# Z1 - Study of Phase Transitions in Thermotropic Liquid Crystals by Polarizing Optical Microscopy Method

Physics Laboratory II – academic year 2017/18

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Liquid crystals are an exceptional state of matter with unique physical properties (characteristic for solid crystal as well as liquid). They are commonly used in the matrices of various displays: computer screens or television sets, where one of their properties (the optical birefringence), is used. The phase sequences of liquid crystalline materials are determined by using polarizing optical microscope method, during investigation in this lab. This is possible by observation the thin film of liquid crystal under polarizing microscope versus temperature during heating and cooling as well. The phase sequences of chosen substances from the homologous series of thiobenzoates are determined according to the changes in textures (interference images of tin film of liquid crystalline materials) with temperature.

# Preparatory questions

- 1. Liquid crystals definition, types, macroscopic properties and applications [1].
- 2. Clasification of thermotropic liquid crystals, phase transitions in liquid crystals [1].
- 3. Polarization of light [1].
- 4. Anisotropy of optical properties, birefringence, Fresnel's formula [1].
- 5. Textures of liquid crystals- definition, types [1].
- 6. Construction and principle of operation of a polarizing microscope [1].

# **Computational assignments**

A thin film of birefringent liquid crystal, with optical anisotropy  $\Delta n = -0.045$ , variable thickness and nonuniforml alignment, was illuminated with white light. Because of the interference of ordinary and extraordinary rays penetrating the liquid crystal domains with a different alignment it is possible to observe various colors of these domains. Use the Fresnel's formula to calculate the smallest difference in the thickness of the red layers ( $\lambda = 640nm$ ) and the green layers ( $\lambda = 530nm$ ).

# Apparatus and materials

- 1. Polarizing microscope with a digital camera.
- 2. Heating stage.
- 3. Thin films of liquid crystals (different homologues of thiobenzoate series) between two glass plates.

# Experiment

- 1. Observation of transmission light throught mica plates of various thickness by using a polarizing microscope.
- 2. Observation and registration of the textures of a liquid crystalline thin layer at different temperatures.
- 3. Determination of the phase transition temperatures for chosen liquid crystalline substances from n OS5 homologous series (n = 5-12) by a texture observation.

# Data analysis

- 1. Identification of the liquid crystalline phases by comparison of the observed and literature textures.
- 2. Determination of the phase transition temperatures and phase sequences.
- 3. Discussion of the existing monotropic and enantiotropic phases in the phase sequences.
- 4. Discussion of the influence of the molecular structure on the polymorphism of liquid crystals.

# Safety rules

The heating stage can become hot. Do not open it and do not take off the samples out before cooled down.

#### References

 [1] Lab-manual available from (you have to log in): http://www.2pf.if.uj.edu.pl/web/ii-pracowniafizyczna/z1.





Figure 1: Experimental set-up.

