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A Study on Phase diagram of a binary mixture

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ABSTRACT : An experimental phase diagram of a binary mixture of two compounds of liquid crystal has been made with the help of high resolution temperature scanning technique. Nonyloxy cyanobiphenyl (9OCB) and octyl cyanobiphenyl (8CB) has been chosen to generate binary mixtures with different concentrations. Both the compounds exhibits nematic phase as well as smectic phases so that the compounds are smectogenic. In the entire concentration range it is seen that the binary mixtures show three different phases which are known as nematic phase, smectic A phase and isotropic phase with the variation of temperature. The nematic range (T_{NA}-T_{NI}) of the binary mixtures decreases with increases of the concentration of 9OCB of all mixtures.

KEYWORDS: liquid crystal, binary mixture, nonyloxy-cyanobiphenyl, octyl- cyanobiphenyl.

I. INTRODUCTION

It is fairly straightforward to describe a crystal and a liquid separately or come up with their simple properties. In crystals, molecules are well ordered and constrained to each site but In the case of liquids, molecules can move randomly pointing any directions. Within the two well known phases, crystalline solid and isotropic liquid, of all matters interesting states of matter has been observed. These intermediate states of matter are referred as Liquid Crystals (LCs). Such types of material has great significances in various types of display areas such as in wristwatches, pocket calculators, mobile phones, video games, pocket diary, portable computers, camera view finder, projection TV, etc. due to Low power consumption, sleeker appearance and non-emission of the electromagnetic radiation and many other technological devices [1-4]. For such application of liquid crystals the stability of mosophase range, an intermediate phase between the solid and the liquid states [5], and the existence of mesophases at desired temperature need to be satisfied. Some liquid crystalline materials which have stable mesophases in technologically useful temperature range faced with several difficulties. To overcome these difficulties binary mixtures of liquid crystalline materials has been used [6]. The material which exhibit LC phase, shape of these molecules should be anisotropic such as may be rod like, disc like and banana shaped molecules. In spite of such types of phases a columnar phase [7] is seen in liquid crystal. In this phase, molecules are aligned in disk-like way and the columns that molecules forms make two dimensional arrays. However**,** majority of thermotropic LCs are composed of rod-like molecules. Liquid crystalline compounds exhibit many attractive mesophases. The nematic (N) phase is known as the simplest mesophase of LCs. This nematic (N) phase formed by rod-like molecules, a long-range orientational order of the long molecular axis along a preferred direction is called the director. In smectic phases, partial positional order is also present in addition to the long-range orientational order and the orientational ordering is considered as the anisotropic shape of molecules [8]. Also depending on the structures of compound, it jumping from one phase to another phase is making possible.

The aim of the experiment is to study the phase transition temperatures by analyzing the optical birefringence data while heating or cooling of liquid crystalline binary mixtures.

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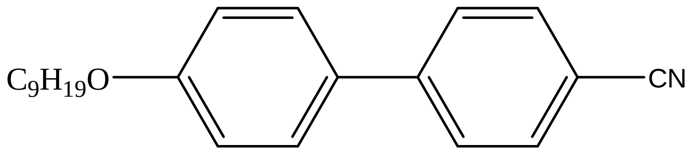
II. EXPERIMENTAL

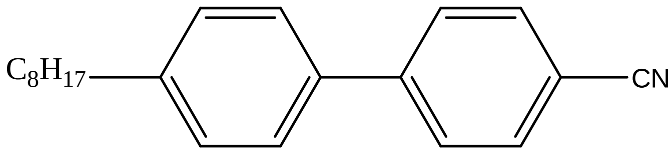
A. Materials

The compounds 9OCB and 8CB were purchased from AWAT Co. Ltd. (Warsaw, Poland) and were used without further purification. The structural formulae, chemical names and transition temperatures are as follows:



Cr 61.3°C SmA 77.5 °C N 80°C I

Compound 1: Nonyloxy-cyanobiphenyl (9OCB in short)



Cr 21.5 °C SmA 33.5 °C N 40.5 °C I

Compound 2: Octyl-cyanobiphenyl (8CB in short)

Nine mixtures having molar concentration of 9OCB equal to 0.16, 0.26, 0.36, 0.42, 0.51, 0.65, 0.8 and 0.92 were prepared.

B. Methodology

A solid state green laser of wave length 532 nm was directed onto a homogeneously aligned (planar) liquid crystal cell of thickness 5.1 mm (purchased from AWAT Co. Ltd., Warsaw, Poland) , placed between two crossed linear polarizer's. The temperature of the cell was regulated and measured with a temperature controller (Eurotherm PID 2404) with an accuracy of ± 0.1 °C by placing the cell in a custom built heater made of brass. The transmitted light intensity was measured by a photo diode at an interval of 4 seconds. When the heater temperature is varied at a rate of 0.5°C min-1, this translates into a temperature difference of 0.025°C between two readings [9-11].

III. RESULTS AND DISCUSSION

A. Phase diagram

An experimental phase diagram of the binary system with nontyloxy-cyanobiphenyl (9OCB), octyl- cyanobiphenyl (8CB) has been shown in the Figure 1. Within the considered temperature range three phases of this mixture has been revealed. These phases have been regarded as isotropic phase (I), nematic phase (N) and smectic-A phase (SmA). During cooling the phase transition temperatures of all the mixtures have been recorded. The nematic–isotropic (N-I) and smectic A–nematic (SmA-N) temperatures have been plotted against the mole fraction of 9OCB. Although, both the pure compounds are smectogenic, the nematic phase along with smectic A phase appears for the mixtures of all the concentration range of x_{9OCB} which is shown below in

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two component phase diagram. The nematic range of all the intermediate composition continually drops off with the increase of an amount of 9OCB in the mixtures.

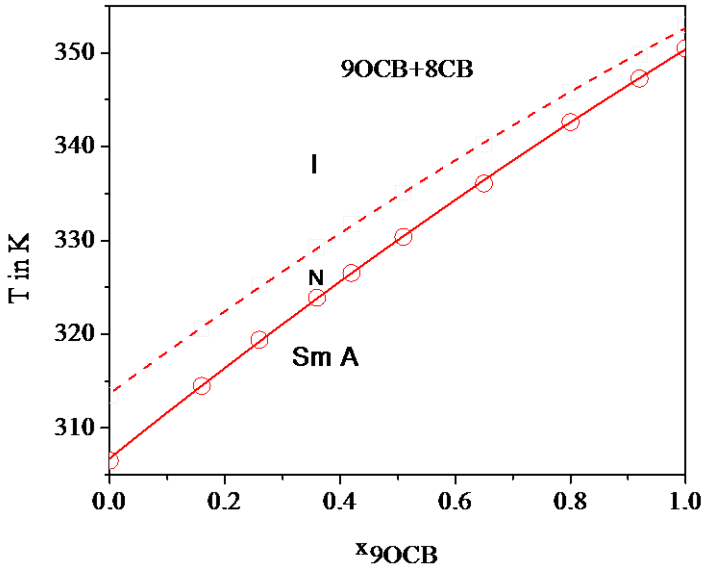

Figure 1. Phase diagram for the binary system of 9OCB + 8CB. X_{9OCB} is the mole fraction of 9OCB. I- isotropic phase, N- nematic phase and SmA- smectic A phase. □- nematic to isotropic phase transition temperature; □**o**-nematic-smectic A phase transition temperature for the eight mixtures under study. Dashed and Solid lines represent the nematic-isotropic, nematic-smectic A phase transition respectively throughout the entire composition along with pure compounds.

IV. CONCLUSION

Among many experimental techniques, High resolution temperature scanning technique is widely used. It is a method to obtain phases of a liquid crystal by detecting transmission as a function of temperature. High resolution temperature scanning technique is sufficient to make obvious the phase transitions temperatures, solid to liquid crystal and liquid crystal to isotropic liquid. DSC and optical microscopy are the method to observe the phase transition of which by former phase transition is determined by detecting the enthalpy change associated with. The various physical properties which are required for display devices have lead to establish the phase transition behavior of liquid crystal samples and their mixtures. The mixtures produced using the individual samples have their own phases giving an opportunity of an extension of phase related several properties of these materials.

V. ACKNOWLEDGEMENT

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