22.7 LIQUID CRYSTAL DISPLAY (LCD)

Liquid Crystal Displays (LCDs) are used for display of numeric and alphanumeric character in dot matrix and segmental displays. The two liquid crystal materials which are commonly used in display technology are nematic and cholesteric whose schematic arrangement of molecules is shown in Fig. 22.21(a). The most popular liquid crystal structure is the Nematic Liquid Crystal (NLC). In this type, all the molecules align themselves approximately parallel to a unique axis (director), while retaining the complete translational freedom. The liquid is normally transparent, but if subjected to a strong electric field, disruption of the well ordered crystal structure takes place causing the liquid to polarise and turn opaque. The removal of the applied electric field allows the crystal structure to regain its original form and the material becomes transparent.

Based on the construction, LCDs are classified into two types. They are (i) Dynamic scattering type, and (ii) Field effect type.

Dynamic scattering type The construction of a dynamic scattering liquid crystal cell is shown in Fig. 22.21(b). The display consists of two glass plates, each coated with tin oxide (SnO_2) on the inside with transparent electrodes separated by a liquid crystal layer, 5 to 50 μm thick. The oxide coating on the front sheet is etched to produce a single or multi-segment pattern of characters, with each segment properly insulated from each other. A weak electric field applied to a liquid crystal tends to align molecules in the direction of the field. As soon as the voltage exceeds a certain threshold value, the domain structure collapses and the appearance is changed. As the voltage grows further, the flow becomes turbulent and the substance turns optically inhomogenous. In this disordered state, the liquid crystal scatters light.

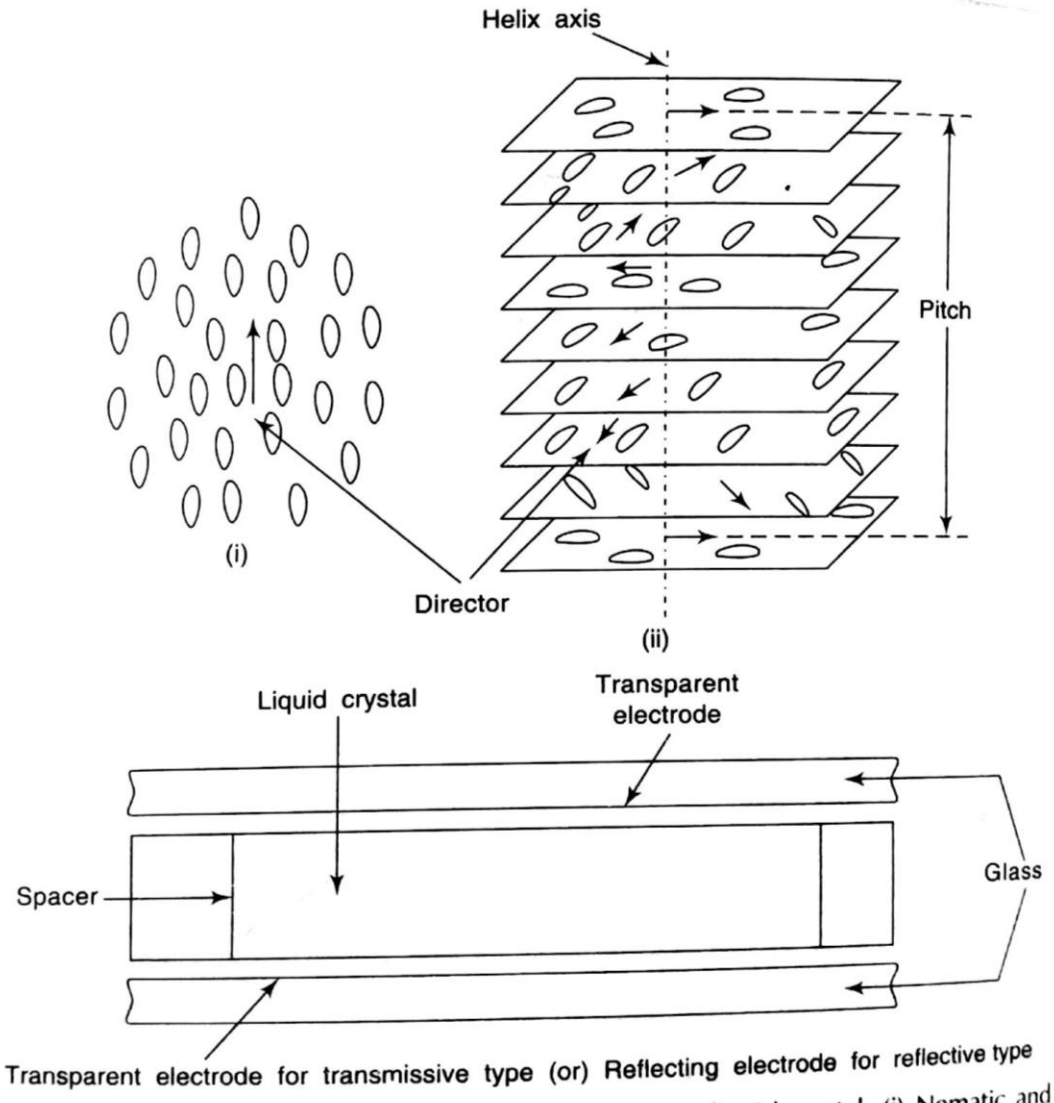

Fig. 22.21 (a) Schematic arrangement of molecules in liquid crystal, (i) Nematic and (ii) Cholesteric and (b) Construction of a dynamic scattering LCD

Thus, when the liquid is not activated, it is transparent. When the liquid is activated, the molecular turbulence causes light to be scattered in all directions and the cell appears to be bright. This phenomenon is called dynamic scattering.

Field effect type The construction of a field effect LCD display is similar to that of the dynamic scattering type, with the exception that two thin polarising optical filters are placed at the inside of each glass sheet. The LCD material is of twisted nematic type which twists the light (change in direction of polarisation) passing through the cell when the latter is not energised. This allows light to pass through the optical filters and the cell appears bright. When the cell is energised, no twisting of light takes place and the cell appears dull.

Liquid crystal cells are of two types: (i) Transmittive type, and (ii) Reflective type. In the transmittive type cell, both glass sheets are transparent so that light from a rear source is scattered in the forward direction when the cell is activated.

The reflective type cell has a reflecting surface on one side of the glass sheet. The incident light on the front surface of the cell is dynamically scattered by an activated cell. Both types of cells appear quite bright when activated even under ambient light conditions.

Liquid crystals consume small amount of energy. In a seven segment display the current drawn is about 25 μA for dynamic scattering cells and 300 μA for field effect cells. LCDs require a.c. voltage supply. A typical voltage supply to dynamic scattering LCDs is 30 V peak-to-peak with 50 Hz. LCDs are normally used for seven-segmental displays.

Advantages of LCD

(i) The voltages required are small.
(ii) They have a low power consumption. A seven segment display requires about 140 W (20 W per segment), whereas LEDs require about 40 mW per numeral.
(iii) They are economical.

Disadvantages of LCD

(i) LCDs are very slow devices. The turn ON and turn OFF times are quite large. The turn ON time is typically of the order of a few ms, while the turn OFF time is 10 ms.
(ii) When used on d.c., their life span is quite small. Therefore, they are used with a.c. supplies having a frequency less than 50 Hz.
(iii) They occupy a large area.

Table 22.1 Comparison between LED and LCD