Egypt. J. Chem. **Vol. 64,** No. 12 pp. 7277 - 7281 (2021)

Egyptian Journal of Chemistry

http://ejchem.journals.ekb.eg/

Liquid Crystal as Solar Cell Concentration

Suhad . H. Mohsen[a], Hawraa A. Abdulridha[b], Shireen N. Alebadi[c] and Ali Abid Abojassim[b*]

[a] Directorate of Education Najaf

[b]University of Kufa, Faculty of Science, Department of physics, Iraq

[c]University ofAlkafeel, Faculty of Dentistry, Iraq

Abstract

In this work, a solar concentrator was constructed using liquid crystalline material of the isotropic type to increase the efficiency of the solar cell. Two different concentrations of this liquid crystal were prepared and mixed with epoxy resin to manufacture the plates with an equal area of solar cell space. having Considered this kind of mixture, it was found that a high concentration of this material has contributed to increase the efficiency of the solar cell from 8.51 to 10.85, were also calculated the absorption, fluorescence spectra, short circuit current (Isc), open circuit voltage (Voc) and fill factor(FF). The quantum efficiency of fluorescence in this concentration was (93%, 90%).

Keyword: *Liquid Crystal, solar cell concentration*.

1. Introduction

Due to the growing demand for energy, there is an urgent need to increase the sources of this energy, and because the traditional energy sources cause great environmental pollution and high thermal retention [1,2], so to obtain a clean source of energy and environment-friendly such as wind power, hydropower, wave and tidal power solar cell, solar thermal, biomass-derived liquid fuels and photo-voltaic technology [3,4]. The need to use solar cells has increased and the conversion efficiency of this cell will remain low. There is a need to find ways to increase the efficiency of these cells. One of these ways is the use of Luminous concentration s (LS) [5]. There are many types of Luminous concentration used to increase the conversion efficiency of the solar cell. concentrators following the path of the sun can be used or the lenses and prisms. Florescence films can be used as a method to increase the efficiency of the solar cell. The idea of this concentration depends on the manufacture of film containing Luminous pigment or mixing with more than two dyes [6]. Liquid crystal materials are an intermediate state between solid and liquid materials. The normal crystalline lattice in the solid state is a three-dimensional uniform geometry system. When heating to a certain temperature, the kinetic energy generated by thermal signals will overcome the inter-molecular bonding forces of this uniform geometrical shape. If the inter – molecular bonding forces break in three dimensions once, the material will convert from the solid state to the normal isotropic state [7,8]. However, if there is an inconsistency in the bonding forces between these molecules in the three axes, one of the forces in one axis may be weaker than in the other two axes. This means that these mesophases whether two-dimensional or one-dimensional systems will have common characteristics with liquids and solid materials on their own [9]. Liquid crystal materials are organic compounds that show at least one mesophase between the crystalline phase and the isotropic liquid phase [10]. The liquid crystals that display a mesophase as a function of the temperature called (Thermotropic) either liquid crystals that show a mesophase as a function of concentration in the solution called (Lyotropic) [11]. Many of the molecules that show the mesophase have two distinct chemical structures: Rigid Aromatic group and Semi Flexible Aliphatic as in Figure (1).

*Corresponding author e-mail: ali.alhameedawi@uokufa.edu.iq.; (gggggggggggggggggggg).
Receive Date: 06 June 2021, Revise Date: 23 June 2021, Accept Date: 01 July 2021
DOI: 10.21608/EJCHEM.2021.79405.3900
©2021 National Information and Documentation Center (NIDOC)

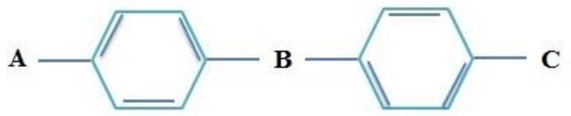

Fig. 1. Chemical structures

Where A: group of strong dipole group, B: is a linking group between the two O rings, C: series alkyl oxide

2. Materials and Methods

Liquid crystal ($C_{27}H_{39}NO_2$) with two concentrations (1×10^{-2} and$1\times10^{-3)}$ mol/L was prepared in the laboratories of the Chemistry Department at the University of Kufa in the form of the following chemical composition as shown in Figure (2).

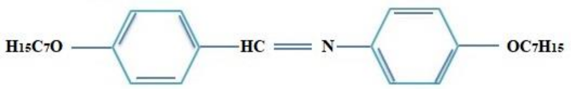

Fig. 2. Liquid crystal

A film (as a solar concentrator) of liquid crystalline material with Epoxy risen was prepared by a mixing ratio of (2 /1) of epoxy risen and hardener respectively [12, 13], and (10 × 10) cm in diameter equal the solar cell area after dissolving liquid crystal with ethanol solvent.

Lyotropic type liquid crystalline with two concentrations (1×10^{-2}, 1×10^{-3}) mol/L was used for the purpose of drawing the absorption and fluorescence spectrum using spectrophotometer and uv spectrum.

Through these graphs the area under the curve was calculated which represented the molar absorptivity by using the Matlab program and the radiation lifetime(τfm), quantum efficiency(Φfm) and fluorescence life time(τf) also calculated , After that making Pure epoxy panels and two panels mixing with the material (Liquid Crystal) are prepared with one thickness (1mm) and its dimensions are (10x10) cm, they were placed on the solar cell. to calculate solar cell parameters such as the efficiency of solar cells (η), Maximum value of current(Imax), Maximum value for voltages (Vmax) and Fill Factor (FF) and the effect of different concentrations were investigation on increasing the solar cell efficiency(Δη**)**,

3. Results and Discussion

The results were summarized in Table (1). Where the highest absorption and higher fluorescence were calculated and also, stokes shift, radiation lifetime (t_{fm}), fluorescence lifetime (t_f), and quantum efficiency (Φ_{fm}) were all calculated. The highest quantum efficiency was at the highest concentration. The spectra of absorption and fluorescence, are also drawn for both concentrations. Figure (3) shows the spectra at high concentration (1×10^{-2}), where they are all within the range of the visible spectrum and Figure (4) shows the absorption and fluorescence, spectra at the lowest concentration (1×10^{-3}) within the range of the visible spectrum. The liquid crystalline showed a high fluorescence intensity at the highest concentration of 1×10^{-2} at 654.85 and at a concentration of less than (1×10^{-3}) at 579.3 as shown in figure (5) and in Table (2). This is stressed high. Fluorescent organic dyes cannot reach these ranges in the best conditions. The possibility of improving the conversion efficiency of the solar cell when there is a Luminous concentration made of this crystalline liquid. After a film of liquid crystalline material was synthesized from the two concentrations above and mixed with epoxy resin and using ethanol as a solvent for dilution purposes, which does not absorb contribution absorption as absorption spectrum as shown in figure (6). The solar cell efficiency was calculated before and after the use of the Luminous concentration with these two concentrations. Table (3) shows the parameters of the solar cell and the increase in efficiency, thus, Short-Circuit Current,(Isc) Open Circuit Voltage (V_{oc}) Fill Factor (FF) were calculated. The results showed that the efficiency of the solar cell at the concentration of $1x10^{-2}$ increasing by 27% exceeds the value of solar cell efficiency without the Luminous concentration.

Figures (7,8) below shown the current I_{SC} – voltage V_{OC} curves for solar cell by using (LSC) panels for of Liquid crystal.

4. Conclusions

Ethanol succeeded in dissolving the liquid crystal material. All (LSC) panels for the liquid crystal material succeeded to increase the efficiency of the solar cell. High concentrations are preferable to use in improving the efficiency of the solar cell. The quantum efficiency of fluorescence in this concentration is (93%, 90%). In liquid crystal material, the fluorescence increases by increasing concentration. Best results were obtained of (LSC) panels with liquid crystal material of(1×10-2)mol/L and thickness (1) mm at which the efficiency reached(η=10.85) and the ratio of increase in efficiency ($\Delta\eta$ = 0.274%). Finally, it may be used these liquid crystal (prepared and mixed with epoxy resin) to increase in efficiency of solar cell.

Table 1 Summarized results for two concentrations.

Concentration mol/L	A_{max}	F_{max}	Stokes Shift $\Delta\lambda=\lambda_{flo}-\lambda_{abs}$	The radiated Life time τ_{fm} (ns)	The fluorescence Life time τ_f (ns)	The quantum efficiency% Φfm
1×10^{-2}	378	462	84	749.9264	701.4061	0.9353
1×10^{-3}	375	464	89	1.11E+2	9.98E+01	0.9003

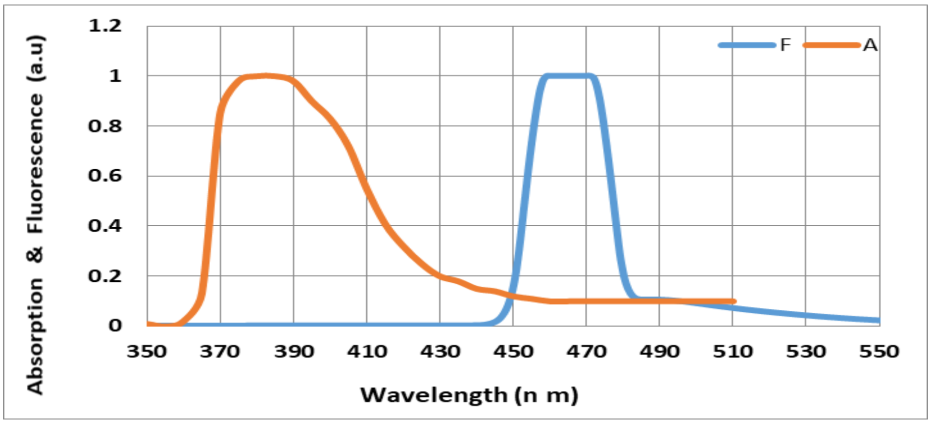

Fig. 3. Absorbance and fluorescence spectra for 1×10-2 mol/L

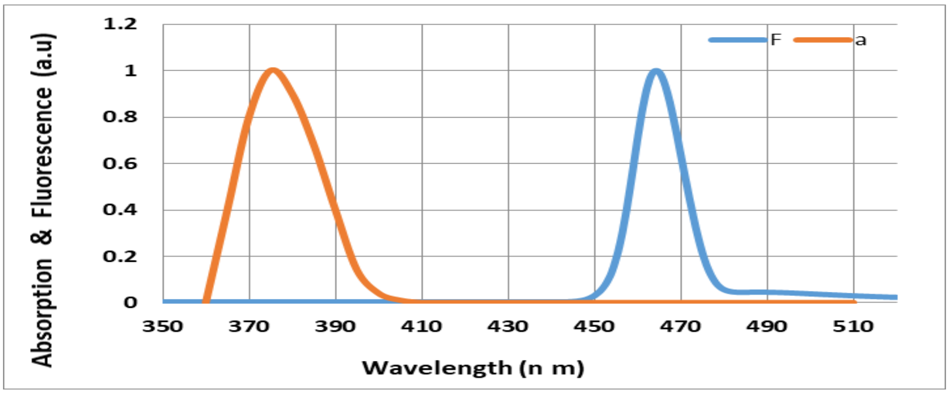

Fig. 4. Absorbance and fluorescence spectra for 1×10-3mol/L

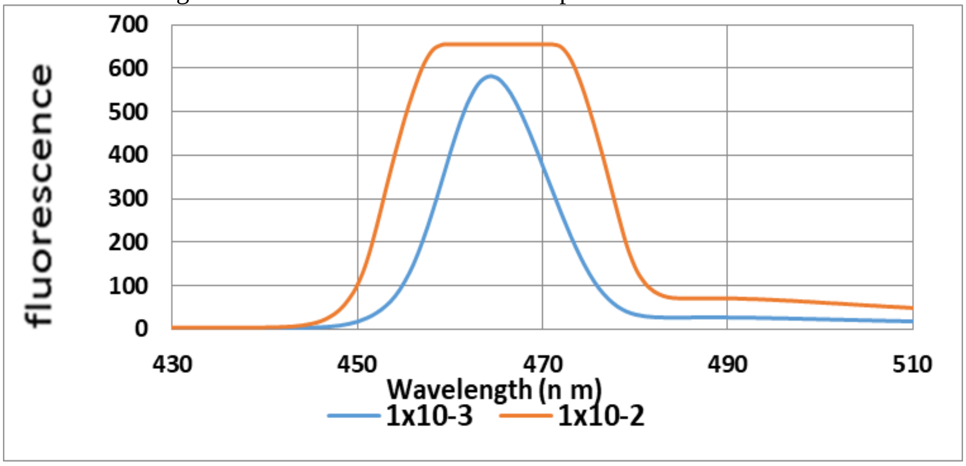

Fig. 5. Fluorescence spectrum values of Liquid crystal

Table 2. Maximum wavelength and fluorescence intensity for Liquid crystal

Concentration	λ $F_{max\ nm}$	Fluorescence
1×10^{-2}	462	654.85
1×10^{-3}	464	579.3

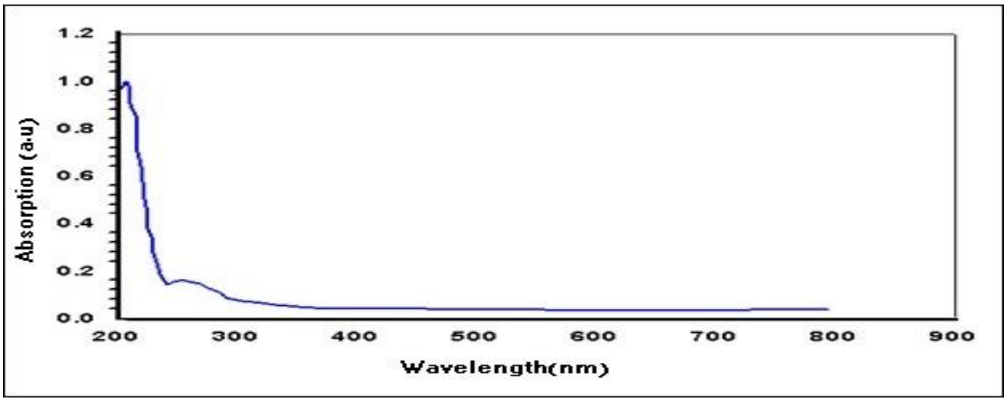

Fig. 6. Absorption spectrum of Ethanol

Table 3. parameters of the solar cell and the increase in efficiency

Concentration mol/*L*	**Thickness (mm)**	**FF**	**Voc**	**I_{sc}**	***V*max volt**	**Imax mA**	**η%**	**Δ η%**
	1	0.864	4.761	62.00	4.320	59.10	8.510	
1×10^{-2}	1	0.858	4.704	80.60	4.179	77.90	10.85	0.274
1×10^{-3}	1	0.876	4.804	76.50	4.212	76.50	10.74	0.262

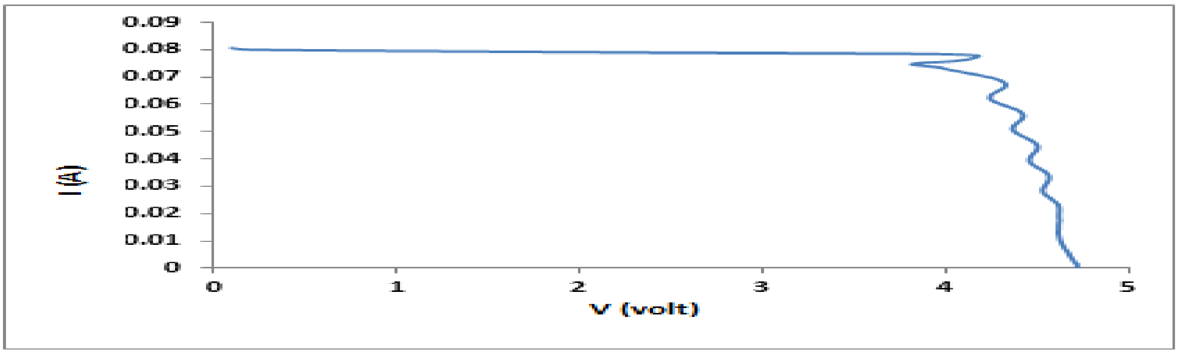

Fig. 7. current ISC – voltage VOC curve solar cell using Liquid crystal (1x10-2) ***mol*/*L***

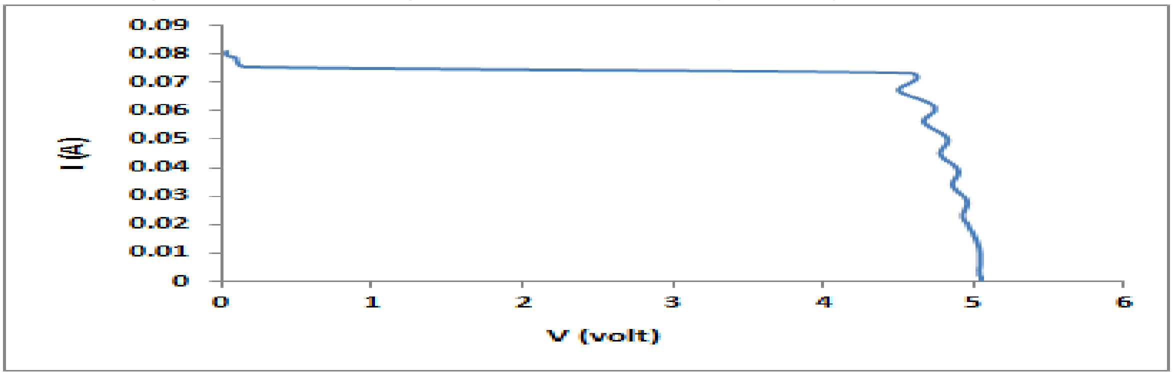

Fig. 8. current ISC – voltage VOC curve solar cell using Liquid crystal (1x10-3) ***mol*/*L***

5. Conflicts of interest

There are no conflicts to declare.

6. Formatting of funding sources

The funding sources by authors.

7. Acknowledgments

We acknowledgements university of kufa.

8. References

[1] Farag, H. K., El-Shamy, A. M., Sherif, E. M., & El Abedin, S. Z. (2016). Sonochemical synthesis of nanostructured ZnO/Ag composites in an ionic liquid. *Zeitschrift für Physikalische Chemie*, *230*(12), 1733-1744.

[2] Poelking, C., & Andrienko, D. (2016). Long-range embedding of molecular ions and excitations in a polarizable molecular environment. *Journal of chemical theory and computation*, *12*(9), 4516-4523.

[3] Zohdy, K. M., El-Sherif, R. M., & El-Shamy, A. M. (2021). Corrosion and Passivation Behaviors of Tin in Aqueous Solutions of Different pH. *Journal of Bio-and Tribo-Corrosion*, *7*(2), 1-7.

[4] Zohdy, K. M., El-Sherif, R. M., Ramkumar, S., & El-Shamy, A. M. (2021). Quantum and electrochemical studies of the hydrogen evolution findings in corrosion reactions of mild steel in acidic medium. *Upstream Oil and Gas Technology*, *6*, 100025.

[5] Aduloju, K. A., & Shitta, M. B. (2012). Dye sensitized solar cell using natural dyes extracted from red leave onion. *International Journal of Physical Sciences*, *7*(5), 709-712.

[6] Bassett, D. C. (Ed.). (1982). *Developments in crystalline polymers* (Vol. 1). London: Applied Science Publishers.

[7] De Gennes, P. G. (1974). The Physics of Liquid Crystals (Claren.

[8] Allen, M. P., & Tildesley, D. J. (2017). *Computer simulation of liquids*. Oxford university press.

[9] De Jeu, W. H., & Jeu, W. H. (1980). *Physical properties of liquid crystalline materials* (Vol. 1). CRC Press.

[10] Goodby, J. W., Saez, I. M., Cowling, S. J., Gasowska, J. S., MacDonald, R. A., Sia, S., ... & Vaschenko, V. (2009). Molecular complexity and the control of self-organising processes. *Liquid Crystals*, *36*(6-7), 567-605.

[11] Shehata, M. F., El-Shamy, A. M., Zohdy, K. M., Sherif, E. S. M., & Zein El Abedin, S. (2020). Studies on the antibacterial influence of two ionic liquids and their corrosion inhibition performance. *Applied Sciences*, *10*(4), 1444.

[12] Hussin, S. H. A. S. (2010). Study the optical properties of transparent epoxy resin (Epoprimer) plates. *Baghdad Science Journal*, *7*(1).

[13] Solanki, C. S. (2015). *Solar photovoltaics: fundamentals, technologies and applications*. Phi learning pvt. Ltd.