Effect of Nanoparticles (CO₃O₄) on the Electro - Optical Properties of Liquid Crystal Acrylate Polymer

Baidaa y.mohemed[1,] Khalid Al.Amma[2] , Fouad SH. Hashim[3]

[1,2,3]Dep. of Physics, College of Education for Pure Sciences, University of Babylon, Iraq

baidaayehia@yahoo.com[1] dr-khalid1959@yahoo.com[2], foaad.hashim@yahoo.com[3]

Abstract:
In this paper, the effect of cobalt oxide nanoparticles (CO₃O₄) 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 (CO₃O₄) on the voltage and response times.

Keywords: CO₃O₄ nanoparticles, polymer acrylate , electro – optic response

I. INTRODUCTION

The history of liquid crystal appeared in the twentieth century In 1888 the world revealed to Frédéric Rinzer that benzoy cholesterol was merged at a temperature of 145.5 ° C [1,2] . 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 [3,4].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 [5,6].Liquid crystal properties differ from solid characteristics and liquid characteristics.

The liquid crystals are: refraction, elasticity, conductivity, viscosity and refractive index [7,8],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 [9] .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 [10,11] .

II. Practical part

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 minutes and then placed in heat oven for 30 minutes and 80 degrees And then placed on the polymer and after heating for 10 - 15 minutes and then put the second glass panel of the cell, and uses kapton to connect the wires in the cell.[12]

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 [13,14] .
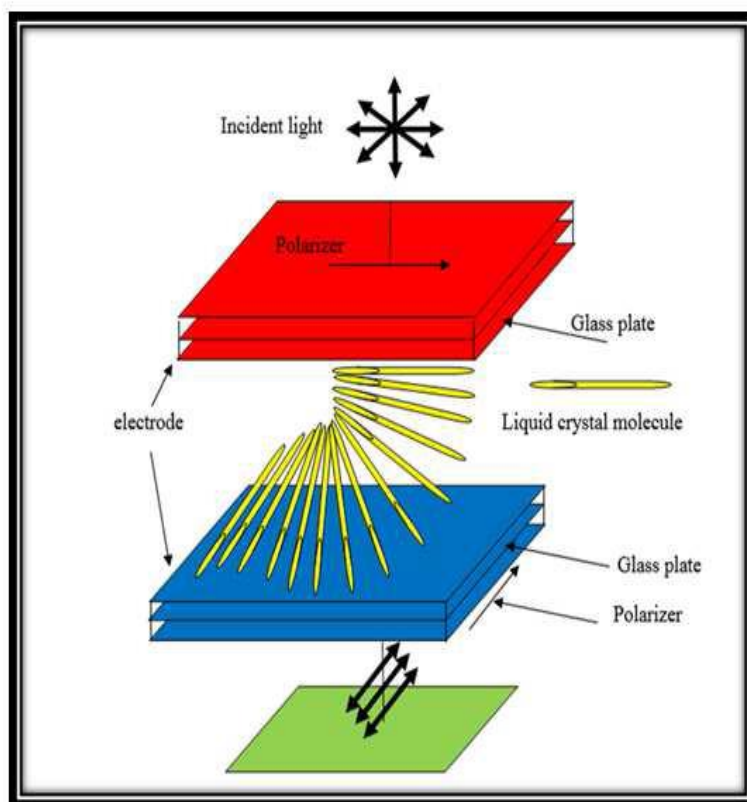

Fig.1. illustrates the working system used

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 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.[15,16]

III. Results and discussion

The electrophysiological properties of each cell were calculated, where a constant molecular weight of the liquid crystal ($1.7 \times 106 \ g / mol$) 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 [(2),(3),(4),(5), and (6)].
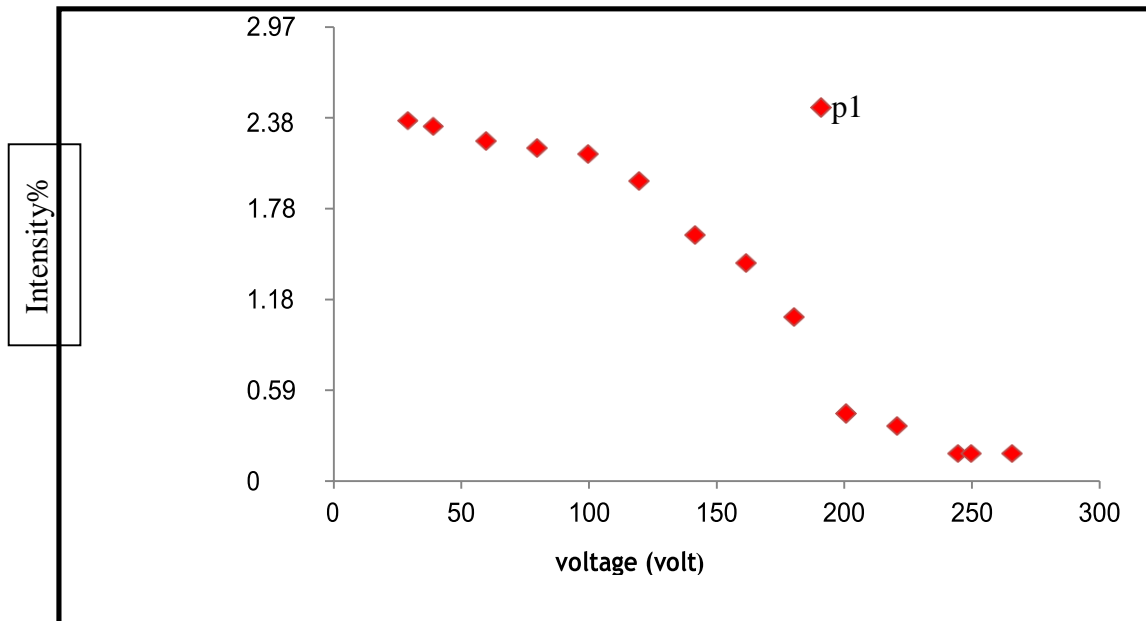
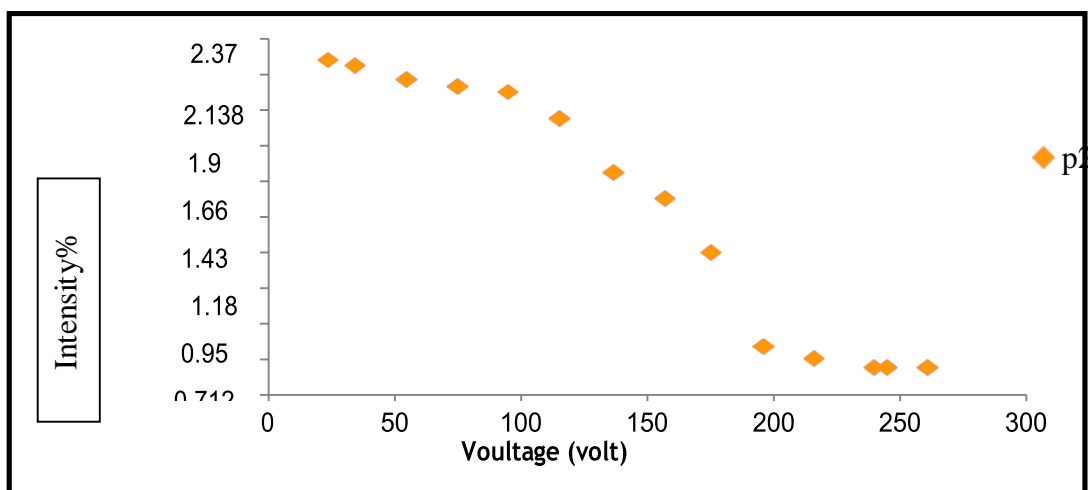Fig.2. Variation of the normalized intensity for addition P1

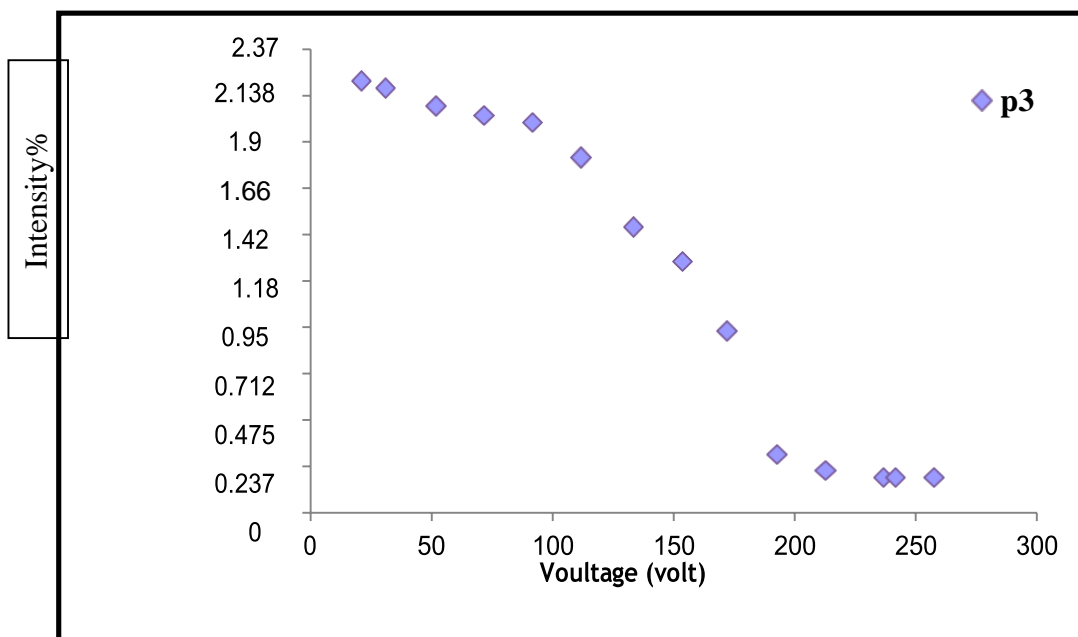Fig.3. Variation of the normalized intensity for addition P2

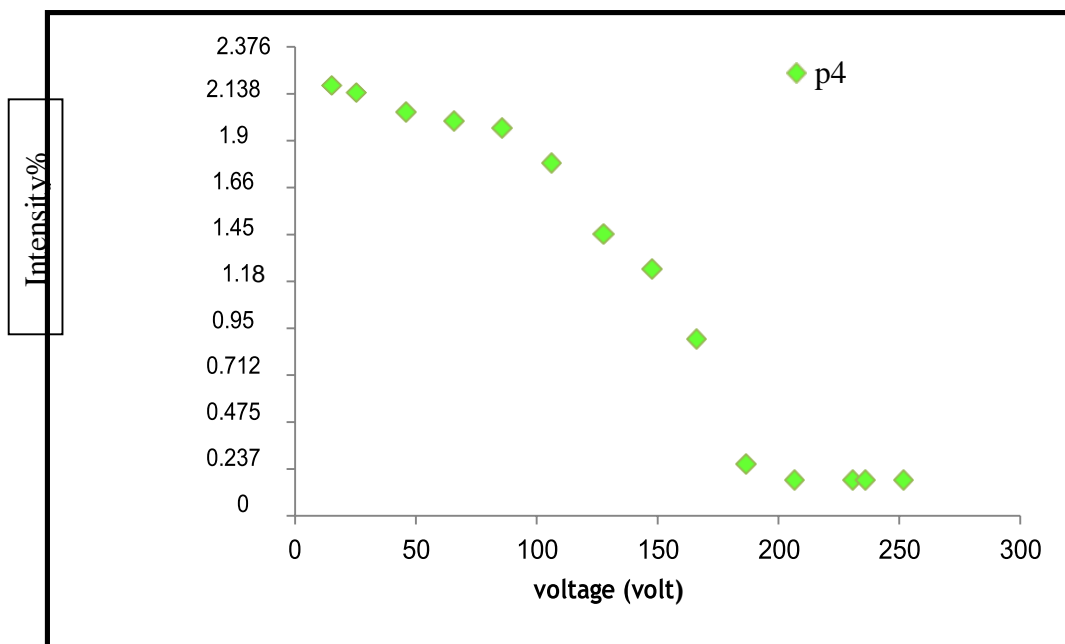Fig.4. Variation of the normalized intensity for addition P 3.

Fig.5.Variation of the normalized intensity for addition P4.
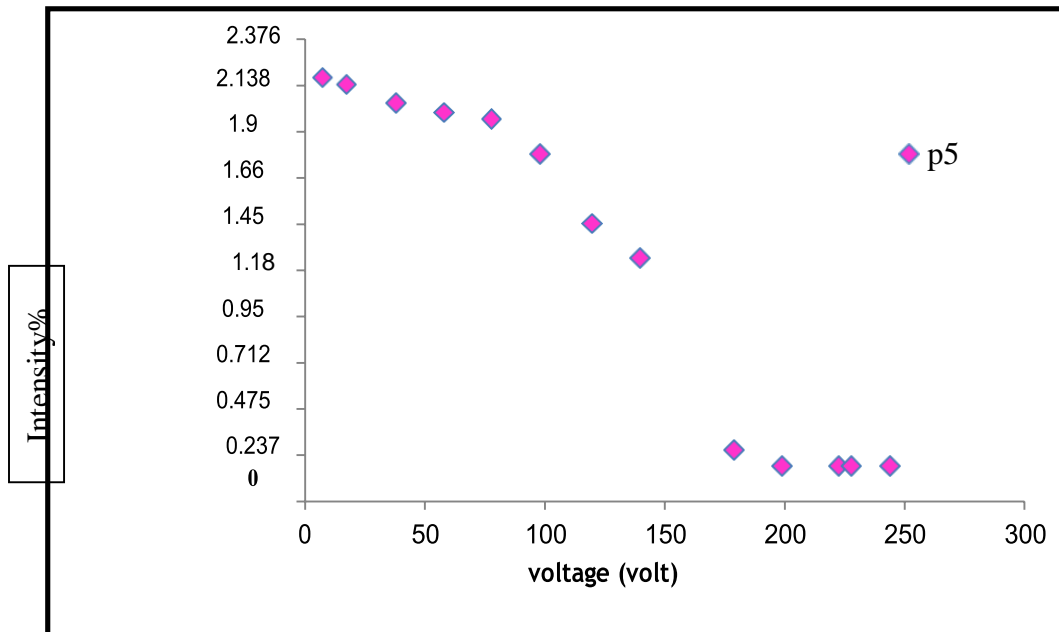
Fig. 6. Variation of the normalized intensity for addition P 5.

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 Figures(7)and(8).
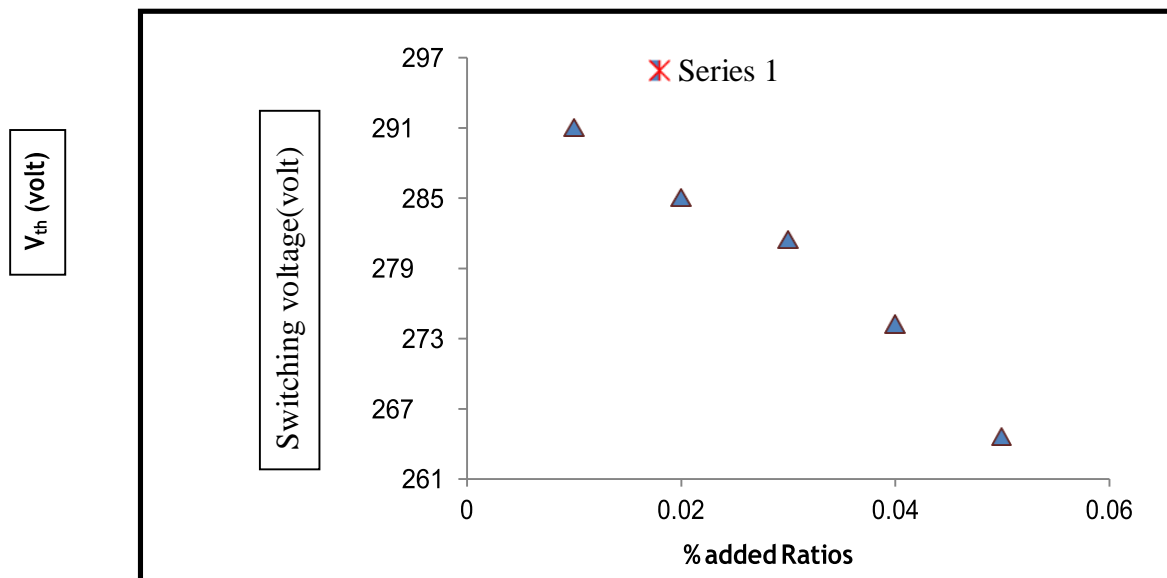

Fig.7. shows the relationship of the threshold voltage is added with the five used in this study ratios

▲ Series 1

Figure (8): shows the operating voltage as a function of rates CO_3O_4 added to the polymer

The added nanoparticles (CO_3O_4) reduce the degree of kiure transmission and thus reduce the visual response times, voltages are determined for the full direction, they are applied to the cell, and the time required for the full direction to occur occurs. Figure (9-13) shows run-time operation as a function of when the field is turned off before

measuring out. Using the system and method described in the work, the approach allows assessment of both ton and toff. In order to achieve complete switching, we usually applied (143 to 240) volts (peak to peak) at a frequency of 500 Hz. Variable intensity of light transmitted as a function of the applied voltage and the voltage required for each polymer in this work
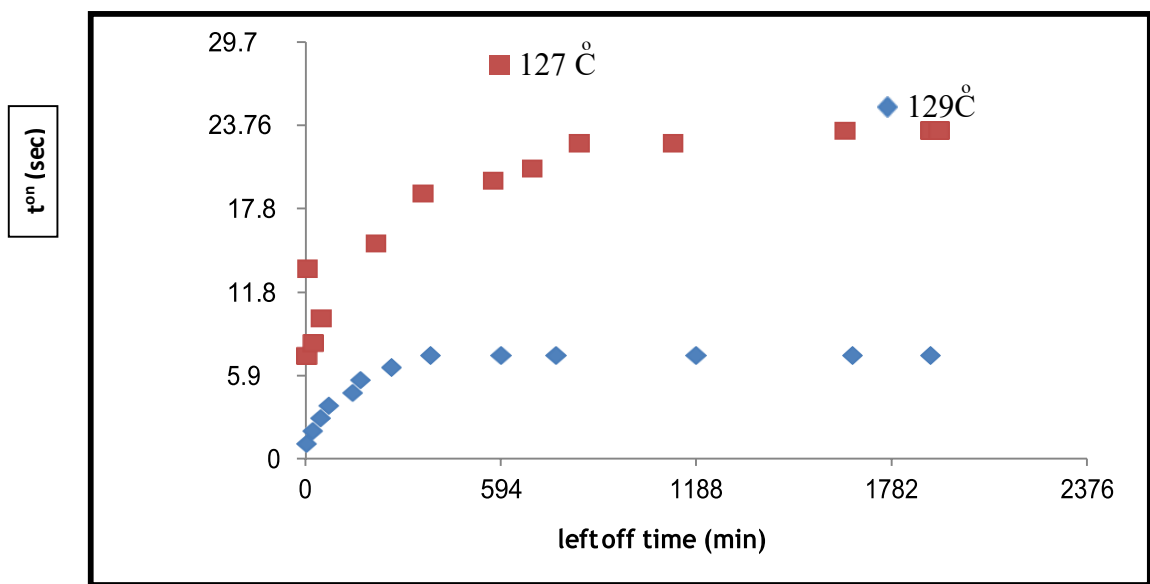

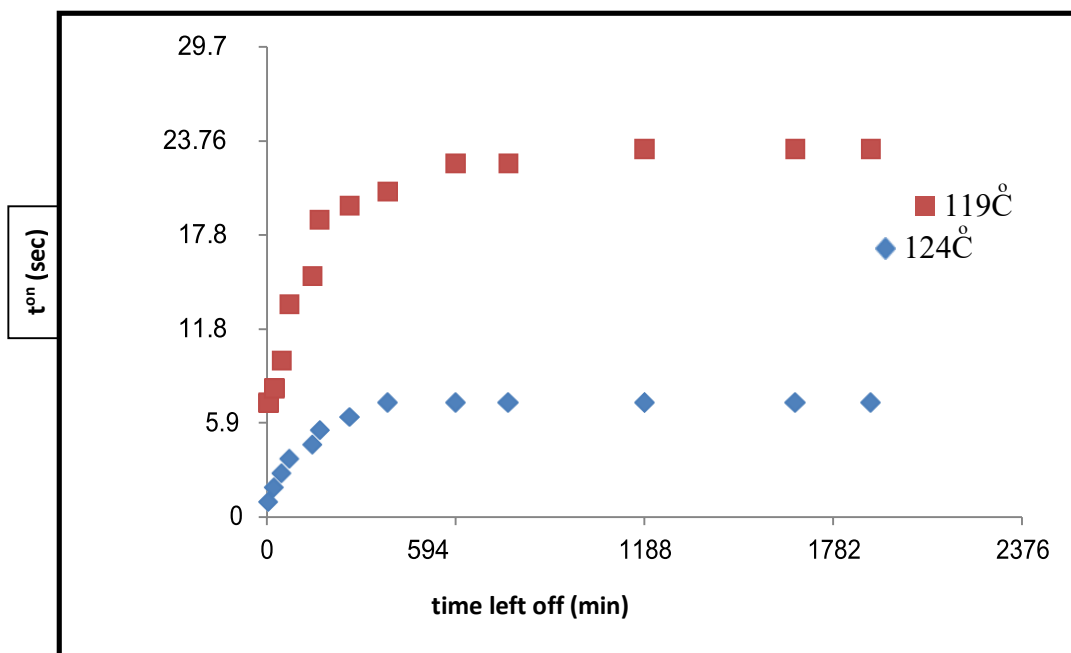Fig.9. Switching-on (τ^{on}) and time left off (τ^{off}) for addition P 1

Fig.10. Switching-on (τ^{on}) and time left off (τ^{off}) for addition P 2
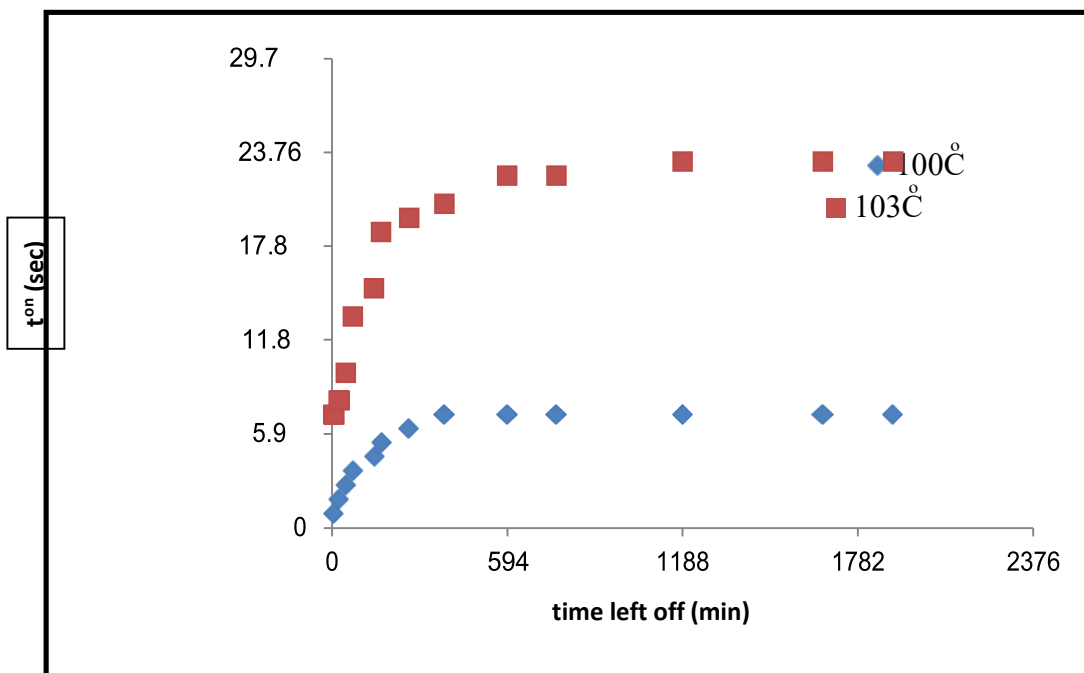
Fig. 11. Switching-on (τ^{on}) and time left off (τ^{off}) for addition P 3.
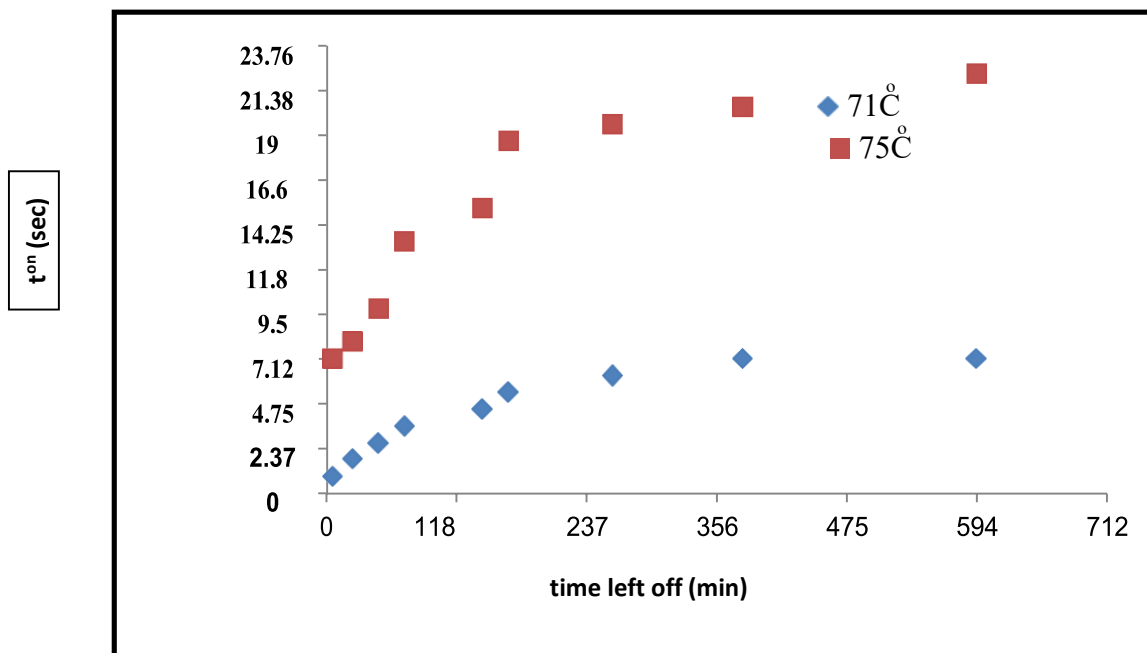
Fig. 12. Switching-on (τ^{on}) and time left off (τ^{off}) for addition P4.
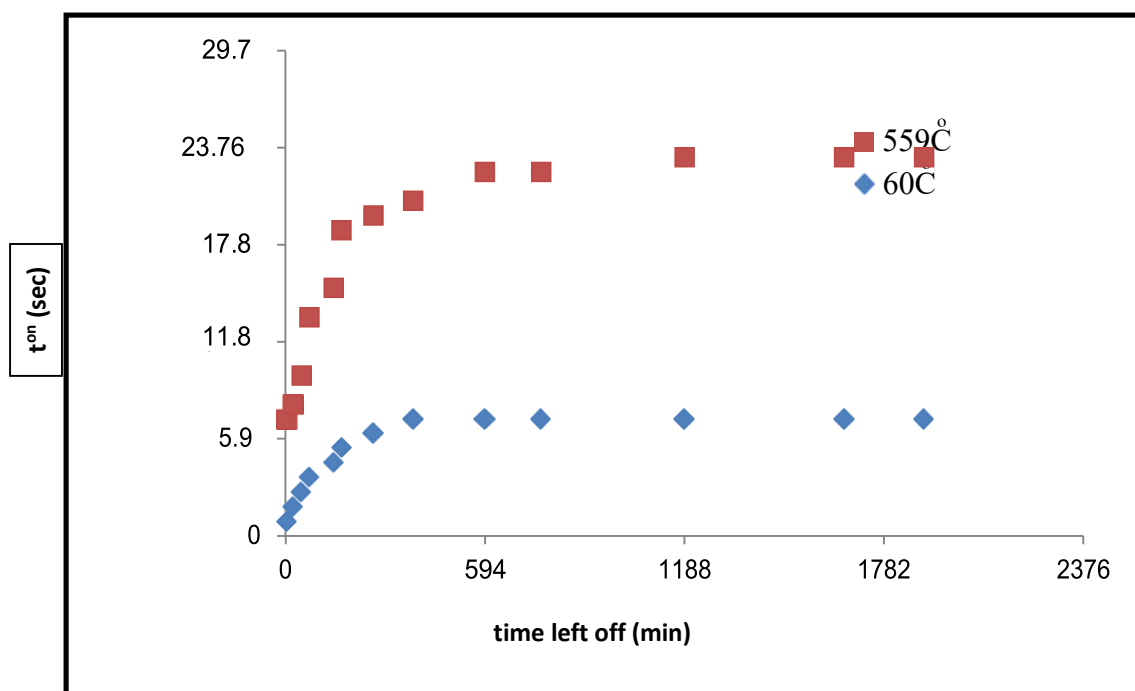
Fig. 13. Switching–on (τ^{on}) and time left off (τ^{off}) for addition P 5

The opening time decreases with the increase of the percentage of nanomaterial added and this is shown in Figure (14).

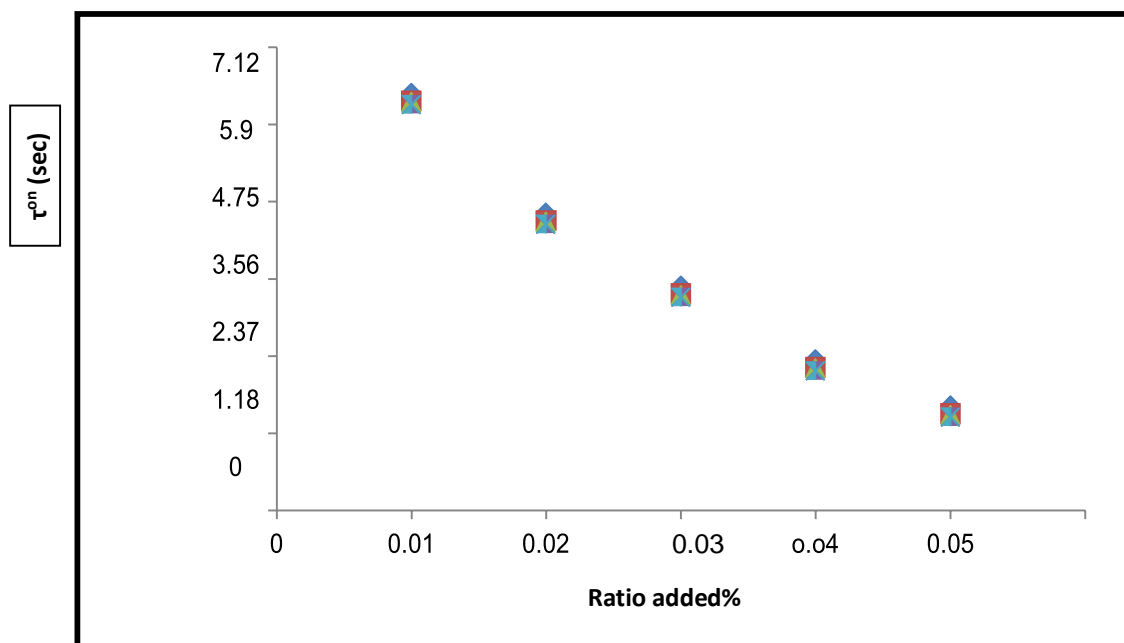Fig. 14. Switching – on (τ^{on}) as a function of the ratios addition.

IV. CONCLUSION

This study focused on the electrical properties of a series of fixed molecular weight polymers based on the acrylate backbone, when the addition of (CO_3O_4) nanoparticles with different molecular weights.

In this research , Nanoparticles added improves the electro - optical properties the liquid crystal,

we observe that the opening time is less than the increase in the percentage of added nanoparticles.

The added nanoparticles (CO_3O_4) reduce the degree of kiure transmission and thus reduce the visual response times ,and the degree of polymer transfer decreases and the viscosity of the polymer increases.

V. REFERENCES

[1] Drexler,K.E.," Engines of Creation ,The Coming Era of nanotechnology ",New York, Anchor Press ,Doubleday , 1989.

[2] De Gennes,P.G and Prost .J,"The Physics of Liquid Crystal",2nd Edition ,OUP,Oxford ,1993.

[3] H. Finkelmann ,D.Naegele, H. Ringsdorf, Makromol. Chem.180, 803,1979.

[4] For a general outline of the field of side chain liquid crystal polymers, see McARDLE,C.B.(editor) ,SideChain Liquid Crystals Polymers (Blakie) , 1989.

[5] Khalid Al. Ammar and Hawra'a Abd-Al Amear Salih,"Electro-Optical Properties and Effect of BaTiO of Polysiloxane", Journal of Engineering and Applied Sciences, 9519-9523 , 2018.

[6] Khalid Al.Ammar, Hawra'a Abd-Al Amear Salih, "Effect of BaTiO3 Nanoparticles Amount Addition on Electro-Optical Properties of Side Chain Liquid Crystal Polymer", International Journal of Science and Research (IJSR) , Volume 6 Issue 2, February 2017.

[7] Khalid Al.Ammar and Lina Abd Oun Al.Jamal,"Influence of Ferroelectric Nanoparticles on Liquid Crystal Polymer Nanocomposites and Studying their Electro-Optic Response", Journal of Engineering and Applied Sciences, 10232-10237, 2018.

[8] Khalid Hassan Al.Ammar, Fouad Sh. Hashim and Ahmed Najm Obaid," The Influence of Non – Polar Group on the Properties of Poly-Siloxanes Side Chain Liquid Crystal Polymers", Journal of Babylon University/Pure and Applied Sciences, No.(3), Vol.(24), 2016.

[9] Khalid Al.Ammar, Baidaa y.mohemed, " Effect of nanoparticles (BaTio3) on the optical properties of liquid crystal (acrylate)", Journal of Engineering and Applied Sciences, 5, 9149-9153 ,2019.

[10] GRAY, G.W. and GOOD BY, J.W., smectic liquid crystals, Leonard Hill, Glasgow, 1984.

[11] " Developments in Crystalline polymers ", springer nature ,1988.

[12] HILSUM, C. and RAYNES. E.P, Eds, Phil Trans R.soc. London, Leon, 1983.

[13] Saengsuman S., Bualek–limcharoen, S., Mitchell, G. R and Olley R. H, polymer, 44, pp.3407-3415, 2007.

[14] S.B.Clough,A.Blumstein,A.deVries,in: " Mesomorphic Order in Polymers and Poly-merization in Liquid Crystalline Media ",A.Blumstein,editor,ACS Symposium Series 74,Washington ,p1, 1978.

[15] Khalid Al.Ammar, M.J.Whitcombe, G.R.Mitchell, " The effect of the molecular weight on the electro-optic properties of methacrylate-based side-chain liquid crystal polymers" , polymer ,v:34, Issue 10,p 2060-2064 , 1993.

[16] Khalid Al.Ammar, G.R.Mitchell,"Electro-optical properties of liquid crystal copolymers and their relationship to structural order", polymer,vo:33,Issue1, pages11-21,1992.