UNIT-III **Liquid state**

Liquid crystals

Definition

Liquid crystals are substances that exhibit properties intermediate between solids and liquids, known as the mesomorphic state. In this phase, molecules can flow like a liquid but retain a certain degree of order, similar to solids. Mesomorphic state.

Differences between liquid crystal and solid/liquid.

Property	Solid	Liquid Crystal	Liquid
Molecular order	Long-range positional & orientational order	Partial order (orientational ± positional)	No order
Flow	No	Yes	Yes
Optical property	Anisotropic	Anisotropic in mesophase	Isotropic
Shape rigidity	Rigid	Soft, can flow	Flows freely
Examples	NaCl, Ice	Cholesteryl benzoate, p-azoxyanisole	Water, ethanol

Classification of liquid crystals into Smectic and Nematic.

Depending on the type of ordering (molecular arrangement), and based on the conditions under which they form liquid crystals are classified into (i)Thermotropic Liquid Crystals and their liquid crystals are classified into nematic and smectic types in thermotropic systems(Liquid crystal phases that form due to changes in **temperature**.When the temperature increases or decreases, the substance transitions between solid, liquid crystal, and isotropic liquid phases.Example: **p-azoxyanisole** shows a nematic phase upon heating.

) , and lyotropic types (Liquid crystal phases that form due to the **presence of a solvent** ,usually water) and depend on **concentration**.Molecules (often amphiphilic like soaps or phospholipids) organize into micelles or layered structures when mixed with solvent. Example: **soap-water mixtures** forming micellar or lamellar phases.) in solution systems.

In the nematic phase, long rod-like molecules are aligned parallel without positional order, as seen in p-azoxyanisole, whereas in the smectic phase, molecules are arranged in parallel layers with higher order, as in cholesteryl nonanoate. Lyotropic liquid crystals form when amphiphilic molecules, such as soap or phospholipids, organize into micelles or bilayers in solvents. Liquid crystals are optically anisotropic and respond to external fields, making them useful in LCDs, temperature indicators, biosensors, and drug delivery systems. Examples include cholesteryl benzoate, used historically in the discovery of LCs, and cholesteryl esters for thermographic applications. Thus, liquid crystals bridge the structural features of crystalline solids and isotropic liquids, with wide-ranging technological importance.

Application of liquid crystals as LCD devices.

Liquid crystals are widely used in **Liquid Crystal Display (LCD)** technology due to their ability to change optical properties (light transmission) under the influence of an **electric field**.

- **Working principle** – In an LCD, a thin layer of **nematic liquid crystal** is sandwiched between two glass plates coated with transparent electrodes and alignment layers. The molecules are initially aligned so that they twist the plane of polarized light (Twisted Nematic effect). When an electric field is applied, the molecules realign, altering light transmission through the display.

- **Backlighting** – A light source (like an LED) passes through the liquid crystal layer, and the control of molecular orientation allows the formation of images, numbers, or text.

- **Advantages** – Low power consumption, thin and lightweight design, and the ability to produce clear displays.

- **Examples** – Used in calculators, watches, smartphones, computer monitors, televisions, and instrument panels.