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Electro-optical Properties of a Nematic liquid crystals -Display Material with Nanoparticles

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Abstract
Electro-optical properties have been investigated for the pure and doped samples exhibiting nematic phase. The electro-optical experiments show that the steepness of the transmission voltage curve improves with doped sample. The study shows that the relaxation frequency and the activation energy increase. It is shown that the changes in electro-optical parameters due to the doping of NPs can be utilized to control the display performance of the device to a certain extent.

Keywords: Electro-optical, Nanoparticles, Display Device

Introduction

Nematic mode is the first most widely used mode in the manufacturing of the liquid crystal displays (LCDs) because of its high contrast ratio, analog grey scale, low driving voltage and wide gap margin. Because of the before mentioned properties they found applications in the formation of LCDs ranging from wrist watches to computer monitors to wide screen televisions. These displays are frequently used in regions such as war fields and space which are major sources of radiation. Liquid crystalline materials by which these displays made up of possesses highly anisotropic and sophisticated molecules. When these displays are used in such fields high doses of radiation strongly affect these molecules and normally create the malfunctioning of the devices made by these materials. Earlier studies on some of the basic liquid-crystal materials suggest that their physical properties are strongly affected by various types and doses of radiation [1-5]

Nematic is a basic display material and most of its physical properties are already reported It possesses a nematic phase in the temperature range 18-35 °C. The nematic materials possesses two types of relaxation modes due to director rotation around its short and long axes. We have doped with Nanoparticles +Nematic and investigated the changes in its electro-optical properties. [6-11]

Experimental Techniques

For the electro-optical measurements, a cell in the form of parallel-plate capacitor was prepared by using indium tin oxide or gold-coated glass plates as electrodes, separated by Mylar spacer of thickness 40 μm. ITO-coated glass plates give spontaneous homeotropic alignment (long axes of the molecules normal to the plates), whereas gold coated electrodes give spontaneous planar alignment (long axes of the molecules parallel to the plates). For the electro-optical work, polymer based and parallel rubbed ITO coated glass plates with pre tilt angle of about 1-3° have been used to prepare the cells of thickness 5 μm. The transmission intensity was determined by a photo-detector of Instec model for electro optical work.

Results and Discussion

Electro-optical Study:

Table2 shows the transmission voltage curve of pure Nematic material and doped samples respectively. The value of the threshold voltage (V_{th} in volt), splay elastic constant (K_{11}) from the electro optical experiments at temperature 27 ºC are listed in table 2.

Dielectric Studies:

From the optical-texture studies we found that the transition temperatures of the irradiated samples are lowered as compared to the pure sample. Variation of the clearing point temperature (Tc in ºC) with the doped sample is listed in table 1. The values of the dielectric permittivity of the pure in the longitudinal and transverse configuration are in a good agreement with the literature data[5] which signifies that the alignment is good. From the comparison of the pure and doped data we found that the value of the longitudinal and transverse component ($\varepsilon'_{||}, \varepsilon'_{\perp}$) and hence the dielectric anisotropy $\Delta\varepsilon'$ (= $\varepsilon'_{||}$-$\varepsilon'_{\perp}$) is almost constant.

Conclusions

From the above mentioned experiments and results we are able to conclude the following for the doped sample.

1. Although the threshold voltage V_{th} is increasing by 1.1V for the steepness of the transmission voltage curve is improving.
2. The threshold value, above which the changes in the dielectric parameters ($\Delta\varepsilon'$ and $\Delta\varepsilon'/\varepsilon'_{\perp}$) occur.
3. We can use the dose around the threshold value for controlling the display parameters ($\Delta\varepsilon'$ and $\Delta\varepsilon'/\varepsilon'_{\perp}$) for the optimization of the display devices.

Table-1: Variation of Isotropic-Nematic clearing point temperature with doped sample.

Sample	Transition Temperature (ºC)
Pure	35.5
doped	36.0

Table-2: Variation of threshold voltage (V_{th} in V), effective elastic constant (K_{11}), at temperature 27 ºC

Sample	V_{th}	K_{11}	ΔV
Pure	4.0	1.55e-10	1.21
Doped	5.1	1.71e-10	1.24

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