Effect of molecular weight on electro – optic switching times of liquid crystal polymer doped with cobalt oxide nanoparticles

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Abstract
Nonlinearity liquid crystal cell which doped with Ferroelectric nanoparticles characters studied in this paper according to their eclectic absorption. Polysiloxin series with side chain liquid polymers used with side chain polymers and molecular weight ran. This study consternate on polymers electro-optic characteristic with various molecular weights by using the mesogenic units and a stable polysiloxane. Suspension sensitivity or Electro-visual response to the mark of the used electric field, a real character to electric liquid crystals. The addition of Co3O4, nanoparticles to polymer rise dielectric anisotropy and minimize response times. It observed that the voltages rises with molecular weight rising, and when intensity value rise we gain voltage operating. Spectrometer used infrared measurements to locate the orientational order parameters, (δ̂) for liquid crystals with a side series. The orientational order parameters (δ̂) rely on temperature with various molecular weights and the threshold voltage.

Key words: cobalt oxide nanoparticles, polymer Poly-siloxane, electro – optic response.

1. Introduction

The LCD technologies have incredible sources and versatility. For each new LCD engineers capable to widen LCD capabilities to enroll with the modern demands in work rival each new application. For example By using new TV application, the LCD engineers able to solve matters as wide watching angle, fast response, color changing versus gray stages and watching angles[1]. There will be distinction between two types between liquid crystals. The former is thermotrope and the latter is lyotropic.
Changing the temperature effects of transfer with liquid thermotropic crystals[2]. A liquid crystalline phase is generally defined the crystalline phase or amorphous between the isotropic liquid and crystalline phases[3]. A liquid crystalline level known in tall – range intermolecular arrange displayed by its stable molecules. There are three degrees of tall – range positional arrange in crystalline level [4]. A polymer may contain hundreds, thousands, tens of thousands or more monomer molecules. So that, its molecular weight is very big, giving it special and good mechanical and chemical characters [5]. Item made from more than one kind of monomer, they made copolymers [6]. Cobalt oxide (Co$_3$O$_4$) powder has many range of Different industry fields applications industry including anode items for rechargeable Li-ion battery, catalyst, gas sensor and magnetic items [7] in low cost and friendly nature, (Co$_3$O$_4$) chosen to be the perfect electrode material for EPCs. Also, modern reports proved that Co$_3$O$_4$ with special microstructure[8].

Experimental:

Chemical structure and molecular weight influences on polymer work and peak speed indicate that the substance involve in a very speed way .[9][10]. Blazers Z20 tin oxide – coloured glass slides which used with electro visual cells that enhanced in this research. It cut and become smooth quickly enough to make manufacture parallel plate cells work in a good way. Important Chemical structure and molecular weight influences on polymer work and peak speed indicate that the substance envolved rapidly.

Electrodes cells, covered with a precursor polyimide thin film [consisting of Rodeftal 322 (Rh one Poulenc chemical Ltd) . Solution in dimethyl formimed] by using spin coater operating at 4,500 rpm. These slides coated heated for 30 minutes in an oven at 80°C. In this temperature and by Using frequent technique, They rubbed with a cloth in one hand after that, and but again at 130°C for 30 minutes. It is put in the oven for one hour at 200°C.

MATERIALS AND METHODS

Experimental Sat – up:
MK 1000

Hcs 402

ALCT

The MK 1000 chains temperature controller show precise results, stability and accuracy temperature measurement and control. When it coupled with heating/cooling tools from instc, the MK 1000 could show temperature control around to (0.001°C). Operation and keypad operation use controller of front panel and software control pc as well as adjustable ramp (heating/cooling rate) to use set temperature point. Programmable operation order set. In a precise way, controls temperature to 0.001°C option save temperature data in the computer. RTD thermistor or thermocouple, LC cell holders for various LC cells kinds [11][12].

Temperature running mechanism have MK 1000 monitor, Nitrogen bottle pump (LN2-p) and hot refrigeration move, It involves large double pane open window to enhance optimized thermal insulation. Opening window defrost system gas sample Internal room which covered to enhance Vertical uniformity of sample temperatures and horizontal mounting available X-Y micro positioner positioning sample application program, win temp provide remote control from computer[13].

ALCT sub-system to calculate liquid crystals, which involves ALCT-EO1 (referred as ALCT after), holder for test cell, head for photo detector and connecting cables, by using this system with good LC test cell and suitable method, user able to measure the blend.

Liquid crystal mixture physical parameters:

- Dielectric constants, g||, gZ, )g
- Elastic constants, k11 and k 33
- Threshold Voltage, Vth
- Polarization current, IP
- Viscosity.

LCD devices visual performance:

- Voltage-transmittance detour
Controlling speed, increase, falling time
LC win application software put an integrated tool for making measuring system in user hand also data, collection, their analysis and optics. Optical testing stall system make light source (white LCD), rotatable heating-cooling level holder and photo detector, and polarizer. This test bench enable the user to (Fig. 2):

- Arrange polarizer and analyzer perpendicular and, parallel to each other.
- Test cell in side of the hot-cooling stage can be rotated in full 360° range.
- Light source, polarizer and analyzer are installed in sealed dark sections to prevent the contamination of optical components.
- Light sealable working chamber shields a way the room lighting.[14][15].
Chemical structures:
Chemical structure of the used poly-siloxanes is shown in Fig. 3.

Fig. (2) Scheme work system

Fig. (3) Materials chemical structures
RESULTS

In transformation process start, transmitted light thickness difference as a work of applied voltage and the voltage must have substance which showed in the figures, Transmitted light thickness become less by rising the required voltage which used to allow the work of transformation voltage, so to finish transformation can determined; With molecular weight Mw rise, voltage is rise, interconnection degree between the molecules is good according to the viscosity $\eta$, The same attitude reported for the liquid crystal poly-siloxane, in spite of some variations in the required voltage; The required voltages to complete orientation are known to be useful to cell, and required time to finish orientation is determined.

Where Fig. (5-9) display changing-time on as a time function which the field is change off before the off measurement. By Using the system and the way which mentioned in this work, we execute cyclic experiment in which we use the values of $\tau^{on}$ to locate when a steady condition is reach. Relying on the adopted system and mentioned methodology, a periodic experiment applied at different values in order to specify the conditions at which the system reaches the stable condition in this work. It must mentioned because it is important because it is presented procedure evaluate and sake of a complete enhancement process. A peak to peak of (147-250) V put at 500 Hz frequency. The difference in light transmitted thickness applied voltage dependent work like the voltage need to Finish the changing of every single material. As the TNI temperature make \{TNI Nematic – isotropic transition temperature\} less, the need voltage to finish the work raised in this case. The same attitude found for the items in work, So the items in this study show important variations in the voltages needed for items compared to study items. The reproducible changing effect noted at temperatures close to the isotropic nematic transformation temperature where the polymer 's viscosity is low. Reproducible switch effect noticed close to the transformation temperature at which the polymer viscosity is low measured in the range of TNI-TNI-4 for military vehicles 1 and 2. The applications has not responded and field items observed in the smectic level. While, items measurements No. 3, 4, and 5 presented within the range of TNI-TNI-5 Both experiment group performed at stable temperature.
For the fluid electro-optic impacts, experimental structure used in static electro characters used previously. Measuring fields with a frequency of 500Hz used. By using infrared dichroism to resolve the orientational system of liquid crystalline side-series polymers on prealigned cells. By using different molecular weights to gained knowledge on head portion orientation. By noting the bands which response of relevant functional groups vibrations, where the main vibration absorption band C≡N lies in the 2235 cm⁻¹ region. Temperature work with different molecular weight MW. Where these liquid crystals is found. It is clear that, polymers with high MW presenting have a little reflection for unfinished mono because large viscosity, value. There was testal evidence that the measurements were random but true stable condition values. Fig. (10) shows that even when the changing according to parameters in considers remain substantial difference members of this molecular weight series, in other words if the increasing of the threshold voltage of molecular weight work. The difference in slope shows that there is hard coupling between the mesogenic side groups and the polymer series which plays a important part even in the static electro-optic characters in other meaning.

Fig. (4): Variation of the normalized intensity with voltage for polymer 1,2,3,4,5
Fig. (5): Switching on ($\tau_{\text{on}}$) and time left off ($\tau_{\text{off}}$) at constant temperature below TNI for polymer 1.

Fig. (6): Switching on ($\tau_{\text{on}}$) and time left off ($\tau_{\text{off}}$) at constant temperature below TNI for polymer 2.

Fig. (7): Switching on ($\tau_{\text{on}}$) and time left off ($\tau_{\text{off}}$) at constant temperature below TNI for polymer 3.
Fig. (8): Switching-on ($\tau_{on}$) and time left off ($\tau_{off}$) at constant temperature below TNI for polymer 4.

Fig. (9): The variation of the measured order parameter S obtained through Measurement of the infra-red dichroism

Fig. (10): Threshold voltages a function of temperature for polymer poly-siloxanes.
Discussion

This study concentrate on the electro-optic characters of polymers chains in differing molecular weight according to polysiloxane backbone By contacting Co3O4 nanoparticles equal to polymer polysiloxane with the side series (0.1% weight). Chemical structure and molecular weight of significant affect on activity and peak speed indicate that substance envolve rapidly. Nanoparticles stimulate function to rise polymer viscosity; As well as the work of these nanoparticles put to make the connectivity of polymer shedding better when an electrical field, This increase changing times and helps to minimize the grade step polymers changings (t^{on}, t^{off}) . The mesogenic sections in the polymer do not work on the same time scale. The polymer series may take long time to make equilibrium and may take three days or more to take off the electric field because of its nature of coupling. This slow relaxation of the polymer series happened only when the subsequent response to the electrical field happened.

It is observed that rising the molecular weight will not transform the magnitude of Δε and then if the curvature elastic stable doesn’t affect by polymerization degree of threshold voltage must be stable the observation that U_c rise of the intrinsic molecular weight present an increase in the elastic constant K_{11}.

Difference in polymerization degree in the indicate polysiloxane-based side series liquid crystal polymers has an affect on attitude level, The order parameter and the charaters of electro-optic. The minimize in molecular weight is low, The temperature transformation level for high molecular weight polymers (material No.1,2 and 3) noted with very tiny nematic range where nematic process is noted for its low molecular weight (material No.4 and 5).

At the end, add nanoparticles of Co3O4 to rise the thickness of the mesogen section in either condition. Attached to polymers chains to rise the dual-electrode parallel group Syano molecules torque along the mesogenic axis region, the dielectric anisotropy is in effect rise Δε.
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