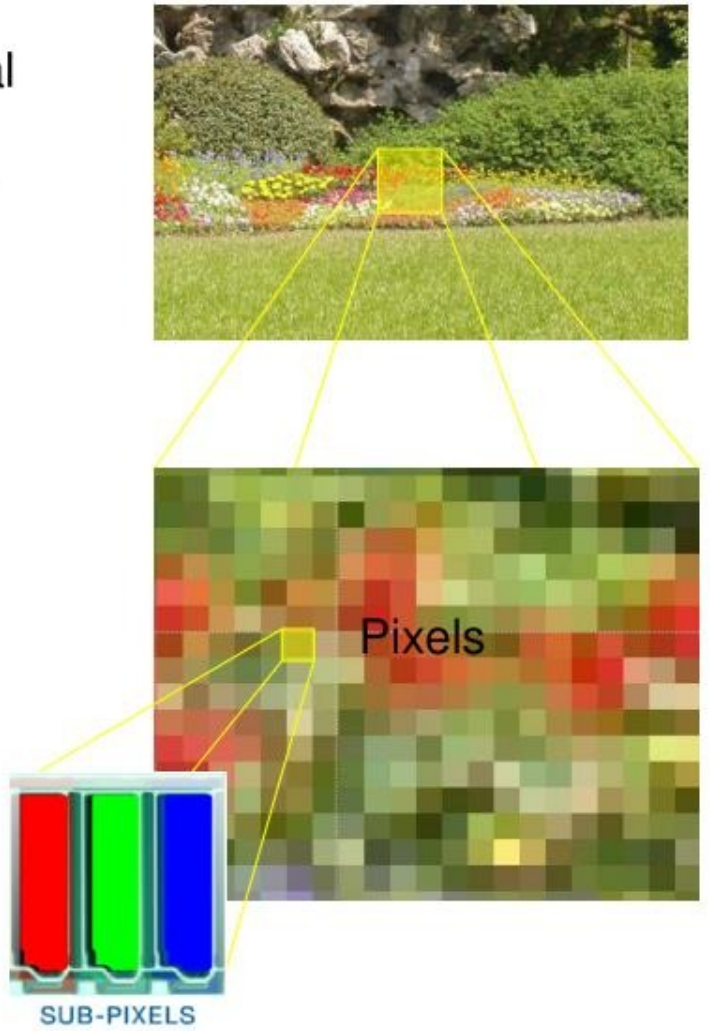
LCD DISPLAY TECHNOLOGY

Program

Figures are curtsy of 3M

Digital Images and Pixels

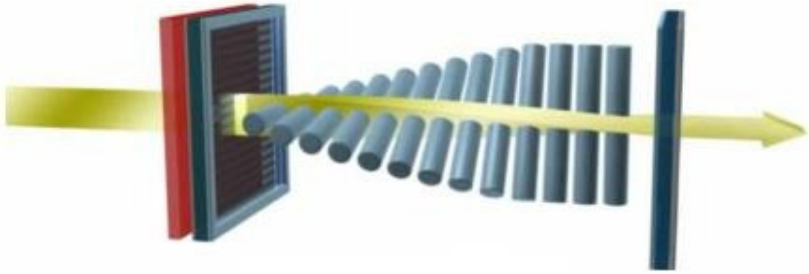
- A digital image is a binary (digital) representation of a two-dimensional pictorial data.
- Digital images may have a raster or vector representation.
- Raster Images defined over a 2D grid of picture elements, called pixels.
- A pixel is the basic items of a raster image and include intensity or color value.

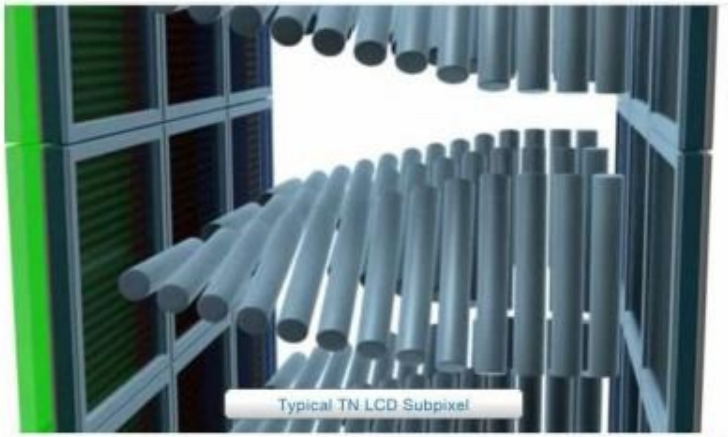


Figures are curtsy of 3M

LCD (Liquid Crystal Display)

- LCD Panel is based on
  - A light valve for each pixel that turn the light on, off, or an intermediate level.
- Grid of such light valve for the LCD display panel.
- A back light and display enhancement films create the illumination.

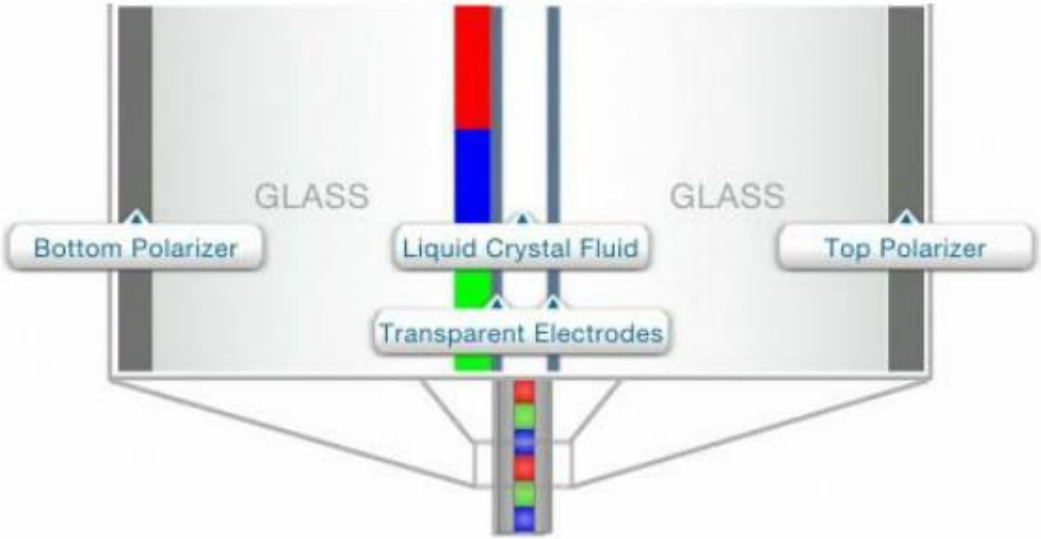


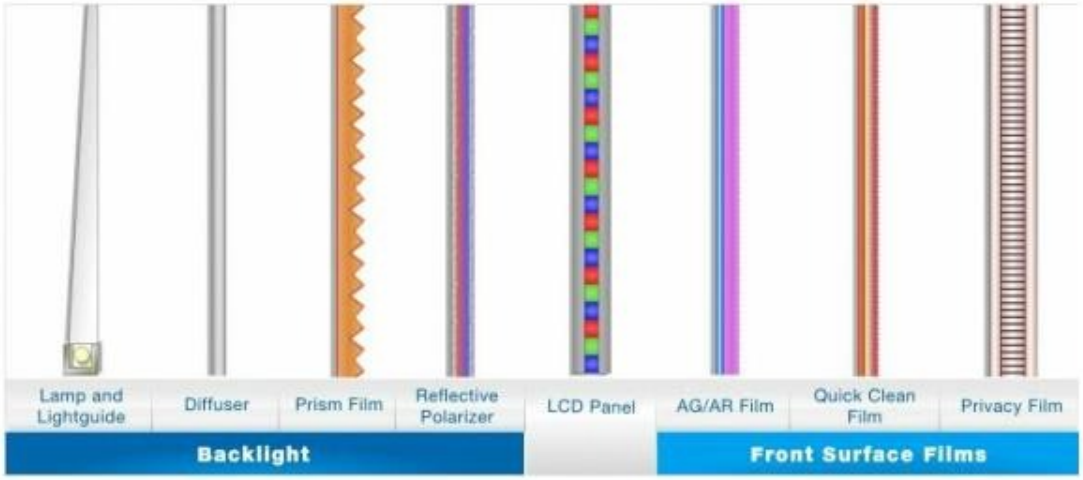


Figures are curtsy of 3M

LCD-Display

- Applying voltage to the electrodes changes the level of illumination in each sub-pixel
- The panel is sandwiched between
  - Front surface films to enhance display property
  - Backlight

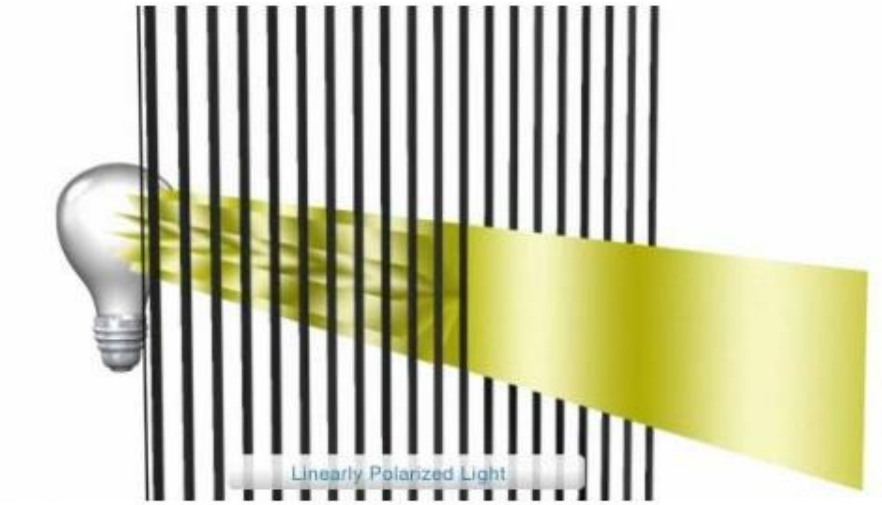




Figures are curtsy of 3M

Linear Polarized Light

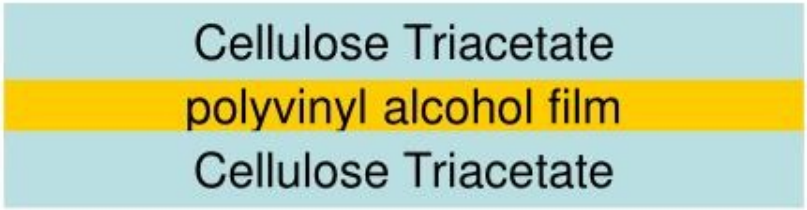
- Light usually vibrates in all direction
- A linear polarized light limit the vibration to one direction
- It absorbs the component of light that vibrate in all other direction.
- LCD require light to vibrate in one direction

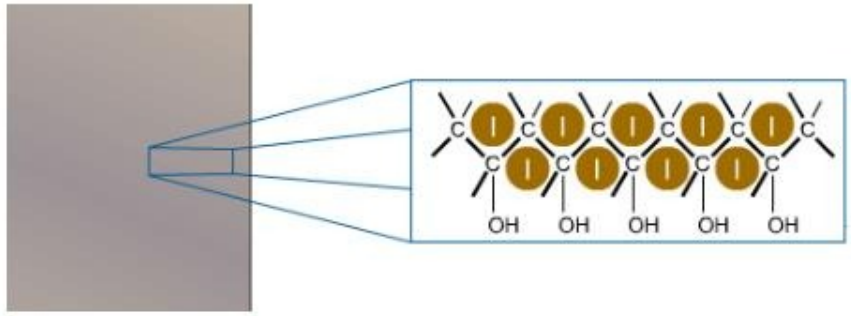


Figures are curtsy of 3M

Iodine Based Polarizer

- Is the most common polarizer
- It is made by
  - Stretching a cast polyvinyl alcohol film (PVA) to align the iodine in turn.
  - Staining it with iodine
  - The stained PVA laminated between two slices of cellulose triacetate.
- The cellulose triacetate
  - Provide physical rigidity
  - Some degree of heat and humidity protection



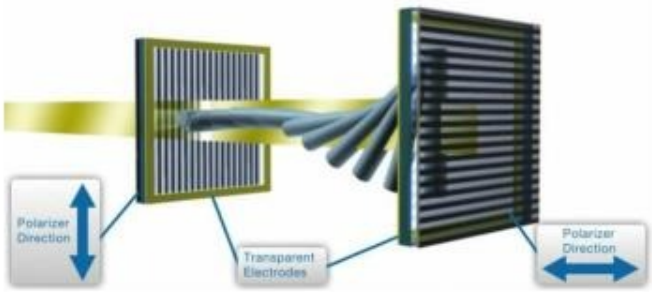


polyvinyl alcohol film

Figures are curtsy of 3M

About Liquid Crystal

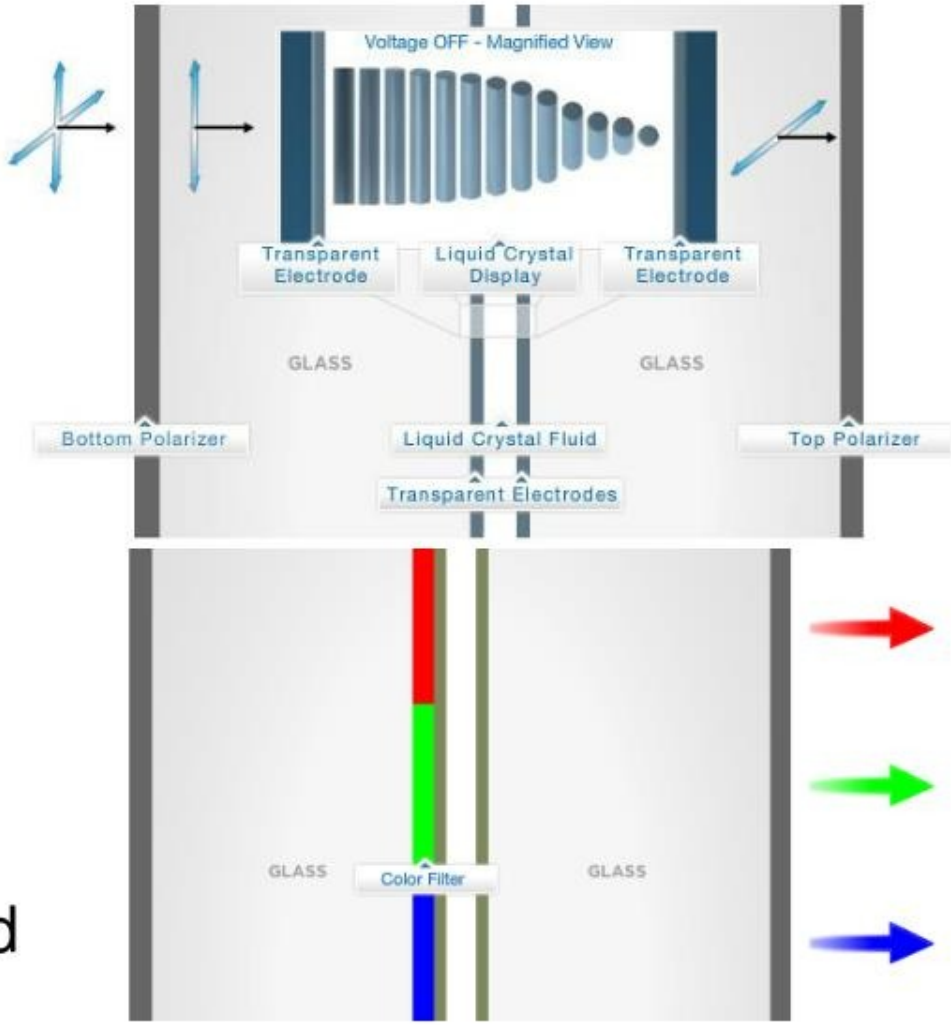
- Liquid crystal molecules can move freely while maintaining their orientation.
- It align itself to a polyimide film to the inside of a panel glass.
- When the two glass panels are not aligned the liquid crystal twists accordingly.
- The liquid crystal will also align to electric field.



Figures are curtsy of 3M

Light Path

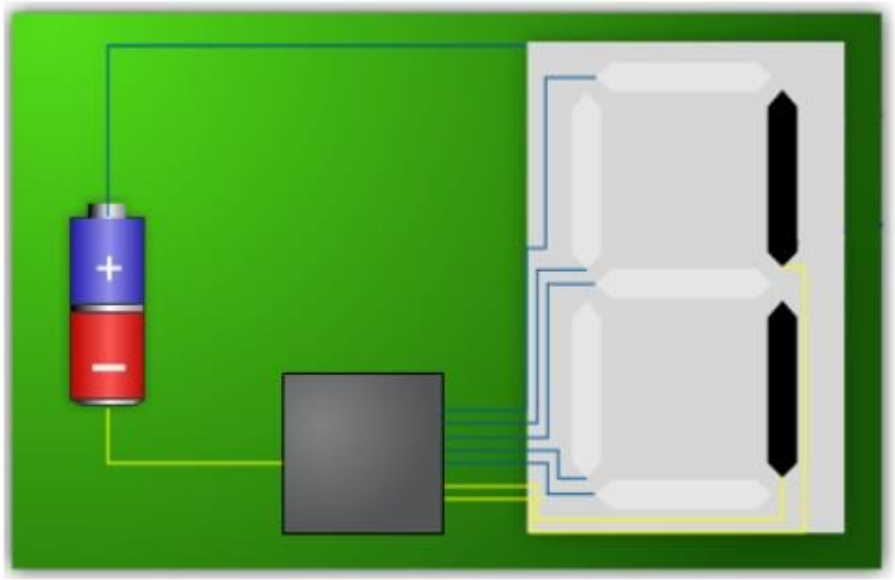
- The light passes through the polarizer.
- The voltage applied to the electrodes controls the liquid crystal orientation
- The liquid crystal orientation controls the rotation of the incoming polarized light.
- Color filters are used in color LCD, where each color sub-pixel is controlled individually



Figures are curtsy of 3M

Direct Address Display

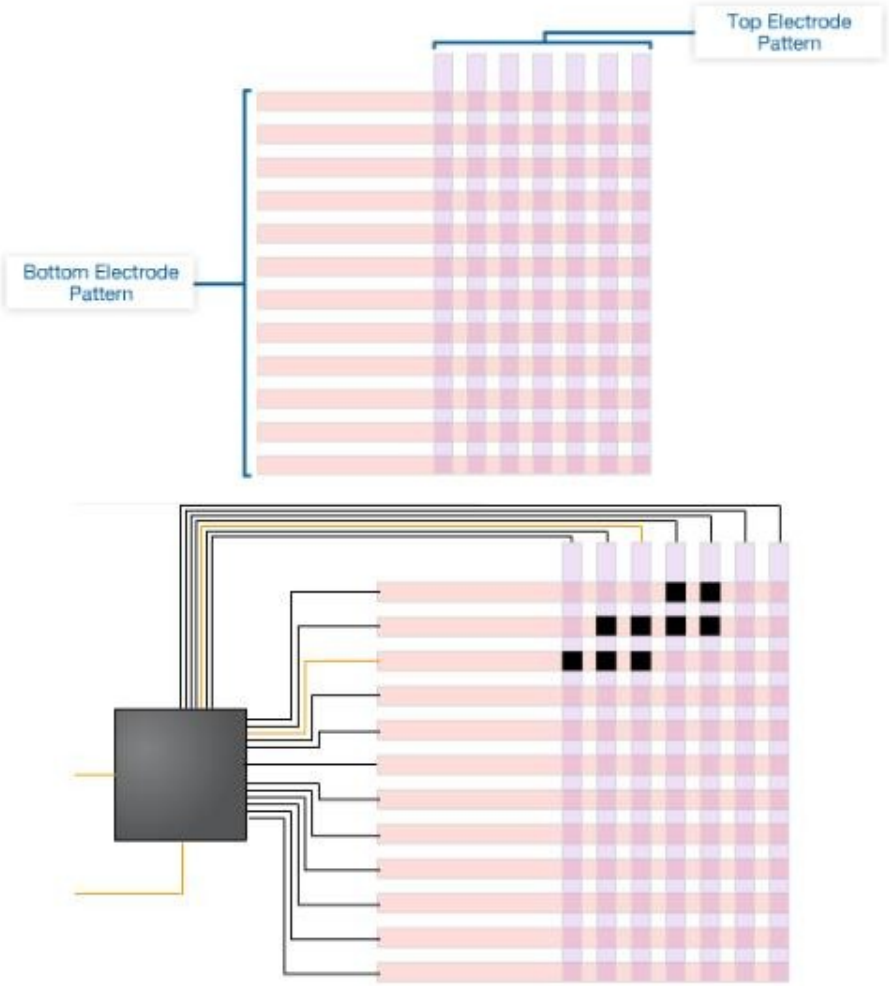
- When the display include limited variable components such as
  - Watches
  - Calculators
- Simple electronics is used to control the components



Figures are curtsy of 3M

Passive Matrix Display

- Passive matrix display has
  - Rows of electrodes on one piece of glass.
  - Columns of electrodes on the opposing piece of glass.
  - Complex electrical waveform control the voltage differential at the intersection of the electrodes.
- The intersection of the columns and rows are the pixels



Figures are curtsy of 3M

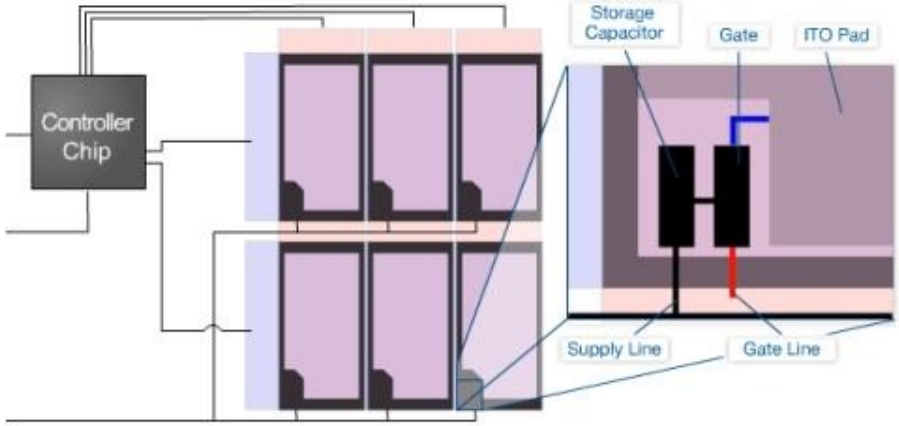
Passive Matrix Display
-disadvantages-

- As more rows and columns are added the range of the allowed voltage is reduced.
  - At high range adjacent channels interferes
  - Range limit reduces contrast
  - Limit the types of useful liquid crystal.
- It is usually limited to about 50 rows
- Twisted nematic (TN) Display work best with large voltage variation.
  - It can not be used in Passive Matrix Display

Figures are curtsy of 3M

Active Matrix Display

- Allow very high resolution
- Each sub-pixel is individually controlled by an isolated thin-film transistor (TFT).
- It allows the electrical signal for each sub-pixel to avoid influencing adjacent elements.
- The TFT is patterned into the glass layer



A display with 1024x768 resolution Include 1024x768x3 = 2,359,296 sub-pixels

Figures are curtsy of 3M

Twisted Nematic (TN) Display

- Is the most common LCD Display.
- The two alignments layer for the liquid crystal material are orthogonal.
- The light entering the polarize panel rotates by the twist in the liquid crystal and allowing it to pass through the second polarize

Figures are curtsy of 3M

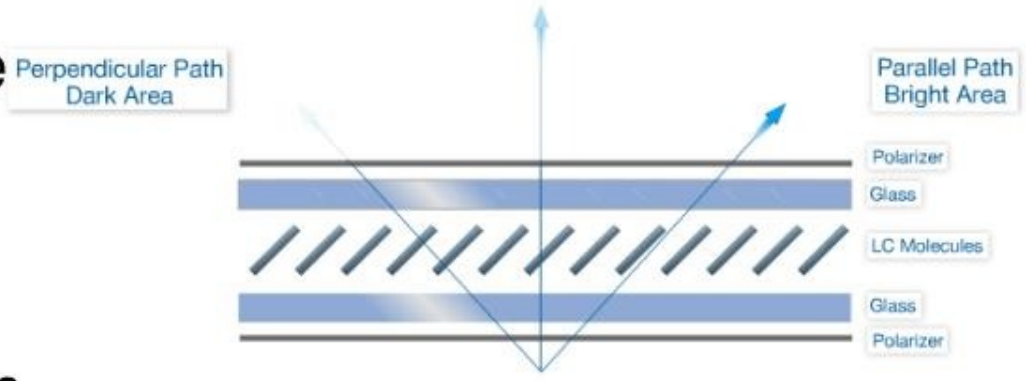
Twisted Nematic (TN) Display

- The electric field is applied
  - The liquid crystal loses its twist.
  - Alight to the electric field.
  - Prevents the rotation of the polarized light
  - The second polarizer absorbs the light.
- The applied voltage control the absorbed and transmitted light

Figures are curtsy of 3M

Twist Nematic Viewing Angle

- Light passes through the TN display from one angle may be blocked in other angles by the twist of the liquid crystal.
- To overcome this limitation different approaches have use various orientations for the polarize layers.



Figures are curtsy of 3M

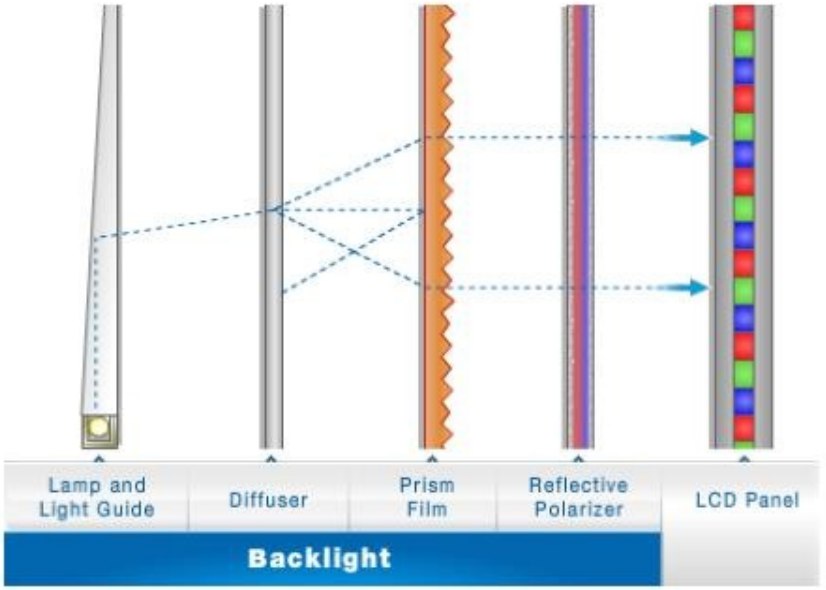
Front Surface Films

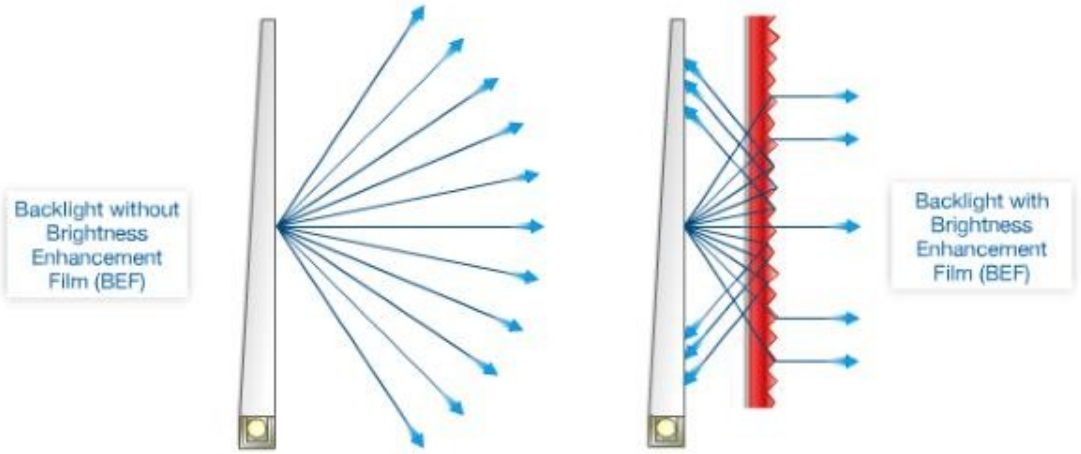
- Hard-coat Films
- Quick Clean Films
- Anti-Glare Films
- Anti-Reflection Films
- Privacy Films

Figures are curtsy of 3M

Back-Light

- The light generated by the backlight.
- The light is evenly distributed the light evenly over the LCD panel.
- Display enhancement films are placed between the light diffuser and the LCD panel. They aim to maximize the light reaching the observer.





Figures are curtsy of 3M

3-D LCD Displays

- This technology aims to generate stereoscopic 3D images with the need for glasses.
- The idea is based on combining
  - Active-matrix LCD with
  - Lenticular lens: an array of magnifying lenses, designed to magnify different images when viewed from slightly different angles.
- Applications
  - Industrial Visualization
  - Medical imaging
  - Entertainment

Figures are curtsy of 3M