1.1 Liquid Crystals: A Review:

First scientist to encounter the liquid crystalline state of matter was the Austrian botanist F. Reintzer, who found that some organic compounds exhibits one or more intermediate phases between crystalline solid and isotropic liquid phases. These types of phases are termed as the liquid crystalline phases, and the materials are called “liquid crystals”.

1.2 Types of Liquid Crystals:

Two type of liquid crystal mesophases can be differentiated, viz. thermotropic and lyotropic. Thermotropic liquid crystals are of interest both from the standpoint of basic research and also for applications in electro-optic displays, temperature and pressure sensors etc. While Lyotropic liquid crystals, on the other hand, are of great interest biologically and appear to play an important role in living system.
1.3 Classification on the Basis of Molecular Shape:

1.3.1 Rod Shaped Molecules:

Thus group is best-investigated one and most important with respect to practical applications. These phases are known as Calamitic (Greek world for rod) too. Their molecular axes are much longer than other remaining two as shown in fig. 1.3a. A modifications is lath type molecules shown in fig. 1.3b.

Fig. 1.3: Rod and lath like molecules
1.3.2 Banana Shaped Molecules:

These materials, which form Smectic phases, are interesting, because of shape they form a peculiar smectic phase in which banana shaped molecules (shown in fig. 1.4),

Fig. 1.4: Banana Shaped molecule
1.3.3 Disc-Shaped Molecules:

About 1977, Chandrasekher and Billard were independently, able to prove that the disk like molecules can in fact form mesophases called, columnar phases.

![Diagram of discotic liquid crystals]

**Fig. 1.6.** A general structure template for discotic liquid crystals.
1.4 Classification of Liquid Crystals According to Molecular Order:

This scheme was first proposed by Friedel in 1922. According to Friedel’s classification the states of matter appear as shown in fig. 1.8.

![Phase diagram of liquid crystals](image)

**Fig. 1.8:** Phase sequence in a liquid crystalline material
1.4.1 Nematics:

There are some order, however, in the direction of molecules; they tend to be parallel to some common axis, labeled by a unit vector (or ‘director’) $n$.

Fig. 1.9(a) Shows alignment of molecule with director in nematic phase and (b) optical texture of nematic
1.4.2 **Cholestric Phase liquid Crystals:**

They are composed of optically active molecules, those which differentiate between left and right asymmetries. The main structural difference between Nematic and cholestric crystal is the presence of a chemical group in the latter which has the effect of destroying the cylindrical symmetry of molecules this gives the bulk liquid crystal a twisted structure.

![Systematic representation of molecular structure and optical texture of cholestric phase](image)

**Fig. 1.11:** Systematic representation of molecular structure of (i) cholestric liquid crystal (ii) optical texture of cholestric phase
1.4.3 The Smectic Phase Liquid Crystals:

Smectic (from the greek word smatos meaning soap) is the name coined by G. Fredel for certain mesophases with mechanical Properties reminiscent of soaps. From a structure point of view, all smectic are layered structures, with a well defined interlayer spacing, which can be measured by X-ray diffraction. Smectic are thus more ordered than Nematics

1.4.3.1 Smectis A:

A picture of molecular arrangement for smectic A is shown in fig. 1.12. The major characteristics areas follow:

(i) A layer structure (with layer thickness close to the full length of the constituent molecules).

(ii) Inside each layer, the centres of gravity show no long range order.

Each layer is a two dimensional liquid.
Fig. 1.12: (i) Smectic A phase of liquid crystal. The long axes of the molecules in each layer, on an average, are perpendicular to the layer plane containing the molecules (ii) Optical micro texture of smectic A phase

1.4.3.2 Smectics C:

The structure of smectic C is defined as follows:

(i) Each layer is still a two-dimensional liquid.

(ii) The material is optically biaxial.
Fig. 1.13: Smectic C phase of liquid crystal. The long axes of the molecules in each layer, is tilted at an angle with respect to layer normal.

1.4.3.3 Smectic B:

In both the A and the C type of Smectics, each layer behave as a two dimensional liquid. In the B type, mesophase orients with the director perpendicular to the smectic plane, but the molecules are arranged into a network of hexagons within the layer, just like the SmA phase. In this phase the LC molecules are locally hexagonally packed and are perpendicular to the plane as shown fig. 1.15.
Fig. 1.15: A planar view of molecules within a layer of a hexagonal smectic B phase, the molecules are perpendicular to the smectic plane

1.5 Ferroelectric Liquid Crystals:

Since their discovery by Meyer et al. in 1975, ferroelectric liquid crystals (FLCs) (also referred as chiral smectic C liquid crystals) remain the object of intensive investigation. In 1978, Pikin and Indenbom suggested a model for the thermodynamic description of the FLC physical properties including the macroscopic response to the external fields.
1.8 Aims and Objective of Present Work:

The fantastic development of micro-electronics in the last forty years has given many impulses for techniques and science of course, the new generation of electronic digital instruments needs new kinds of electrooptical displays. One of these are liquid crystalline displays. Liquid crystal have been a traditional sphere of research work, therefore, the present work we have made efforts to understand the electrical and optical properties of nematic liquid crystal mixture. The cells typically of thickness 12μm were used in present investigations. We have taken liquid crystal namely nematic liquidcrystal mixtures E-80, E-180 and cholesteric liquid crystal important from the point of applications study of liquid crystals is a challenging field of research because of its technological and biological importance. From application point of view a liquid crystal material should have an appropriate mesophase over a wide temperature range (Usual -50°C to 140°C) suitable value of viscosity, electrical permittivity, elastic
constant and refractive indices, optical and thermo-optical properties of nematic and cholesteric liquid crystal have been carried out. No single liquid crystal compound fulfills these requirements so, usually multicomponent mixture are needed. Molecular interaction in liquid crystal mixture are least understood and therefore the fundamental study of these mixture becomes inevitable.