Application of lcd

A liquid crystal display (LCD) is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals (LCs). LCs do not emit light directly.

Photo showing subpixels in detail

They are used in a wide range of applications including: computer monitors, television, instrument panels, aircraft cockpit displays, signage, etc. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones. LCDs have displaced cathode ray tube(CRT) displays in most applications. They are usually more compact, lightweight, portable, less expensive, more reliable, and easier on the eyes. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they cannot suffer image burn-in.

LCDs are more energy efficient and offer safer disposal than CRTs. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically-modulated optical device made up of any number of pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in colour or monochrome. The earliest discovery leading to the development of LCD technology, the discovery of liquid crystals, dates from 1888. By 2008, worldwide sales of televisions with LCD screens had surpassed the sale of CRT units.

Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters, the axes of transmission of which are (in most of the cases) perpendicular to each other. With no actual liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer. In most of the cases the liquid crystal has double refraction.[citation needed]

The surface of the electrodes that are in contact with the liquid crystal material are treated so as to align the liquid crystal molecules in a particular direction. This treatment typically consists of a thin polymer layer that is unidirectionally rubbed using, for example, a cloth. The direction of the liquid crystal alignment is then defined by the direction of rubbing. Electrodes are made of a transparent conductor called Indium Tin Oxide (ITO).

Types of LED's present in markets

Let us take a look at the different varieties of liquid crystals that are available for industrial purposes. The most usable liquid crystal among all the others is the nematic phase liquid crystals.

Nematic Phase LCD

The greatest advantage of a nematic phase liquid crystal substance is that it can bring about predictable controlled changes according to the electric current passed through them. All the liquid crystals are according to their reaction on temperature difference and also the nature of the substance.

Twisted Nematics, a particular nematic substance is twisted naturally. When a known voltage is applied to the substance, it gets untwisted in varying degrees according to our requirement. This in turn is useful in controlling the passage of light. A nematic phase liquid crystal can be again classified on the basis in which the molecules orient themselves in respect to each other.

This change in orientation mainly depends on the director, which can be anything ranging from a magnetic field to a surface with microscopic grooves. Classification includes Smectic and also cholesteric. Smectic can be again classified as smectic C, in which the molecules in each layer tilt at an angle from the previous layer. Cholesteric, on the other hand has molecules that twist slightly from one layer to the next, causing a spiral like design. There are also combinations of these two called Ferro-electric liquid crystals (FLC), which include cholesteric molecules in a smectic C type molecule so that the spiral nature of these molecules allows the microsecond switching response time. This makes FLCs to be of good use in advanced displays.

Liquid crystal molecules are further classified into thermotropic and lyotropic crystals. The ufurther divided into nematic and isotropic. Nematic liquid crystals have a fixed order of pattern while isotropic liquid crystals are distributed randomly. The lyotropic crystal depends on the type of solvent they are mixed with. They are therefore useful in making detergents and soaps.

Making of LCD

Though the making of LCD is rather simple there are certain facts that should be noted while making it.

The basic structure of an LCD should be controllably changed with respect to the applied electric current.

The light that is used on the LCD can be polarized.

Liquid crystals should be able to both transmit and change polarized light.

There are transparent substances that can conduct electricity.

To make an LCD, you need to take two polarized glass pieces. The glass which does not have a polarized film on it must be rubbed with a special polymer which creates microscopic grooves in the surface. It must also be noted that the grooves are on the same direction as the polarizing film. Then, all you need to do is to add a coating of nematic liquid crystals to one of the filters. The grooves will cause the first layer of molecules to align with the filter's orientation. At right angle to the first piece, you must then add a second piece of glass along with the polarizing film. Till the uppermost layer is at a 90-degree angle to the bottom, each successive layer of TN molecules will keep on twisting. The first filter will naturally be polarized as the light strikes it at the beginning. Thus the light passes through each layer and is guided on to the next with the help of molecules. When this happens, the molecules tend to change the plane of vibration of the light to match their own angle. When the light reaches the far side of the liquid crystal substance, it vibrates at the same angle as the final layer of molecules. The light is only allowed an entrance if the second polarized glass filter is same as the final layer.

The main principle behind liquid crystal molecules is that when an electric current is applied to them, they tend to untwist. This causes a change in the light angle passing through them. This causes a change in the angle of the top polarizing filter with respect to it. So little light is allowed to pass through that particular area of LCD. Thus that area becomes darker comparing to others.

For making an LCD screen, a reflective mirror has to be setup in the back. An electrode plane made of indium-tin oxide is kept on top and a glass with a polarizing film is also added on the bottom side. The entire area of the LCD has to be covered by a common electrode and above it should be the liquid crystal substance. Next comes another piece of glass with an electrode in the shape of the rectangle on the bottom and, on top, another polarizing film. It must be noted that both of them are kept at right angles. When there is no current, the light passes through the front of the LCD it will be reflected by the mirror and bounced back. As the electrode is connected to a temporary battery the current from it will cause the liquid crystals between the common-plane electrode and the electrode shaped like a rectangle to untwist. Thus the light is blocked from passing through. Thus that particular rectangular area appears blank.

Colour Liquid Crystal Display

Colour LCDs are those that can display pictures in colours. For this to be possible there must be three sub-pixels with red, green and blue colour filters to create each colour pixel. For combining these sub-pixels these LCDs should be connected to a large number of transistors. If any problem occurs to these transistors, it will cause a bad pixel.

One of the main disadvantages of these types of LCDs is the size. Most manufacturers try to reduce the height than gain it. This is because more transistors and greater pixels will be needed to increase the length. This will increase the probability of bad pixels. It is very difficult or also impossible to repair a LCD with bad pixels. This will highly affect the sale of LCDs.

Color displays

In colour LCDs each individual pixel is divided into three cells, or subpixels, which are coloured red, green, and blue, respectively, by additional filters (pigment filters, dye filters and metal oxide filters). Each subpixel can be controlled independently to yield thousands or millions of possible colours for each pixel. CRT monitors employ a similar ‘ subpixel’ structures via phosphors, although the electron beam employed in CRTs do not hit exact subpixels.

Zero-power (bistable) displays

The zenithal bistable device (ZBD), developed by QinetiQ (formerly DERA), can retain an image without power. The crystals may exist in one of two stable orientations (“ Black” and “ White”) and power is only required to change the image. ZBD Displays is a spin-off company from QinetiQ who manufacture both grayscale and colour ZBD devices.

A French company, Nemoptic, has developed the BiNem zero-power, paper-like LCD technology which has been mass-produced in partnership with Seiko since 2007. This technology is intended for use in applications such as Electronic Shelf Labels, E-books, E-documents, E-newspapers, E-dictionaries, Industrial sensors, Ultra-Mobile PCs, etc.

Kent Displays has also developed a “ no power” display that uses Polymer Stabilized Cholesteric Liquid Crystals (ChLCD). A major drawback of ChLCD screens are their slow refresh rate, especially at low temperatures[citation needed]. Kent has recently demonstrated the use of a ChLCD to cover the entire surface of a mobile phone, allowing it to change colours, and keep that colour even when power is cut off.

In 2004 researchers at the University of Oxford demonstrated two new types of zero-power bistable LCDs based on Zenithal bistable techniques.

Several bistable technologies, like the 360° BTN and the bistable cholesteric, depend mainly on the bulk properties of the liquid crystal (LC) and use standard strong anchoring, with alignment films and LC mixtures similar to the traditional monostable materials. Other bistable technologies (i. e. Binem Technology) are based mainly on the surface properties and need specific weak anchoring materials.

Brief history

1888: Friedrich Reinitzer (1858-1927) discovers the liquid crystalline nature of cholesterol extracted from carrots (that is, two melting points and generation of colours) and published his findings at a meeting of the Vienna Chemical Society on May 3, 1888 (F. Reinitzer: Beiträge zur Kenntniss des Cholesterins, Monatshefte für Chemie (Wien) 9, 421-441 (1888)).

1904: Otto Lehmann publishes his work “ Flüssige Kristalle” (Liquid Crystals).

1911: Charles Mauguin first experiments of liquids crystals confined between plates in thin layers.

1922: Georges Friedel describes the structure and properties of liquid crystals and classified them in 3 types (nematics, smectics and cholesterics).

1936: The Marconi Wireless Telegraph company patents the first practical application of the technology, “ The Liquid Crystal Light Valve”.

1962: The first major English language publication on the subject “ Molecular Structure and Properties of Liquid Crystals”, by Dr. George W. Gray.

1962: Richard Williams of RCA found that liquid crystals had some interesting electro-optic characteristics and he realized an electro-optical effect by generating stripe-patterns in a thin layer of liquid crystal material by the application of a voltage. This effect is based on an electro-hydrodynamic instability forming what is now called “ Williams domains” inside the liquid crystal.

1964: George H. Heilmeier, then working in the RCA laboratories on the effect discovered by Williams achieved the switching of colours by field-induced realignment of dichroic dyes in a homeotropically oriented liquid crystal. Practical problems with this new electro-optical effect made Heilmeier continue to work on scattering effects in liquid crystals and finally the achievement of the first operational liquid crystal display based on what he called the dynamic scattering mode (DSM). Application of a voltage to a DSM display switches the initially clear transparent liquid crystal layer into a milky turbid state. DSM displays could be operated in transmissive and in reflective mode but they required a considerable current to flow for their operation. George H. Heilmeier was inducted in the National Inventors Hall of Fame and credited with the invention of LCD.

1960: Pioneering work on liquid crystals was undertaken in the late 1960s by the UK’s Royal Radar Establishment at Malvern, England. The team at RRE supported ongoing work by George Gray and his team at the University of Hull who ultimately discovered the cyanobiphenyl liquid crystals (which had correct stability and temperature properties for application in LCDs).

1970: On December 4, 1970, the twisted nematic field effect in liquid crystals was filed for patent by Hoffmann-LaRoche in Switzerland, (Swiss patent No. 532 261) with Wolfgang Helfrich and Martin Schadt (then working for the Central Research Laboratories) listed as inventors. Hoffmann-La Roche then licensed the invention to the Swiss manufacturer Brown, Boveri & Cie who produced displays for wrist watches during the 1970s and also to Japanese electronics industry which soon produced the first digital quartz wrist watches with TN-LCDs and numerous other products. James Fergason while working with Sardari Arora and Alfred Saupe at Kent State University Liquid Crystal Institute filed an identical patent in the USA on April 22, 1971. In 1971 the company of Fergason ILIXCO (now LXD Incorporated) produced the first LCDs based on the TN-effect, which soon superseded the poor-quality DSM types due to improvements of lower operating voltages and lower power consumption.

1972: The first active-matrix liquid crystal display panel was produced in the United States by Westinghouse, in Pittsburgh, PA.

1996 Samsung develops the optical patterning technique that enables multi-domain LCD. Multi-domain and IPS subsequently remain the dominant LCD designs through 2010.

1997 Hitachi resurrects the In Plane Switching (IPS) technology producing the first LCD to have the visual quality acceptable for TV application.

2007: In the 4Q of 2007 for the first time LCD televisions surpassed CRT units in worldwide sales.

2008: LCD TVs become the majority with a 50% market share of the 200 million TVs forecast to ship globally in 2008 according to Display Bank.

L. C. D vs Plasma

Both Plasma and LCD high-definition TV screens produce excellent quality pictures. Most experts believe that Plasma screens produce a slightly better picture than their LCD counterpart.

Plasma screens have the ability to show deeper blacks to help their picture quality but they do generally cost more than LCDs.

LCDs have only recently been able to compete with Plasmas in the very large screen market and are more than competitive in the products they offer.

LCDs use far less power than Plasma screens and have a greater life expectancy.

The consensus amongst most experts is that if you are in the market for a small screen then an LCD screen is your best bet. If you are in the market for a large screen flat panel TV then you should be buying a Plasma screen.

The Plasma flat panel screen is heavier than a LCD flat panel screen so if you are going to have your large flat screen TV on a cabinet so you can move it around the room as you change the furniture then you are probably going to want to buy an LCD flat panel screen for convenience.

Previously the main difference between the two different forms of high-definition television was the price and size of the two products. The price of LCD TV screens compares favourably with that of the Plasmas while the size of LCDs now also increasing with each new product release to catch up to the Plasmas who have traditionally been the larger of the two flat panel screens.

Applications

In TV and MONITORS

Technological improvements to liquid crystal display (LCD) screens have seen them become more popular in the high definition television market. With the improvement of broadcasting pictures moving quickly from analogue to digital television so too is the television market moving from regular Cathode Ray Tube (CRT) to large flat panel LCD or Plasma screens.

While liquid crystal display television (LCD TV) is new technology, we have been using liquid crystal display for many years in other household items such as digital clocks, oven timers and home computers.

LCD technology is not restricted to just large flat screen TVs with LCD projectors available for corporations to display video, images or data in much the same way that the old overhead projector once did.

LCD technology provides a cheaper alternative to large Plasma screens. Historically the LCD screens have been smaller but new technology is increasing the size of these large flat screen TVs to be more competitive than ever before.

While the size of LCDs has increased the advantage one has in price comparison with a Plasma screen has seen the LCD screens enjoy their fair share of high definition large flat screen sales in the home entertainment market.

LCD screens also need less power to function giving the consumers considerable savings on their electricity bills.

LCD technology is not restricted to just large flat screen TVs with LCD projectors available for corporations to display video, images or data in much the same way that the old overhead projector once did.

An LCD projector works by sending light from a halogen lamp through three LCD panels (one for red, blue and green). The individual pixels then open to allow light to pass or close to block the light producing our image.

We also use LCD technology in the world of computers with a LCD computer monitor the most popular display device for computers. An LCD monitor is the popular choice amongst consumers because of the flat panel screen taking up very little space.

Having replaced the bulky computer monitors the LCD monitor is here to stay with all new computer purchases going hand in hand with a LCD computer monitor. The advantages in buying an LCD monitor is not only restricted to the size but also the savings with LCD monitors using very little of your power supply to work.

Liquid crystal display television (LCD TV) provides the viewer with a far greater experience watching television. With the LCD TV set you don’t have to close the curtains because the screen is too bright to see the picture properly like you do with a normal CRT television.

One major advantage an LCD screen has is that it is not only a capable of displaying high-definition TV, video, dvd or normal television but it can also be used as a computer monitor. Just like your everyday PC monitor you can play games on your LCD screen, your just going to have a bigger, better view of your screen playing on your large screen TV mounted on the wall.

In MOBILES Screens

The new LCD modules combine technology characteristics of the Sharp AQUOS Liquid Crystal TV, referred to as the ASV LCD with Sharp's proprietary small format display technology, referred to as the Advanced-TFT. With this breakthrough, Sharp has attained a new mobile display that is ideally suited for mobile devices, such as camera phones, PDAs, and personal media players, which display streaming video content or color images. The displays achieve excellent visibility in any lighting situation, while offering a wide viewing angle, high contrast ratio, and superior color reproduction.

The displays are slated for sampling in December of 2003, with volume production to begin next spring.

" The explosive growth in the use of multi-functional mobile devices has rapidly accelerated the demand for high-resolution color displays that allow users to view a wider range of content," said Joel Pollack, vice president of the Display Business Unit at Sharp Microelectronics of the Americas. " Sharp's new mobile ASV LCD technology offers design engineers high quality display technology similar to that which is used in our AQUOS LCD TVs. The result is a clear, bright display visible from virtually any angle and under any ambient lighting condition.”

The continued growth in the mobile market is expected to stimulate new demand for the capability to view video and graphic content, including photographic images, scenes from television shows, movies, sports events and news.