Liquid crystals

Intermediate between solids & liquid

→ flow like a liquid and take up the shape of the container.

→ Have orderly arrangement of molecules as found in solids and are anisotropic.

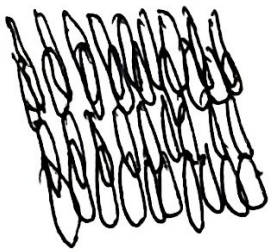
- Thermotropic
  The LC phase formed when the material is heated
  - Polymeric
    - Main chain LC polymers
    - Side chain LC polymers
    - Homo or copolymers
  - Low molecular wt. compounds
    - Rod like molecules (calamitic)
    - Disc like molecules (Discotic)
- Lyotropic
  LC phase formed when the material is dissolved in solvent

Lyotropic :-

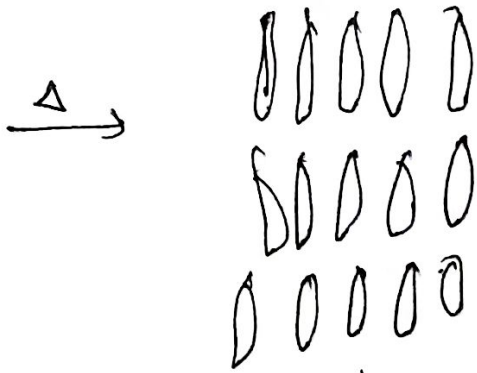
Molecules that are amphiphillic ie, solvent attracting and solvent repelling groups present in the same molecule. For eg. fatty acids. When dissolved in a solvent, they tend to align or orient and form micelles. this happens only at a certain concentration called critical micelle concentration.

ordered structures

LC materials : Phases in thermotropic LC materials



solid



fluid with orientation (LC phase)

liquid. no orientation

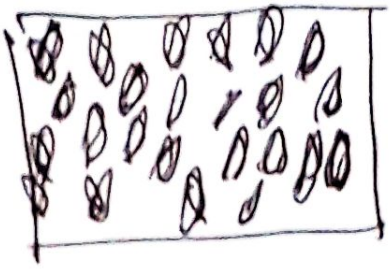
The molecules in a liquid crystal tend to orient in a particular direction. The direction of preferred orientation in the liquid crystal is called the director

thermotropic

Different phases of Liquid crystals

Nematic phase :-

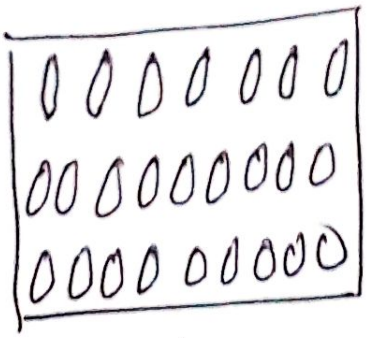
→ No long range ~~tran~~ order. or it is the least ordered mesophase.



i.e, they maintain directional order but are distributed randomly.

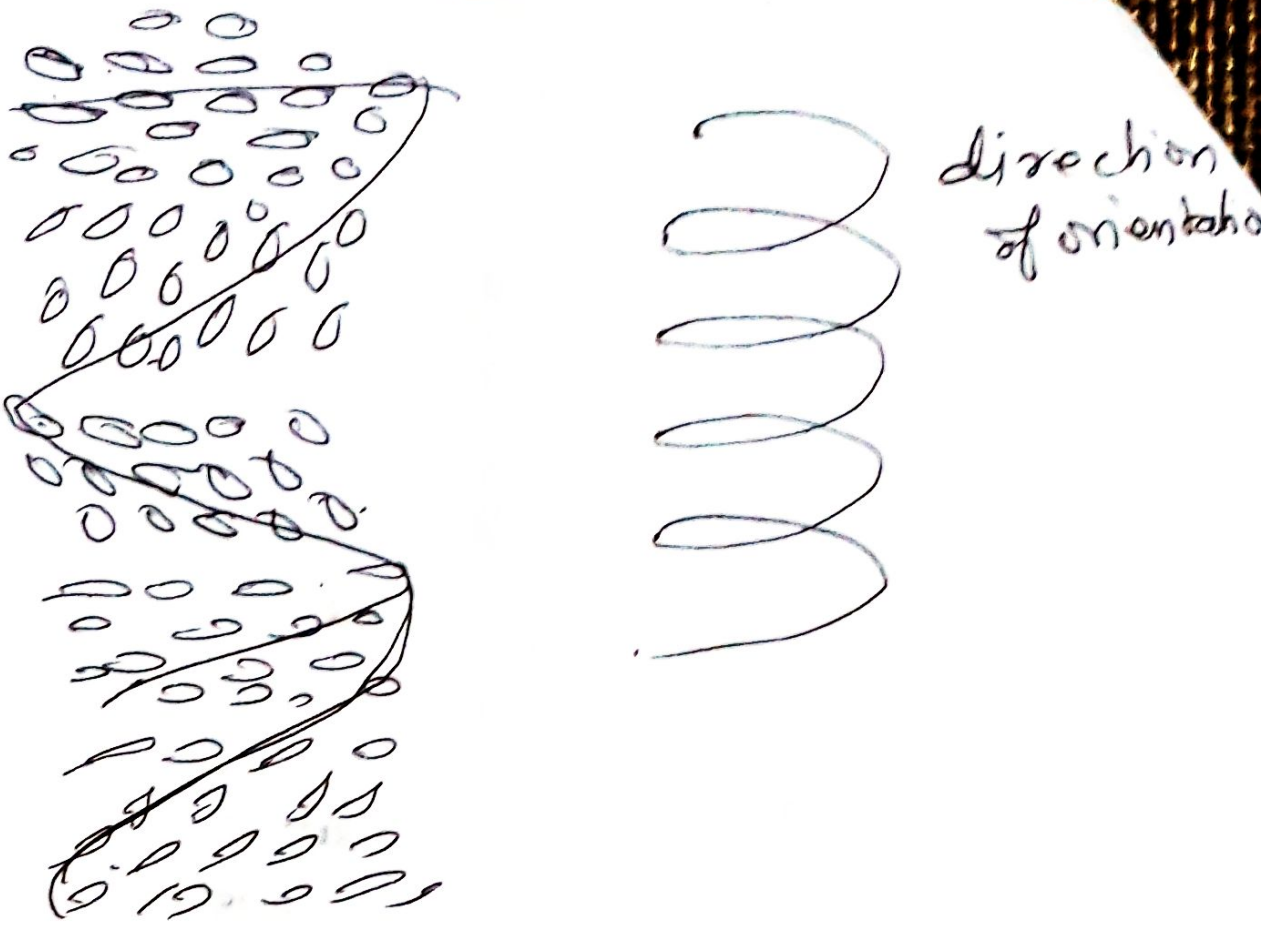
- Smectic phase :-

→ Molecules are arranged in regular layers



cholesteric phase or chiral nematic phase

Molecules are oriented in a particular direction and are randomly arranged. ~~But~~ as in nematic. But the direction of orientation rotates continuously resulting in helical structures



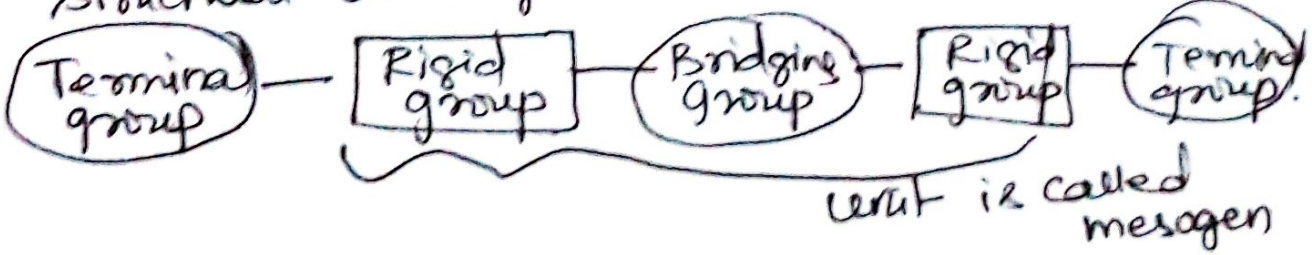
Structural requirements for LC behaviour:-

Molecules exhibiting LC behaviour are of two types.

(a) Molecules having a rigid central part with flexible ends in their structure.

(b) Polymers having backbone chain in which rigid segments are attached by short flexible spacers.

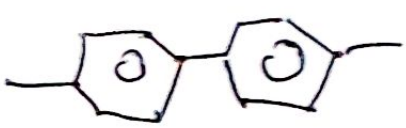
molecules exhibiting LC behaviour are aromatic systems of the following general structural arrangement.



rigid groups are  - p-phenylene

 naphthyl

2,6 or 1,4 or 1,5 linkages

 Biphenyl

 cyclohexyl.

Bridging groups are

$-C\equiv C-$ alkyne

$-N=N-$ azo.

$-N(\rightarrow O)=N-$ azoxy

$-CH=N-$ (schiff bases)

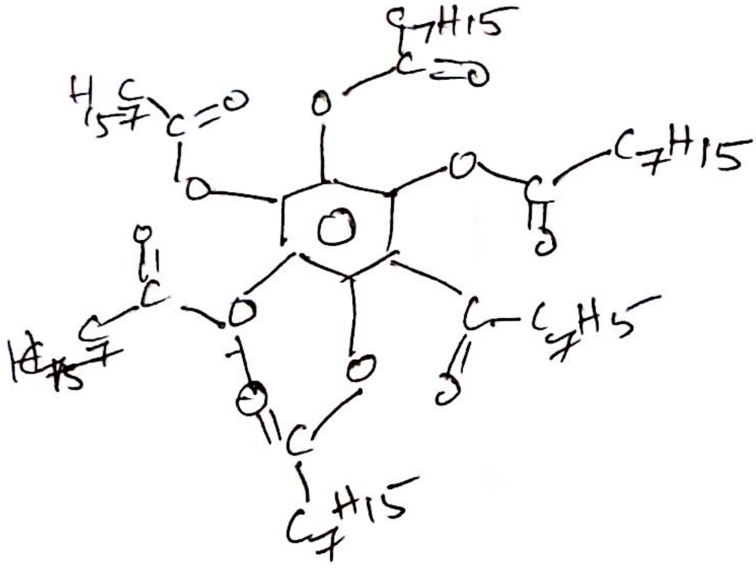
Terminal groups are small groups like $-OCH_3$ or short chains.

Example

P-azoxyanisole 

The above example is a molecule that has rigid rod like structure.

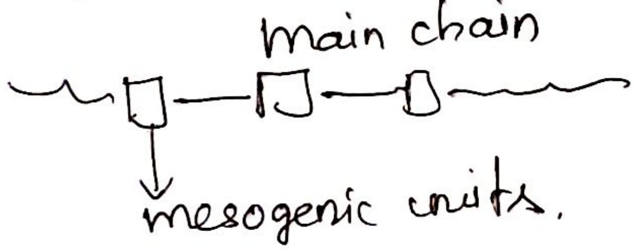
Example of compounds that show disc like or discotic LC phase is benzene-hexa-n-alkanoates



disc like molecule

Polymeric liquid crystals / Liquid crystalline Polymers (LCP)

In polymers the mesogens (aromatic or cycloaliphatic units ~~bsi~~ joined by rigid links) form a part of the polymer main chain or is attached to the side chain.



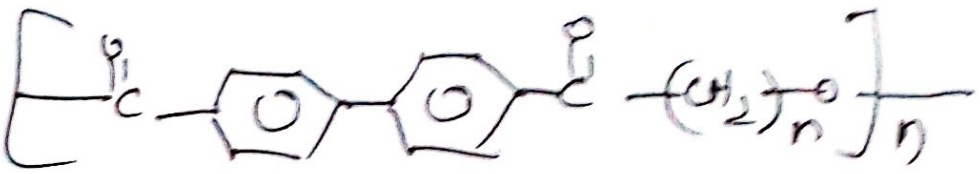
The mesogenic units are linked with spacers which are flexible groups.

common spacer groups are

$-(CH_2)_n-$ $\qquad -S-R-S-$

$-(CH_2-\underset{R}{CH}-O)_n-$

Eg main chain LC polymer



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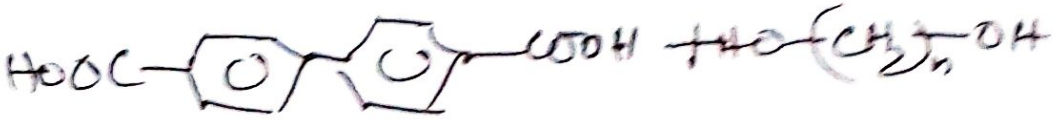
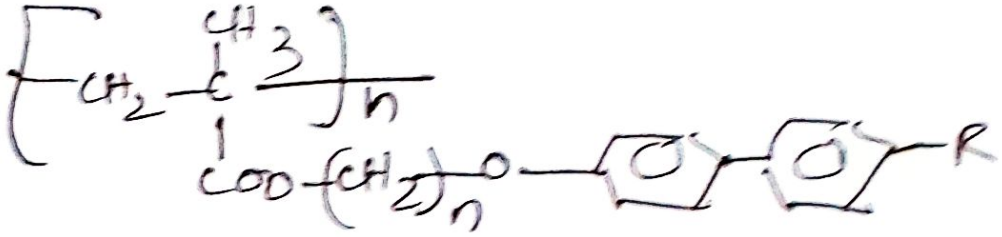


Side chain LC polymer



Advantages of LCP

- High heat resistance
- Flame retardant
- chemical resistance
- Dimentional stability
- low cost
- easy fabrication
- Heat aging resistance
- Adhesion.