

LIQUID CRYSTAL DISPLAY (LCD)

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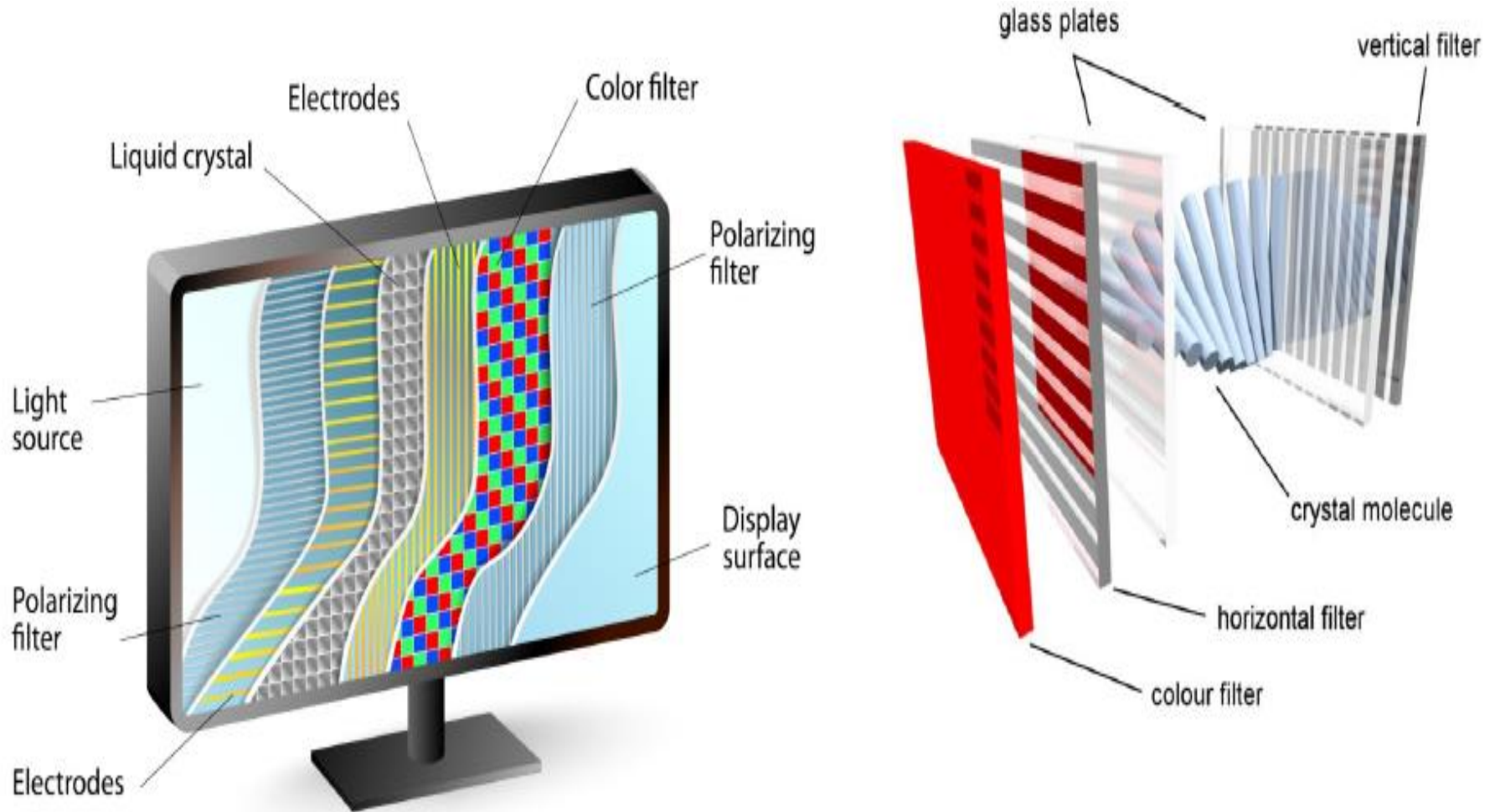
FLAT PANEL DISPLAYS

- Flat-Panel Display refers to a class of display devices that have reduced volume, weight and power requirements compared to CRT.
- There are two categories of flat panel displays:
 - Emissive Displays
 - Non-Emissive Displays
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- **Emissive Displays** (or emitters) are devices that convert electrical energy into light. Plasma Panel (PDP) and light emitting diodes (LED) are examples of **emissive displays**.
- **Non-emissive** displays (or non-emitters) use optical effects to convert sunlight or light from some other source into graphics pattern e.g Liquid Crystal Display (LCD)

LIQUID CRYSTAL DISPLAY (LCD)

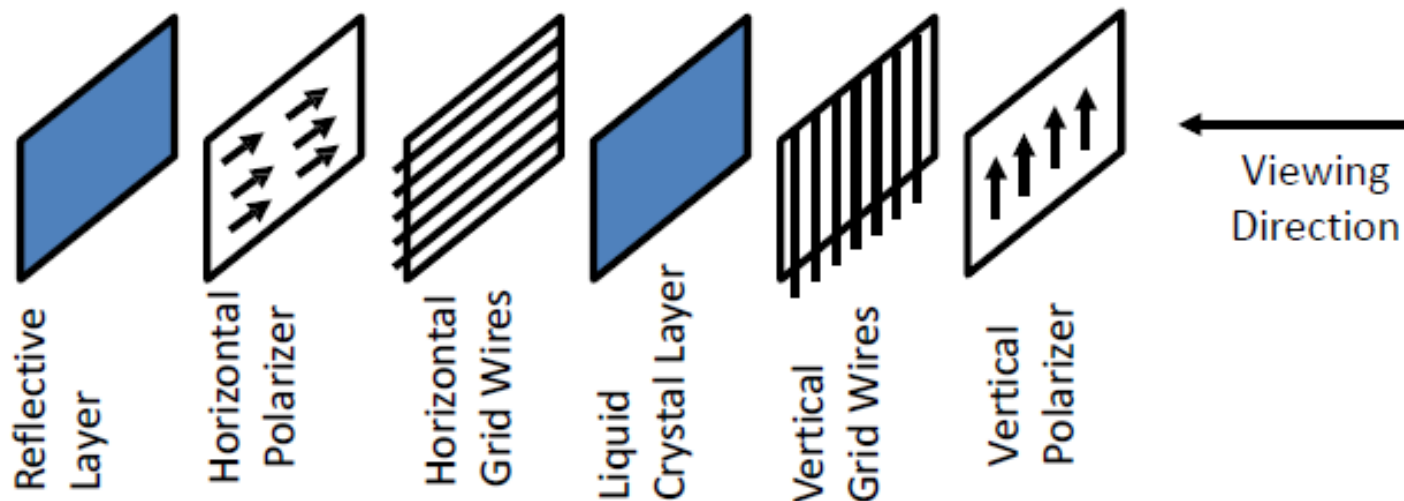
- A **liquid crystal display** is a thin, flat display device made up of any number of pixels arrayed in front of a light source or reflector.
- It uses very small amounts of electric power, and is suitable for use in battery-powered electronic devices.
- Colour displays are possible by incorporating colour filters.
- The heart of all liquid crystal displays (LCDs) is a liquid crystal itself. A liquid crystal is a substance that flows like a liquid, but its molecules orient themselves in the manner of a crystal.
- That is, it is an organic compounds, whose macroscopic behavior resemble that of liquid but shows physical properties of crystals.
- A plane has nematic-like structure, but with each plane molecules change their direction. As a result the molecules display a helical twist through the material.
- They have characteristics like: rod-like molecular structure, or easily polarizable constituents.

LIQUID CRYSTAL DISPLAY (LCD)



LCD CONSTRUCTION

- Each pixel of an LCD consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters, whose axes are perpendicular.
- Orientation of the liquid crystal molecules is determined by the alignment at the surfaces.
- Six Layers of LCD are shown in figure:



- Consider a single pixel area in LCD, in which there are two polarization filters oriented at 90-degree angle to each other as shown in figure 1.1. These filters are used to polarize the unpolarized light.
- The first filter (Vertical-polarized filter in figure 1.1) polarizes the light with one polarization plane (Vertical).
- When the vertically polarized light passes through the second filter (Horizontal polarized filter) no light output will produce.

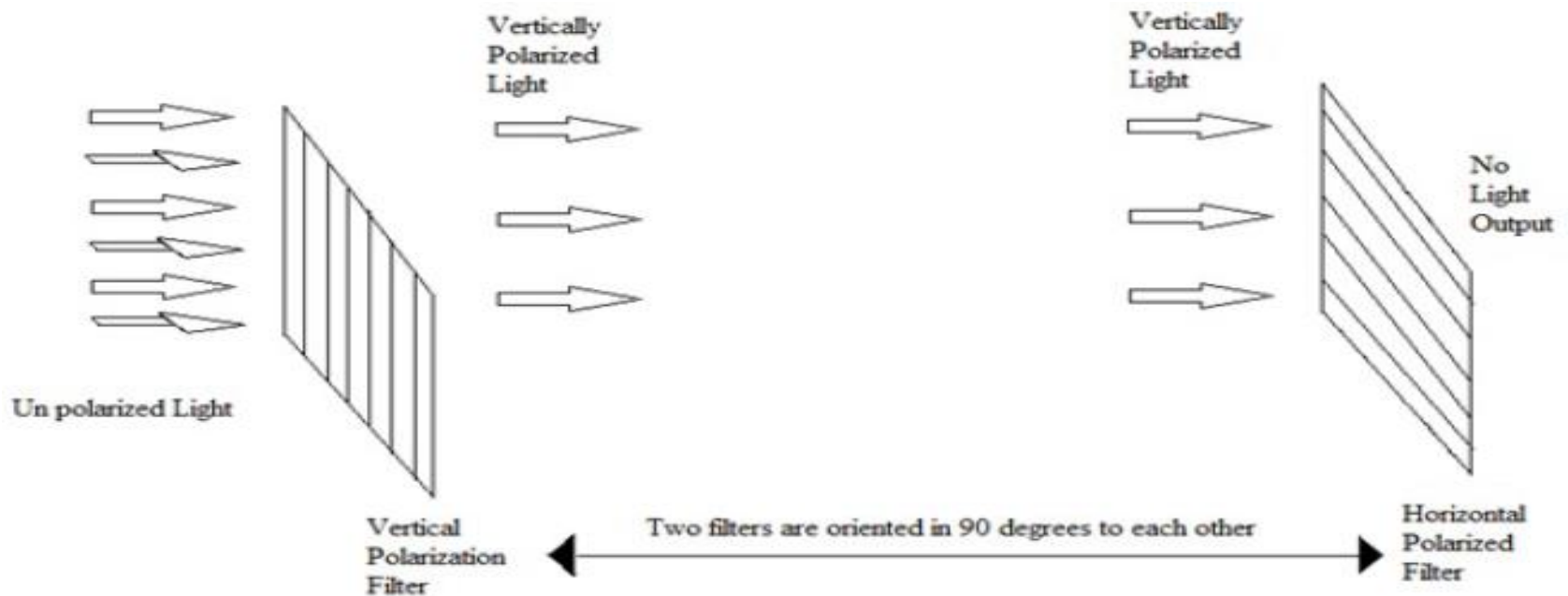


Figure 1.1 Orientation of two polarization filters in LCD

- The vertically polarized light should rotate 90 degrees in order to pass through the horizontal polarized light. This can be achieved by embedding a liquid crystal layer between two polarization filters.
- The liquid crystal layer consists of rod-shaped tiny molecules and ordering of these molecules creates directional orientation property.
- These molecules in the liquid crystal are twisted 90 degrees. The vertically polarized light passes through rotation of the molecules and twisted to 90 degrees. When the orientation of light matches with the outer polarization filter light will pass it and brightens the screen.

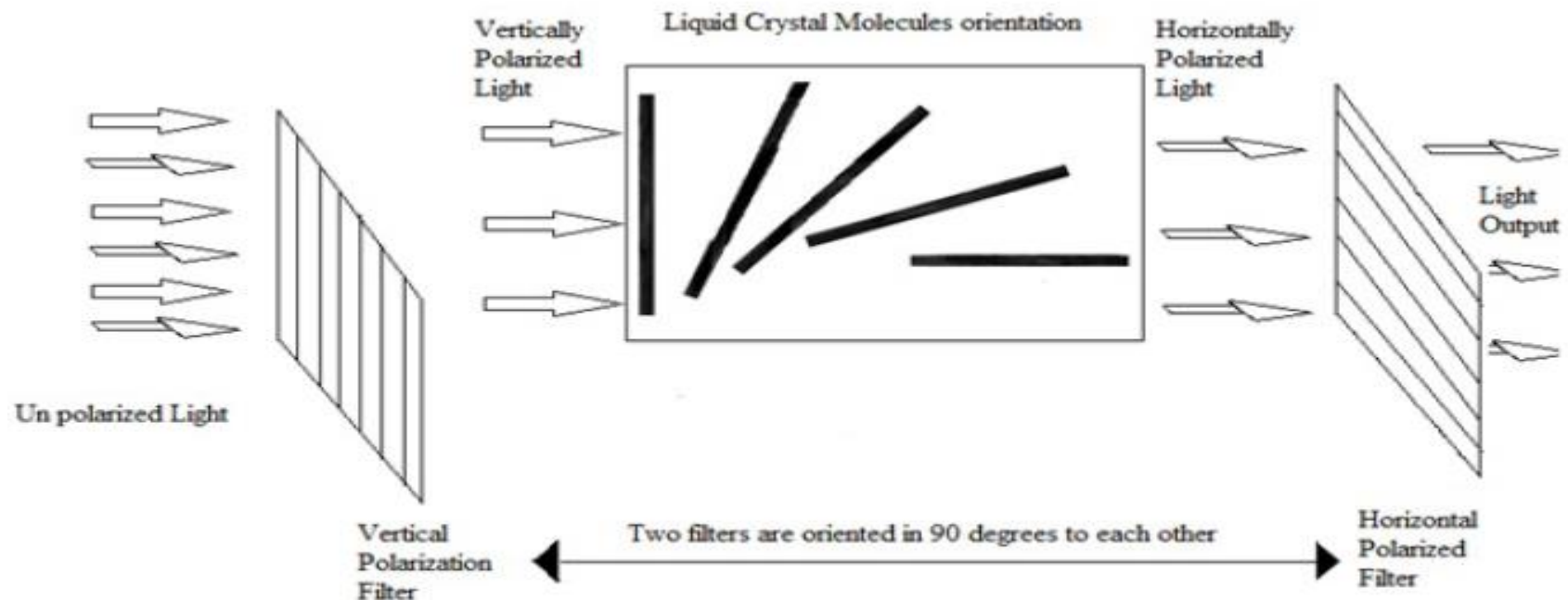


Figure 1.2 Liquid Crystal molecules orientation.

- If the Liquid crystal molecules are twisted 90 degrees more precisely, then more light will pass through it.
- Two glass transparent electrodes are aligned front and back of the liquid crystal in order to change the orientation of the crystal molecules by applying voltage between them.
- If there is no voltage applied between the electrodes, the orientation of molecules will remain twist at 90 degrees and the light passes through the outer polarization filter thus pixel appears as complete white.
- When a voltage is applied across the electrodes, a torque acts to align the liquid crystal molecules parallel to the electric field, distorting the helical structure. This reduces the rotation of the polarization of the incident light and the molecules in the liquid crystal layer changes its orientation (untwist) so that light orientation also changes and then blocked by the outer polarization filter thus the pixel appears black.
- In this way, black and white images or characters are produced.. By controlling the voltage applied between liquid crystal layers in each pixel, light can be allowed to pass through outer polarization filter in various amounts, so that it can be possible to produce different gray levels on the LCD screen.

- Generally the electrodes is made up of Indium Tin Oxide (ITO) which is transparent material, hence it is simply called glass electrodes plates.
- LCD display is also “twisted nematic LCD” because of twist and untwist of molecules in liquid crystal layer.

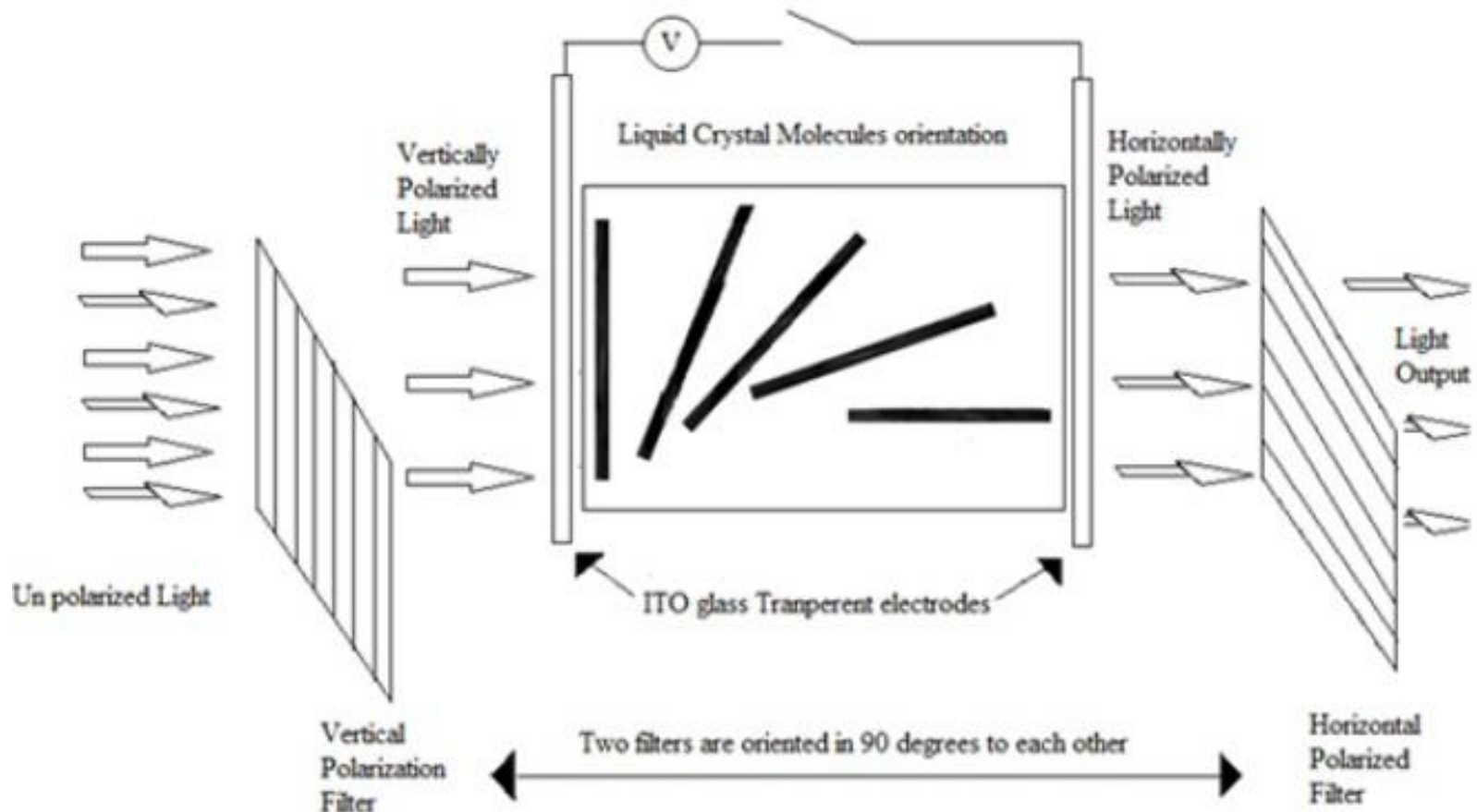


Figure. 1.3 : When no voltage is applied between the electrodes

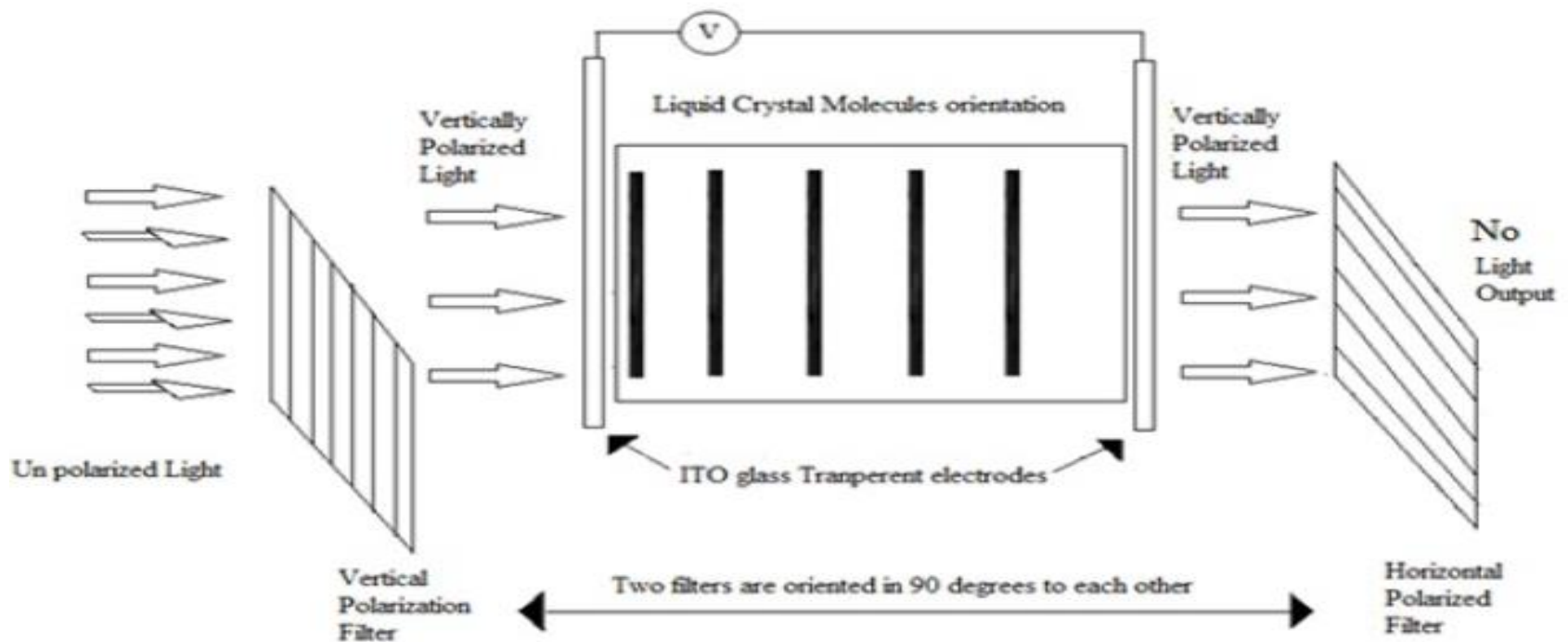


Figure. 1.4 :Orientation of Liquid crystal molecules altered by applying voltage between two ITO glass plates.

- In order to produce color images a color filter is placed in front of the outer polarization plate as shown in figure 1.5. The red, green and blue are the three standard color filters are placed for every three pixels to produce different color images by varying the intensity of each color.

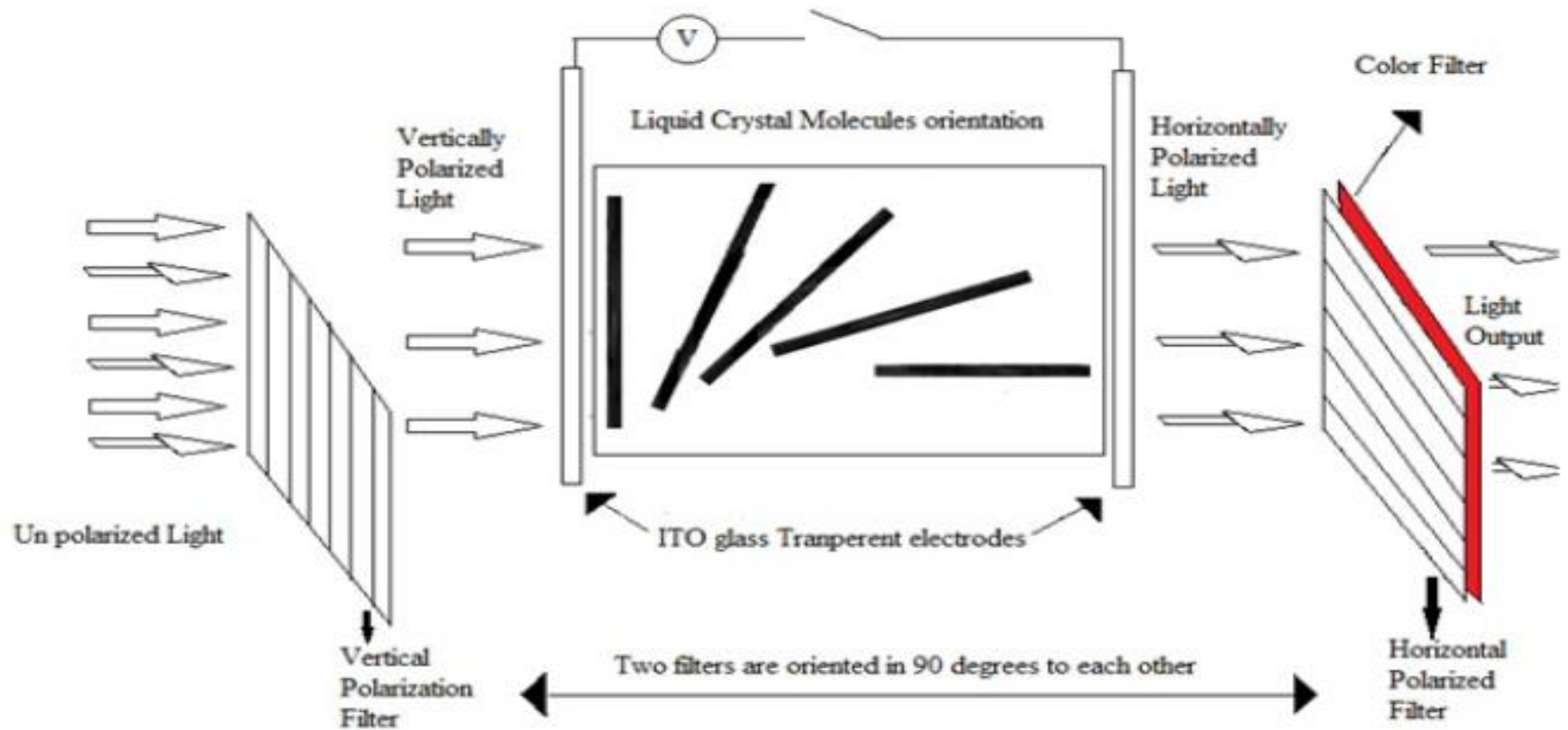
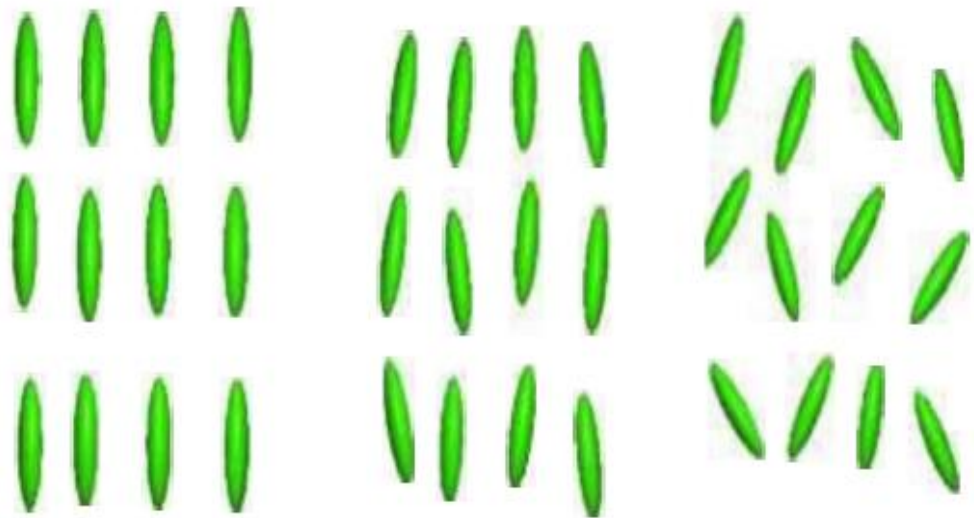
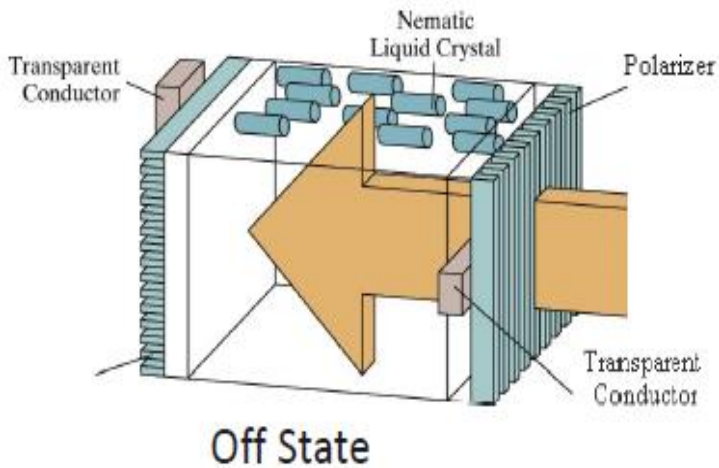
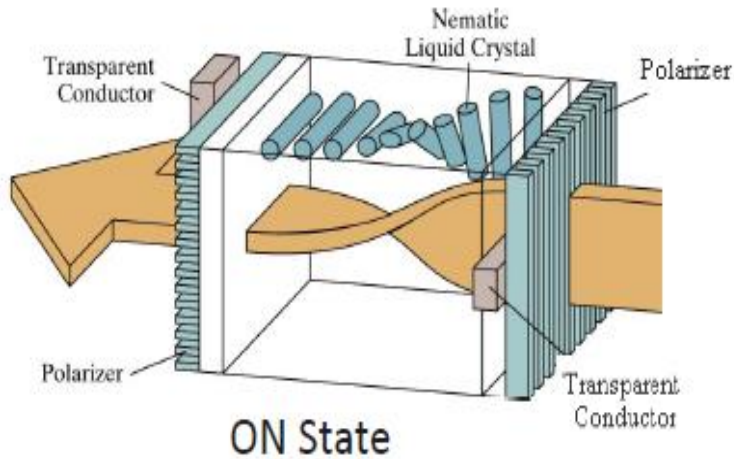


Figure 1.5 Placement of color filter in front of the polarized filter to produced color images.

LCD CHARACTERISTICS



Solid

Liquid Crystal

Liquid

Applications, Advantages & Limitations of LCD

Applications:

- LCDs with a small number of segments, are used in digital watches and pocket calculators, Small monochrome displays in personal organizers, or older laptop screens
- High-resolution color displays such as modern LCD computer monitors and televisions;

Advantages:

- An LCD cell consumes only microwatts of power over a thousand times less than LED displays.
- LCDs can operate on voltages as low as 2 to 3 V and are easily driven by MOS IC drivers.

Limitations:

- They cannot be seen in the dark,
- They have a limited viewing angle;
- They can be operated in limited temperature range.