene, consist of many identical single units, or monomers, combined in a chain. Typically, these organic polymers are based on chains of carbon atoms combined with hydrogen atoms. Conjugated chains comprise alternating single and double bonds between the carbon atoms, which results in delocalised electron states, which is a semiconductor. These can then be transformed within transistors to either conduct or insulate.

In addition to conductive and semi conductive properties, some polymers also display electroluminescent properties and emit light when electric power is applied. The inverse effect also exists, whereby incoming light is converted into electric power. Other classes of organic materials exist that have special sensing properties of which can store information in a memory. As a result, polymer materials creates a new platform that makes it possible to produce high volumes of thin and flexible electronic devices covering the same full range of applications as conventional silicon-based electronic technology.

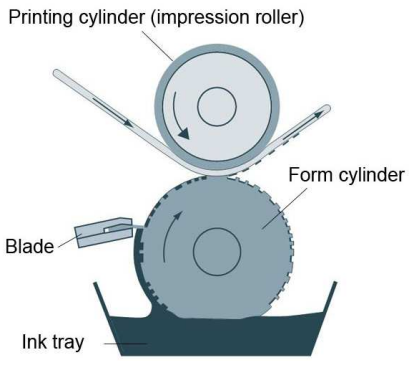
Production Process

The main advantage of polymer electronics compared with conventional electronics is the simplicity with which the polymer electronic devices can be produced. The conventional televisions have many different components, which have to be produced by different machines then all the different parts have to come together and the end to be assembled. Whereas with polymer TV screens they can be 'printed'.

Polymers can be dissolved in special solvents and used as an electronic ink in different printing processes, like the conventional printing of newspapers. This makes it possible to produce electronics in a continuous printing process, without have many different machines and assembly lines, onto a flexible substrate.
This means that the total cost of production for each screen is a lot less than the conventional screen.



Flexo Printing, *EFTA Academy*



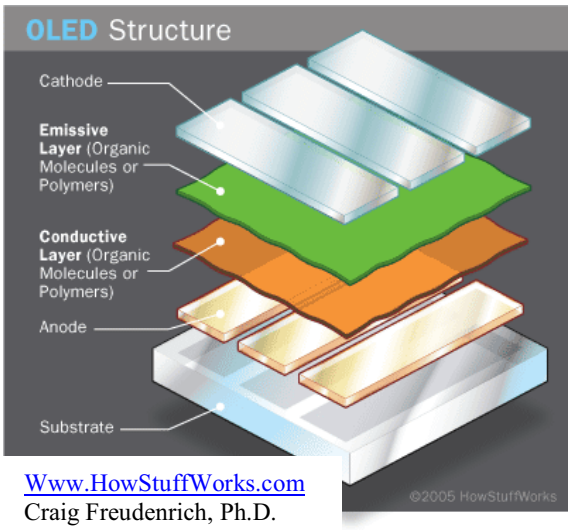
Gravure Printing, www.Siemens.com

There are a wide range of printing processes which can be used, but the most common are 'gravure' and 'flexo' printing. Gravure printing is when the printed structure is engraved on a steel cylinder, while in flexo printing the pattern is made in a raised structure of plastic material.

Devices and Applications

Organic Light-Emitting Diodes (OLEDs)

One of the most current uses for polymer electronics is in the production of super-thin TV screens, known as OLEDs. OLEDs mainly consist of at least four different layers, a top and a bottom electrode with a semi conductive and electroluminescent organic layer in between. All placed on top of a thin substrate. When electric power is applied between the electrodes, the electroluminous materials emit light. The light can be of different colours allowing OLEDs to be used either for displays, or just simply as a light source.



Www.HowStuffWorks.com
Craig Freudenrich, Ph.D.

An OLED consists of the following parts:

- **Substrate** – usually made of clear plastic, glass or foil and is used to support the OLED
- **Anode** – made of a transparent material that removes electrons when a current flows through the device (adds electron 'holes')
- **Organic Layers**
  - **Conducting Layers** – Made of organic plastic molecules which transport 'holes' from the anode
  - **Emissive layer** – Made from different organic plastic molecules which transports electrons from the cathode. This is where the light is made
  - **Cathode** – It injects electrons when a current flows through the device. It doesn't have to be transparent.

Emitting Light

According to Craig Freudenrich, Ph.D OLEDs emit light through the following process:

- *When a power supply is applied to the OLED, and electrical current flows from the cathode to the anode through the organic layers.*
- *The cathode then gives electrons to the emissive layer of organic molecules.*
- *The anode removes electrons from the conductive layer of organ ic molecules, to create an electron hole.*
- *At the boundary between the emissive and conductive layers, electrons find electrons holes.*
- *When an electron finds an electron hole, the electron fills the hole, this means the electron falls into and energy level of the atom that's missing an electron*
- *When this happens, the electron gives up energy in the form of a photon of light*
- *The OLED emits light*
- *The colour of the light depends on the type of organic molecule in the emissive layer, while the brightness depends on the current applied.*

As well as OLED screens polymer electronics has many other useful applications.

One of the main uses of polymer electronics will be in Organic Field-Effect Transistors (OFETs). Transistors are used in every logic circuit, in order to control electric currents by turning the voltage on and off. OFETs enable circuits to be smaller and more flexible as well as more complex.

Organic Photovoltaic cells convert incoming light into electric power, like solar panels. OPVs are less efficient than conventional solar panels, but the advantage of them is that they can be produced in high volumes at low costs and with a large surface area. They are also thinner and have the prospect of being transparent, so in the future, if the technology develops, they could be placed on windows in order to create power, while still being able to see through the window.

Conductive organic materials are often sensitive to factors such as temperature, humidity and pressure. This makes it possible to create a large-area thin and flexible sensor. For example they can be used as position-sensitive pressure detectors; they can be used in the medical world to test for alcohol in the blood as well as blood sugar levels. In a temperature sensor the conductivity and the charge in conductivity can be measure by simple electronic means.

Polymer electronics can also be used as a memory device. One of the main drivers of modern technology is being able to store large amounts of data in the smallest possible area. With the advance of polymer electronics it will mean that we will be able to incorporate the memory chip into a flexible substrate, which could then be used as the screen on a device.

OLEDs can also be used simply to emit light, as a light source. This would be done in a similar way to OLED screens, but just emitting white light. This would mean that the light source could be a lot thinner and therefore more discreet. It could also be on a large sheet of substrate, so it could cover a large area, instead of having to use lots of bulbs. OLED lighting is brighter and more energy efficient than the conventional bulbs. This is an attractive property of the OLED lights, because it means that there is less energy used and wasted and therefore it is cheaper to run and better for the environment.

Advantages and Disadvantages of OLED screens

The LCD is currently the display of choice in small devices and is also popular in large-screen TVs. Regular LEDs often form the digits on digital clocks and other electronic devices. According to Craig Freudenrich, Ph.D. OLEDs offer many **Advantages** over both LCDs and LEDs:

Thinner, lighter and more flexible:

The plastic, organic layers of an OLED are thinner, lighter and more flexible than the crystalline layers in an LED or LCD. As the light-emitting layers of an OLED are lighter, the substrate of an OLED can be flexible instead of rigid. This means that OLED substrate can be made of plastic rather glass, which is used for LEDs and LCDs.

Brighter

OLEDs are brighter that LEDs, because the organic layers of an OLED are much thinner than the corresponding inorganic crystal layers of an LED, the conductive and emissive layers of an OLED can be multi-layered.

Consume less power

OLEDs do not require backlighting like LCDs. LCDs work by selectively blocking areas of the backlight to make the images that you see, while OLEDs generate light themselves. Because OLEDs do not require backlighting, they consume much less power than LCDs.

Production

OLEDs are easier to produce and can be made to larger sizes. Because OLEDs are essentially plastics, they can be made into large, thin sheets.

Large field of view

OLEDs have large fields of view, about 170 degrees. Because LCDs work by blocking light, they have an inherent viewing obstacle from certain angles. OLEDs produce their own light, so they have a much wider viewing range.

But OLEDs also have their **Disadvantages:**

Lifetime

While red and green OLED films have reasonably long lifetimes (46,000 to 230,000 hours), blue organics currently have much shorter lifetimes (around 14,000 hours) *OLED-Info.com*

Manufacturing

The process of manufacturing is very expensive at the moment, and needs to become cheaper and more efficient to make OLED screens a feasible price.

Water

OLEDs are very prone to being damages by water

Trends

Dr. Wolfgang Clemens states that polymer electronics is a new technology platform which will open up new applications where there is a demand for thin, flexible, lightweight and low-cost electronics, and where the functionalities of the electronic device can be limited. It will not replace conventional electronics. Polymer electronics is still a young technology that is not yet fully established on the market.

The electronic parameters of organic polymer materials are lower that those of conventional inorganic materials like silicon and copper. The parameters referred to are the conductivity of conductive materials. The charge carrier mobility of semiconductors and the operating life time in general. Work in this field will focus on the further optimization of the basic materials and processes with new solutions for electronic quality control methods, but also in finding new applications for polymer electronics.

Prospects

Polymer electronics is the new technology platform that is paving the way for innovative thin, flexible, large area electronic devices which can be produced in very high volume, hopefully at a low cost. The technology is bases on conductive and semi conductive organic materials. These materials can be from many different classes, including organic molecules and polymers. In order for the technology to expand OLEDs need to be able to be produced in high volumes on flexible substrates, one method of doing this is by ‘printing’.

Polymer electronics has a huge potential in many different areas of applications. But now, in order to make sure that this is the technology of the future we need to be able

to advance our ideas and coagulate them, so we are able to meet the needs of the future, such as energy efficiency at a low cost.

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