Journal of Engineering and Applied Sciences 14 (Special Issue 9): 10665-10668, 2019
ISSN: 1816-949X

Effect of Nanoparticles (CO_3O_4) on the Optical Properties of Liquid Crystal Acrylate

Khalid Al-Ammar and Baidaa Y. Mohemed
Department of Physics, College of Education for Pure Science, University of Babylon, Hillah, Iraq

Abstract: In this study, the effect of Cobalt Oxide nanoparticles (CO_3O_4) on the electro-optical properties of the acrylate liquid crystal was studied. Five different ratios of nanoparticles have been added to a constant molecular weight of liquid crystal acrylate. Where, we notice that the viscosity of the polymer will increase affecting the characteristics of the liquid crystal as well as the temperature of the transfer of glass will decrease because of the added nanoparticles. The order parameter studied in this research using infrared spectroscopy, this is used with the result of the threshold voltage to test the theory as well as studying the effect of Cobalt Oxide nanoparticles (CO_3O_4) on the Eastern orientational order parameter (S), voltage and response times.

Key words: Cobalt oxide, nanoparticles, electro-optical, molecular, temperature, viscosity

INTRODUCTION

The history of liquid crystal appeared in the twentieth century in 1888 the world revealed to Frederic Rinzer that benzoy cholesterol was merged at a temperature of 145.5°C (Drexler, 1989; De Gennes and Prost, 1993). The fluid formed between solids and liquid (unclear) was described by the German physicist Ituilmann which was added to the known solid, liquid and gaseous states as a fourth case of matter. This situation was called a liquid crystalline state by the physicist Lehman and this designation came from its molecular structure similar to liquid (Finkelmann *et al*., 1979).

In order for the compound to be a liquid crystalline, the molecules must be in the crystalline form with different properties and the physical properties of the liquid crystal shall be different (Ammar and Salih, 2017; Ammar and Al-Jamal, 2018).

Liquid crystal properties differ from solid characteristics and liquid characteristics. The liquid crystals are: refraction, elasticity, conductivity, viscosity and refractive index (Ammar and Al-Jamal, 2018; Obaid *et al*., 2016). It is the arrangement of molecules in the liquid crystal that determines the crystal. There are three types of crystalline phases: smectic, nematic and colystolic (Al Ammar and Mohemed, 2019).

The condition is essential for the liquid crystals, it is the anisotropic of the properties. And the properties such as refractive index, electrical conductivity, viscosity and elasticity are anisotropic. The external sphere (magnetic, electrical, optical, mechanical and thermal) can be used to make changes in the electro-optical properties of the liquid crystals. Recently, liquid crystal phases have been given attention to the interconnection between optical and electrical properties and to obtaining new optical devices (Gray and Goodby, 1984).

MATERIALS AND METHODS

In this study, the electrophoresis properties of the selected glass are examined, cleaned and dyed by a conductive material (tin oxide), then cut into slices. After washing the glass with water and placed in the ultrasonic device for 30 min and then placed in heat oven for 30 min and 80° and then placed on the polymer and after heating for 10-15 min and then put the second glass panel of the cell and uses kapton to connect the wires in the cell.

The working system consists of a laser source (He-Ne) with a capacity of 0.95 MW and a wavelength of 632 nm. It is also polarized to determine the direction of the laser light and also a heating chamber where the model temperature is controlled and the analyzer is vertically oriented on the polarizer and after the analyzer, the photovoltaic cell which calculates the intensity of the passing radiation is also placed as an electric source (oscillator) to generate the sine wave and amplify the wave by the amplifier (Saengsuwan *et al*., 2003; Clough, 1978) (Fig. 1).

The main devices for measuring photovoltaic properties: HCS302, MK1000 and ALCT it is used to measure visual response times. The cell is placed inside the heating chamber to measure the voltages where we get a full direction called high voltage after which the polarized laser is placed on the cell which is perpendicular to the longitudinal axis of liquid crystalline molecules. Then passes through an analyzer outside the heating

Corresponding Author: Khalid Al-Ammar, Department of Physics, College of Education for Pure Science, University of Babylon, Hillah, Iraq

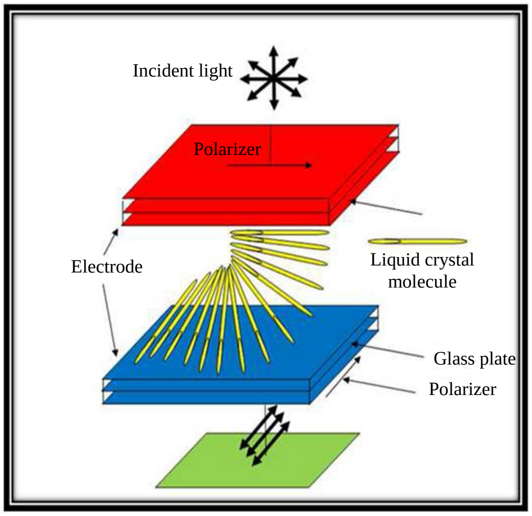

Fig. 1: Illustrates the working system used

chamber to pass the laser light through the largest amount. After which the density is calculated by the optical cell.

Thus, we will obtain different values of voltage where the higher the voltages the lower the intensity, until we get the full guidance of liquid crystalline molecules. This method is repeated for all models used as each model contains a different proportion of nanoparticles (CO_3O_4).

The opening time is calculated as the time between the highest intensity and the least intensity and the voltage at which the complete guidance of the liquid crystal molecules is calculated. It also calculates the return of the laser beam to its first state before the voltages which is the closing time (Al-Ammar *et al*., 1993; AI-Ammar and Mitchell, 1992).

RESULTS AND DISCUSSION

The electrophysiological properties of each cell were calculated. Where a constant molecular weight of the liquid crystal (1.7×106 g/mol) was taken with a side chain of acrylate polymer. Five different ratios of nanoparticles (CO_3O_4) are added to the liquid crystals which increases the conductivity of the liquid crystal when applied to the electric field, improving the viability of the system's molecules and improving the electro-optical properties.

When adding different percentages of nanoparticles (CO_3O_4) to a liquid crystal at a temperature lower than TNI and a constant frequency voltage (500 Hz), we obtain the results in numbers (Fig. 2-6).

Thus, we get the full routing voltage (operating voltage) and also the threshold voltage per cell. Note that the higher the proportion of nanoparticles added, the greater the intensity and density, the dipole group and the insulation properties, the lower the threshold voltage and the operating voltage. As in Fig. 7 and 8.

The added nanoparticles (CO_3O_4) reduce the degree of kiure transmission and thus, reduce the visual response times. The following forms show the relationship between response times and temperature.

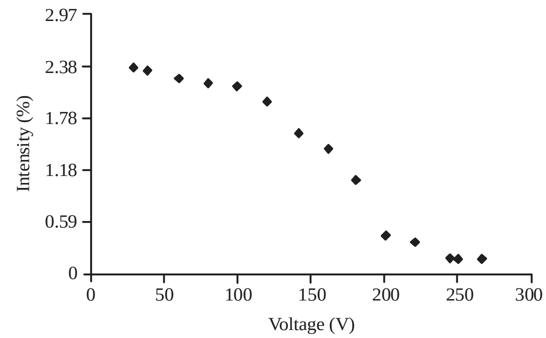

Fig. 2: Variation of the normalized intensity for addition P1

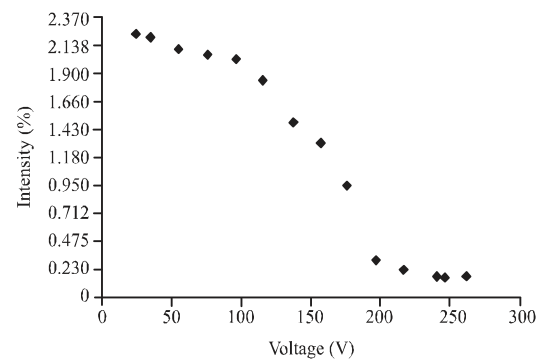

Fig. 3: Variation of the normalized intensity for addition P2

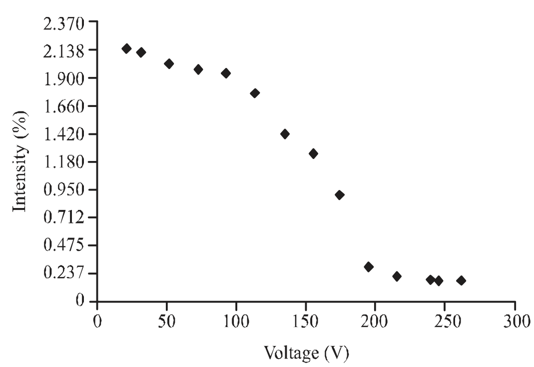

Fig. 4: Variation of the normalized intensity for addition P3

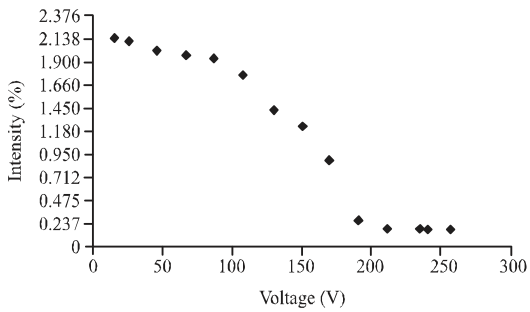

Fig. 5: Variation of the normalized intensity for addition P4

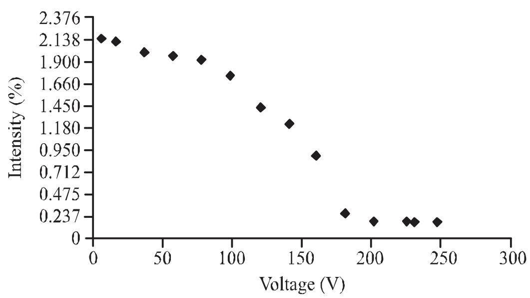

Fig. 6: Variation of the normalized intensity for addition P5

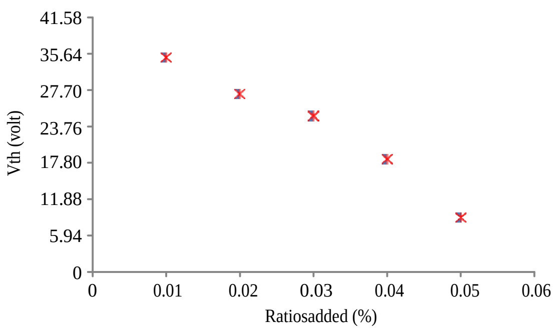

Fig. 7: The relationship of the threshold voltage is added with the five used in this study ratios

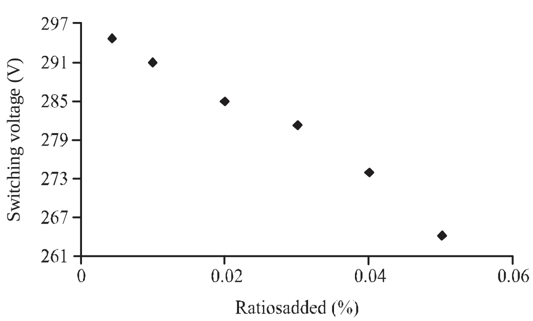

Fig. 8: The operating voltage as a function of rates CO_3O_4 added to the polymer optical response times increase as nanoparticles (CO_3O_4) are added to the acrylate crystal

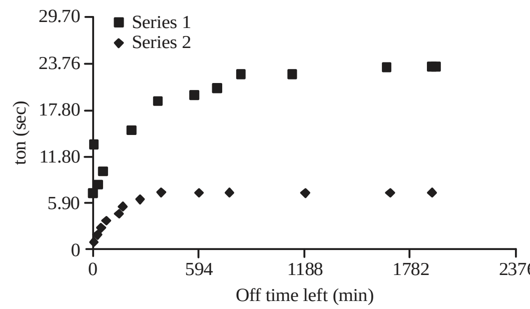

Fig. 9: Switching-on (τ^{on}) and time left off (τ^{off}) for addition P1

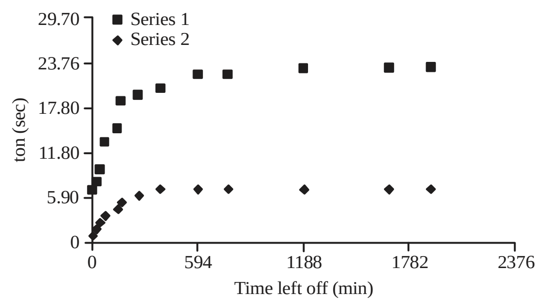

Fig. 10: Switching-on (τ^{on}) and time left off (τ^{off}) for addition P2

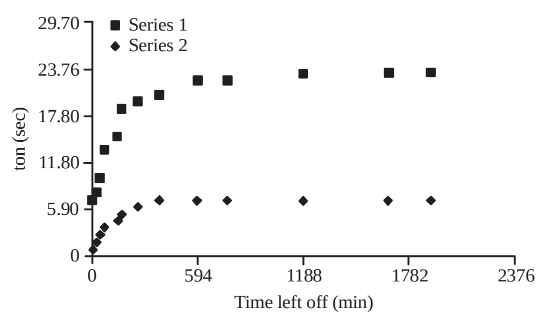

Fig. 11: Switching-on (τ^{on}) and time left off (τ^{off}) for addition P3

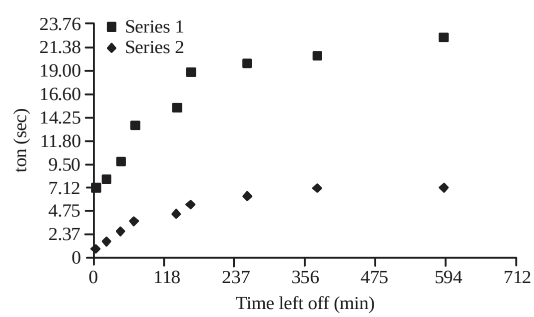

Fig. 12: Switching-on (τ^{on}) and time left off (τ^{off}) for addition P4

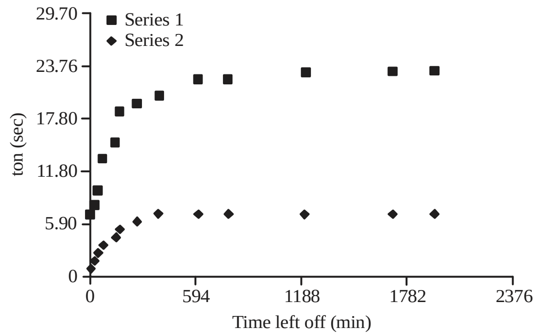

Fig. 13: Switching-on (τ^{on}) and time left off (τ^{off}) for addition P5

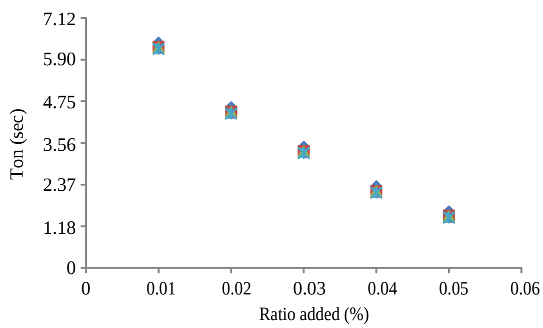

Fig. 14: Switching-on (τ^{on}) as a function of the ratios addition

CONCLUSION

In this study, the effect of nanoparticles (CO_3O_4) on the electro-optical properties of liquid crystalline acrylate was studied, taking a constant molecular weight of liquid crystal acrylate and adding five different ratios of nanoparticles (CO_3O_4).

We note that the added nanoparticle improves the electro-optical properties of the liquid crystal, we observe that the opening time is less than the increase in the percentage of added nanoparticles and the degree of polymer transfer decreases and the viscosity of the polymer increases.

REFERENCES

AI-Ammar, K.H. and G.R. Mitchell, 1992. Electro-optical properties of liquid crystal copolymers and their relationship to structural order. Polym., 33: 11-21.

Al Ammar K. and B.Y. Mohemed, 2019. Effect of nanoparticles ($BaTiO_3$) on the optical properties of 3 liquid crystal (acrylate). J. Eng. Appl. Sci., 14: 9149-9153.

Al-Ammar, K.H., M.J. Whitcombe and G.R. Mitchell, 1993. The effect of the molecular weight on the electro-optic properties of methacrylate-based side-chain liquid crystal polymers. Polym., 34: 2060-2064.

Ammar, K.A. and H.A.A.A. Salih, 2017. Effect of $BaTiO_3$ nanoparticles amount addition on electro-optical properties of side chain liquid crystal polymer. Intl. J. Sci. Res., 6: 927-933.

Ammar, K.A. and H.A.A.A. Salih, 2018. Electro-optical properties and effect of BaTiO3 of polysiloxane. J. Eng. Appl. Sci., 13: 9519-9523.

Ammar, K.A. and L.A.O. Al-Jamal, 2018. Influence of ferroelectric nanoparticles on liquid crystal polymer nanocomposites and studying their electro-optic response. J. Eng. Appl. Sci., 13: 10232-10237.

Clough, S.B., A. Blumstein and A. deVries, 1978. X-Ray Diffraction from Polymers with Mesomorphic Order. In: Mesomorphic Order in Polymers and Polymerization in Liquid Crystalline Media, Blumstein, A. (Ed.). American Chemical Society, Washington, USA., ISBN13: 9780841204195, pp: 1-11.

De Gennes, P.G. and J. Prost, 1993. The Physics of Liquid Crystals. 2nd Edn., Clarendon Press, New York, USA., ISBN:9780198520245, Pages: 597.

Drexler, K.E., 1989. Engines of Creation: The Coming Era of nanotechnology. Anchor Press, New York, USA., ISBN:9780385199728, Pages: 298.

Finkelmann, H., D. Naegele and H. Ringsdorf, 1979. Orientation of nematic liquid crystalline polymers in the electric field. Macromol. Chem., 180: 803-806.

Gray, G.W. and J.W. Goodby, 1984. Smectic Liquid Crystals: Textures and Structures. Leonard Hill, Glasgow, Scotland, ISBN: 9780249441680, Pages: 162.

Obaid, A.N., K.H.A. Ammar and F.S. Hashim, 2016. The influence of non-polar group on the properties of poly-siloxanes side chain liquid crystal polymers. J. Univ. Babylon, 24: 727-739.

Saengsuwan, S., S. Bualek-Limcharoen, G.R. Mitchell and R.H. Olley, 2003. Thermotropic liquid crystalline polymer (Rodrun LC5000)/polypropylene in situ composite films: Rheology, morphology, molecular orientation and tensile properties. Polym., 44: 3407-3415.