Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

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Paper Title: Properties and processes of Molecular Chemistry

Unit: 3

Module Name: Liquid Crystals, Vapour pressure-temperature diagram and thermography

Module No: 06

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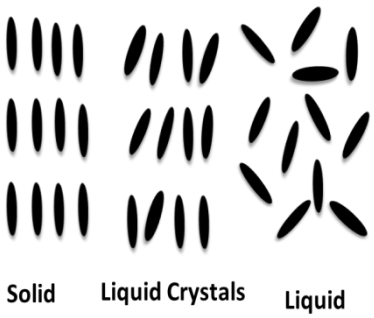
Liquid Crystals

- Liquid crystal is an intermediate state that exists between that of crystalline solids and ordinary liquids.
- There are certain solids which when heated undergo two sharp physical transformation one after the other.
- When solid is heated at one temperature forms turbid or translucent liquids called as Liquid Crystals and at other temperature forms clear or true liquids and these changes are exactly reverse upon cooling at same temperature.

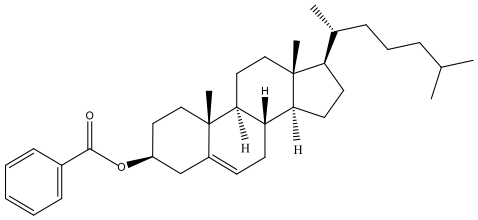
Properties of liquid crystals:



- Elongated rod or disc like shape.
- They are more like liquids in having properties like fluidity, viscosity and surface tension.
- Ordered arrangement like solids.
- Anisotropic properties like optical, electrical and magnetic are associated with crystalline solid.
- They are also called as Mesomorphic state.
- It has long chain organic molecules either terminating in groups such as –OR, -COOR or having groups such as –C=N,-N=NO-, -C=C in the middle.
- They are polar in nature.

Formation of liquid Crystals

- In 1888, Friedrich Reinitzer an Australian Botanist discovered the first liquid crystal that is Cholesteryl benzoate which shows two distinct melting points
- Cholestryl benzoate solid when heated at 145 $^{\circ}$C it forms turbid liquid which is called as Liquid Crystal which on further heating at 178 $^{\circ}$C it forms clear liquid and these changes are exactly reversed upon cooling at the same temperature.
- The temperature at which solid changes into liquid crystal is known as transition temperature. The temperature at which liquid crystal changes into liquid is known as melting temperature.
- The structure of p- cholestryl benzoate, has long hydrocarbon chain and ester group in the middle.



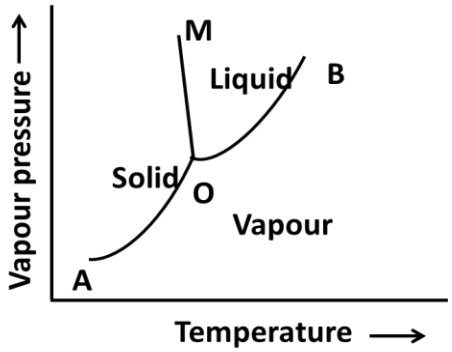
Later many other liquid crystals were discovered as listed in the following table.

Sr. No.	**Name**	**Formula**	**Transition temperature (^{0}C)**	**Melting point (^{0}C)**
1.	P-Azoxyanisole	$CH_3OC_6H_4NONC_6H_4OCH_3$	116	135
2.	P-Azoxphenetole	$C_2H_5OC_6H_4NONC_6H_4OC_2H_5$	137	167
3.	p-Methoxy Cinnamic acid	$CH_3OC_6H_4CH{:}CHCOOH$	170	185
4.	Anisaldazine	$CH_3OC_6H_4CH{:}NN{:}CHC_6H_4OCH_3$	165	180

- In 1991 French Physicist **P. G. de Gennes** awarded noble prize for his contribution to the **physics of liquid crystals and polymers.**

Vapour Pressure-Temperature Curves

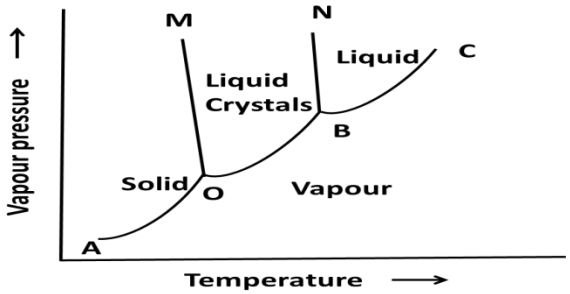
- The phase transformation involved in case of an ordinary solid into liquid and gaseous state, can be represented by **vapour pressure – temperature curves**.



- AO is the vapour pressure curve or sublimation curve of the substance in solid state while OB is vapour pressure curve or vaporization curve of the same substance in the liquid state.
- Thus along AO, the solid phase is in equilibrium with the vapour phase, while along OB, the liquid phase is in equilibrium with the vapour phase.
- At O, called a triple point where all three phases, solid, liquid and vapour coexist in equilibrium with one another. The point O is also called as the melting point of the solid or the freezing point of the liquid.
- Line OM is the fusion curve of solid that shows the effect of varying pressure on the melting point or the freezing point of the substance.

Vapour Pressure-Temperature Curves for Solids showing Mesomorphic behaviour

- The phase transformation involved in case of Mesomorphic state, can be represented by **vapour pressure – temperature curves**.
- In this case solid is in equilibrium with liquid crystals in equilibrium with liquid and vapour.

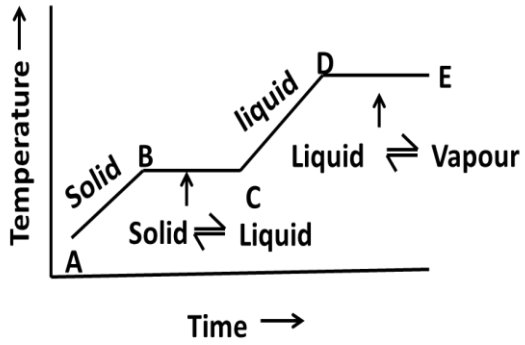


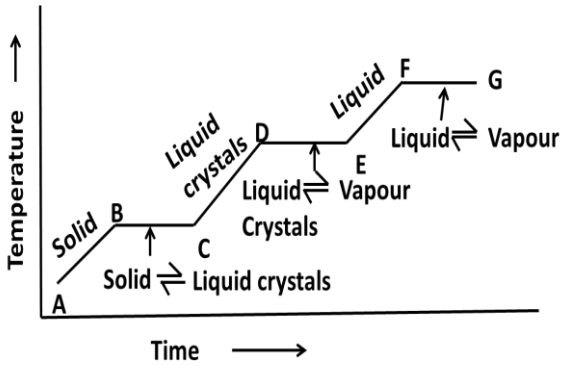
- AO is the vapour pressure curve of the solid crystal while OB is the vapourization curve of the anisotropic liquid or liquid crystal and BC is that of the isotropic liquid.
- O is the transition point at which the solid crystal is converted into liquid crystal and B is the melting point at which the liquid crystal changes into clear liquid.
- O and B are the two triple points. At point O the three phases namely solid crystal, liquid crystal and vapour coexist in equilibrium with one another.
- At point B the three phases namely liquid crystal, liquid and vapour coexists in equilibrium with one another.

- OM shows the effect of pressure on the transition temperature and BN shows the effect of pressure on the melting point of the substance.

Thermography

- The phase changes observed on heating a solid showing **mesomorhpic behaviour** are represented in the form of a **temperature – time** graph. This is known as **Thermography**.





- On heating a solid, the temperature starts rising along the curve AB and this continues till the solid starts changing into the liquid crystals till the point B.
- The temperature remains constant as long as the phases, solid and liquid crystals are present in equllibrium along curve BC.
- When the solid completely changes into liquid crystals, the temperature again starts rising along the curve CD and this continues till the liquid crystals start changing into liquid till the point D.
- The temperature remains constant as long as liquid crystals and the liquid are present in equllibrium along the curve DE.
- When the liquid crystals completely changes into the liquid, the temperature again starts rising along curve EF and this continues till the liquid starts changing into the vapour till the point F.
- The temperature remains constant as long as the liquid and the vapour are present in equllibrium along the curve FG. The temperature would again begin to rise when the vapour is present.