Optical Study Of Polymer Dispersed Mixed Liquid Crystals

Rita A.Gharde, Jyoti R. Amare, Santosh A. Mani

ABSTRACT: *Recently, Liquid Crystal (LC) dispersed with polymer is used to enhance the physical properties of the LCs materials. These materials possess combined application of LC and polymer and their electro-optic applications have been extensively studied during last decades. The LC mixture consists of Nematic and Cholestric that are dispersed in a monomer or prepolymer with different concentration. The existing Polymer Dispersed Liquid Crystal (PDLC) consists of different concentrations of LC and monomer. The textures and Phase transition temperature (PTTs) can be studied by Polarising Microscope Studies (PMS). The Phase transition temperature (PTTs) can also be studied by Fabry-Perot etalon Scattering Studies (FPSS) In this paper, we present the changes in transition temperature along with new phase transition temperature in PDLC. Measurements were performed for both heating and cooling of various samples. In addition to this, Refractive Index (RI) of all samples were found for optical characterization of the material. Texture observation and spectroscopic techniques are used to characterize the other properties of the PDLC samples. The PDLC suspension can be used as a new liquid crystalline material that does not require any additional alignment processing or treatment. Our results will provide new opportunity and their uses in advanced technology development.*

Keywords: *Polymer Dispersed Liquid Crystals (PDLCs), Polarizing Microscopy Study (PMS), Refractive Index (R.I)*

1. Introduction:

Liquid crystal (LC) is a thermodynamic stable phase characterized by anisotropy properties without the existence of a three-dimensional crystal lattice. LCs lie in the temperature range between the solid and isotropic liquid phase, hence the term mesophase. Composites, based on LCs have attracted much attention over a number of years because of their unique optical , electric and magneto-optic properties and novel display applications. PDLC is a typical example of this composite LCs. PDLC consist of small nearly uniform sized (down to sub- micrometer) droplets of a LC in a solid polymer matrix. They are formed during the phase separation caused by a polymerization of organic monomers in a LC monomer mixture. PDLCs are attracting attention because of their application in scattering LC displays and light shutters. For many applications of PDLC, a proper selection of material such as size, shape, preparation methods of mesophase range of and existence of phases at a desired temperature. PDLC materials generally have several common characteristics; one of the characteristics is the transition temperature which is here measured over temperature range phases. To achieve useful temperature range, various mixtures can be used.

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The miscibility of the low molar LC is important both for the identification of various liquid crystalline phases and for the preparation of mixtures with well defined phase transitions. When two compounds are isomorphic within a certain mesophase, both their thermal transition temperatures and corresponding thermodynamic parameters exhibit continuous dependence on their composition, this means that both the components of mixtures behave like an ideal solution. There are several methods used to identify characterization the various liquid crystalline phases Viz. Polarizing Microscope Studies (PMS), Fabry - Perot Scattering Studies (FPSS), X- Ray Diffraction (XRD), Fourier Transform Infrared (FTIR) Spectroscopy, Differential Scanning Calometry (DSC) / Differential Thermal Analysis(DTA) etc. We studied opticall properties of 4 – cynophenyl –4n hexyl benzoate (Solid → Nematic → Isotropic) and Cholesteryl pelargonate (Smectic → Cholestric → Isotropic). The study of phase transition of thermotropic liquid crystal is done by PMS. The phase transition of LC between various mesomorphic forms occurs at a thermodynamically defined temperature as the LC undergoes a change in internal order at the point of phase transition. It is found that, 4 – Cynophenyl – 4n – hexyl benzoate exhibit mesophase of nematic phases. We observe Refractive index of entire samples in pure as well as dispersed form.

2. Experimental details:

In this paper, we have investigated the sample of the Cholesteric LC; Cholesteryl pelargonate (97%) (A) and Nematic LC: 4 –cynophenyl – 4n hexyl benzoate (97%) (B) and their mixtures with and without monomer (M) in appropriate proportions by weight [A+B] and [A+B+M] of various concentrations.The textures and PTTs are found by PMS. From the study of PMS, we analyzed the transition temperatures as well as nature exhibited by LC phases. The PTTs shows more complex behaviour at the lower heating cycle and diverse concentrations. We observed, some interesting phases like Nematic droplet, Marbled, Broken Fan etc. Refractive index of dispersed samples were found which leads to new applications of these dispersed materials.

3. Experimental techniques:

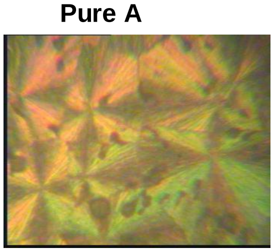
3.1 Polarizing Microscopic Studies (PMS):
PMS is the most widely used method in identifying different phases. LC is placed between two glass cover slips. Depending on the boundary condition and the type of phase, varies textures which are characteristics of a phase are observed. Usually the textures changes while going from one phase to the other. PMS is powerful tool when used in combination with miscibility of binary mixtures. LC phases possess characteristic textures when viewed in polarized light under a microscope. These textures, which can often be used to identify phases, result from defects in the textures. PMS is used for various phases like Nematic, SmA, SmB. SmC,…….. When LC, goes from a solid to liquid crystal phase, the degree of length order decreases. This is expressed by a decrease in order parameters. In case of orientational disorder, it is possible to see changes between different LC phases of heating and cooling from the textures.

3.2 Refractive Index (R.I.):
In optics refractive index (RI) of a substance is a number that describes how light, or any other radiation, propagates through that medium. Its most elementary occurrence it obey Snell's law of refraction. The critical angle for internal reflection, which decides the reflectivity of a surface also depends on the refractive index, as described by Fresnel's equation. Refractive index of materials varies with the wavelength. In opaque media, the refractive index is a complex number, while the real part describes refraction, the imaginary part accounts for absorption. The concept of refractive index is widely used within the full electromagnetic spectrum, from x – rays to radio waves. It can also be used with wave phenomena other than light. In this case, the speed of sound is used instead of that of light and a reference medium other than vacuum.

4. Result and discussion:

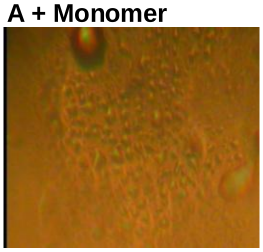
4.1 PMS Observation:
Texture Observed By PMS Technique

Pure A



Fan like texture

A + Monomer



Nematic Droplet

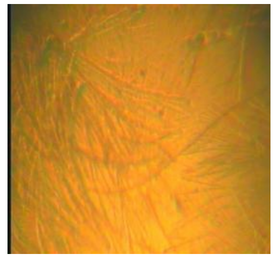
Pure B

Marbled Texture

B + Monomer

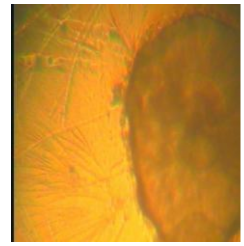
Varient of Marbled

Pure A+B



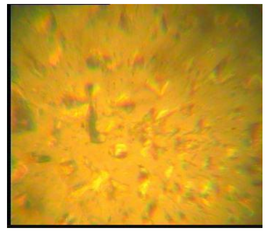
Cholesticoil streak

A+B+Monomer



Cholestic oil streak

2A+3B

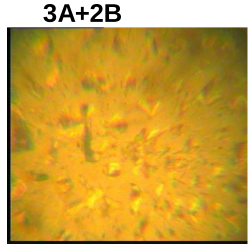


Broken Fan

2A+3B+Monomer.

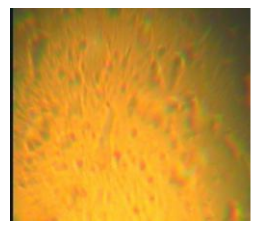
Orientational of the elongated nematic

3A+2B



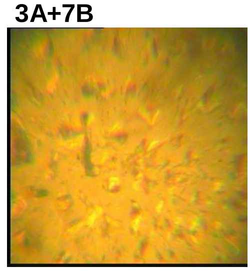
Broken Fan

3A+2B+Monomer



Oil Droplet.

3A+7B

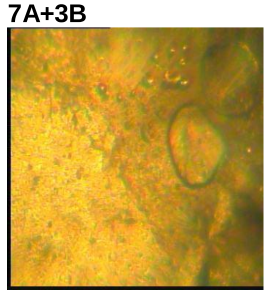


Broken Fan

3A+7B+Monomer.

Nematic

7A+3B



Created fan texture

7A+3B+Monomer

Smectic Phase

4.2 Refractive Index Observation:

Sr. No.	Sample and Mixtures	Refractive Index	Sample and mixtures with monomer	Refractive Index
1	A(100%)	1.448	A(100%) +M	1.482
2	B(100%)	1.439	B(100%) +M	1.491
3	A(30%) +B (70%)	1.467	A(30%) +B (70%) +M	1.472
4	A(40%) +B (60%)	1.462	A(40%) +B (60%) +M	1.473
5	A(50%) +B (50%)	1.443	A(50%) +B (50%) +M	1.443
6	A(60%) +B (40%)	1.438	A(60%) +B (40%) +M	1.464
7	A(70%) +B (30%)	1.452	A(70%) +B (30%) +M	1.452

This change in the refractive index can be used as guiding medium for light propagation. We get the different R.I. values.

5. Conclusion:

Cholesteric-nematic phase transitions can be induced in such compensated mixtures thermally. We found various textures for all samples by PMS. We also observe changes in refractive index for different concentration of mixed LC and PDLC. This shows that these materials can be used as guiding medium for propagation of electromagnetic waves and for other optical applications.

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