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Study of Statistical parameters for MBBA Liquid Crystal

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Abstract:

Phase transition temperatures of nematic mesogens like *N*-(4-Methoxybenzylidene)-4-butylaniline (MBBA) are identified using image analysis technique in conjunction with Polarizing Optical Microscope (POM). In this technique, the statistical parameters of 1st kind and 2nd kind are computed based on gray level intensities of liquid crystal textures as a function temperature. The changes in the intensities of liquid crystal textures as a function of temperature play a key role to identify the phases and phase transition temperatures. The sudden and abrupt changes like increments or decrements in the statistical parameters give the information to determine the transition temperatures of liquid crystals. The obtained results are in good agreement with literature.

Keywords: Nematic Liquid crystals, phase transition temperature, image analysis

Introduction:

Identification of phases and phase transition temperatures are the basic things for the newly synthesized liquid crystal material. In literature, there are several techniques: Optical Polarizing Microscope (POM), Differential Scanning Calorimetry (DSC), Differential Thermal Analysis (DTA), Raman Spectroscopy, etc [1,2] to identify the phase transition temperatures. Here, Phase transition temperatures of *N*-(4-Methoxybenzylidene)-4-butylaniline (MBBA) are identified using Image analysis technique in conjunction with Polarizing Optical Microscope (POM). Using this technique, phase transition temperatures of different thermotropic liquid crystals like nematic, cholesteric, ferro electric and discotic liquid crystals were

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identified. . In this image analysis technique, the statistical parameters of 1st kind: Mean, Standard deviation and Entropy [3,4] are computed based on gray level intensities of liquid crystal textures as a function temperature.

Experimental Details:

The synthesized *N*-(4-Methoxybenzylidene)-4-butylaniline (MBBA) are used. The experiment involve Meopta Polarizing optical microscope in the arthroscopic mode attached with hot stage described by Gray [5] and camera attachment for viewing, recording the textures as a function of temperature. The color images or textures of given liquid crystals are recorded using camera with resolution 2592 x 3888 pixels, which represents the 24bit true color pixel tone. Intensity values of the images are ranges from 0 to 255 in Red, Green and Blue colors. The translated gray scale image is used for analysis [3, 4] and the defined statistical parameters given in are computed using MATLAB software.

(i) Mean:

Mean of an image is simply arithmetic average of the pixel values in the image. This can be obtained by summing up the all pixel values and divided by the total number of pixels.

Mean : $\mu = \frac{1}{N}\sum_{i=1}^{m}\sum_{j=1}^{n} I(i,j)$

(ii) Standard Deviation:

Standard Deviation of the image is defined as square root of the variance. Variance is nothing but the variation of intensity around the mean intensity value of the image. If the variance value is closer to mean, standard deviation is less.

i) Standard Deviation:

$$S = \sqrt{\frac{\sum_{i=1}^{m}\sum_{j=1}^{n}(I(i,j)-\mu)^2}{N-1}}$$

Contrast:

Contrast is also a second order statistical parameter. Intensity contrast between a pixel and its neighbor is measured by the contrast of texture. The value of contrast is to be low if the gray levels of each pixel pair are similar.

Contrast: $\sum_{i=1}^{m}\sum_{j=1}^{n}(i-j)^2 GLCM(i,j)$

iv) Homogeneity:

Homogeneity measures the closeness of the distribution of values in the GLCM. Homogeneous texture will contain only a limited range of gray levels, giving a GLCM with only a few values but relatively high probability (*P(i,j)*) for the GLCM values.

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Thus the sum of squares will be high. Energy and Homogeneity are similar measures; the only difference is that energy considers the elements of the GLCM and homogeneity considers the probability of GLCM values.

Homogeneity

$$: \sum_{i=1}^{m}\sum_{j=1}^{n}(P(i,j))^2$$

Results and Discussions:

As a function of temperature, the value birefringence will vary. In Isotropic phase, due to the absence of birefringence property the textures appear dark in color. By increasing the temperature, the birefringence property reappears due to the occurrence of transition from isotropic phase to mesogenic phase. This can be observed in terms of variations in the textures of liquid crystal material and can be captured as textures of liquid crystals using POM with camera attachment. Analysis of these textural intensities with respect to temperature gives the information to identify the phase transition temperatures of liquid crystals *N*-(4-Methoxybenzylidene)-4-butylaniline . Therefore, the distinctive and abrupt changes observed in the parameters curve at temperature corresponding to the transition temperature of samples which can be observed in Figure 1. The transition temperature of MBBA is shown in Table1.

Table 1. Phases and Phase transition temperatures of MBBA

Compound	Phases	Phase Transition temperatures (^{0}C) from Image Analysis
MBBA	Cr-N-I	Cr 27.0 N 44.0 I

(Cr: Crystal; N:Nematic;I:Isotropic).

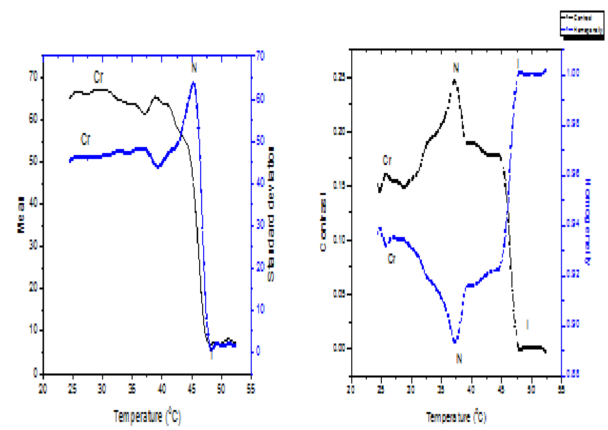

Figure 1: Plots of Statistical parameters against temperature for

***N*-(4-Methoxybenzylidene)-4-butylaniline (MBBA)**

Conclusions:

N-(4-Methoxybenzylidene)-4-butylaniline (MBBA) exhibited the enantiotropic Nematic phase. Statistical parameters of 1st and 2nd kind computed from the textures of samples are successful in identifying the phase transitions between the isotropic – solid phase.

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