



Studying the effect of impurities Bi_2O_3 to SiO_2 used in LCD screens

Wila M. Mohammed

Physics Department, College of Education for pure science, Tikrit University, Tikrit, Iraq

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Corresponding Author:

Name: Wila M. Mohammed

E-mail: rahafwla@gmail.com

Tel:

Abstract

In this study, a liquid crystal display LCD cell was prepared. with the windows made from a thin film of SnO_2 add to it Bi_2O_3 by weight (0,1,3,5,7)%. The effect of adding optical and electrical properties of the cell was studied. The thin film was prepared by vacuum evaporation technique. It was added to use powder mixing technique. The results showed a decrease in the value of the current passing through the cell and an increase in resistance value from $9.7\text{M}\Omega$ to $12.5\text{M}\Omega$. The results also showed an increase in the cell's ability to control the light and darkness it with lower voltages by increasing the add rate. This leads to a decrease power used of a single cell. The value of the capacitance is not affected by the addition of Bi_2O_3 and was stable at ($3\text{nf} \pm 1\%$).

Introduction

In the early 1970's, digital watches started showing up in the marketplace with a new and different type of display-the liquid crystal display (LCD) [1] Which is characterized by LED screens with little consumption of current, and the long life in operation [2]. Liquid crystals rotate the optical axis if placed under the influence of a weak electric field[3]. Thin SnO_2 films can work to connect the current and a window. They are usually used TiO_2 as windows. These properties can be improved using some additives for greater transparency and less energy consumption [4]. Plus being cheap, it is easy to manufacture and non-toxic, LCD can be obtained interms a variety of physical and chemical ways [5]. The purpose of the research is to use windows SnO_2 and study the effect of addition Bi_2O_3 to the electrical and optical properties .

Experimental part

$(\text{SnO}_2)_{1-x}(\text{Bi}_2\text{O}_3)_x$ thin film

Powder technique was used in the process of adding powder of Bi to Sn, where the addition process is done based on weight ratios [6]. Tin and bismuth were used in the form of high purity powder up to 99.9%. Tin was handled as base material (1-X) and Bismuth as an additive for weight $x=(0.01,0.03,0.05,0.07)\%$. After calculating the ratios by a sensitive balance that was mixed using a gate mortar for a period of 30 minutes. The sedimentation was done out of throughout a vacuum evaporation system under vacuum 2.5×10^{-4} mpa. The weight of 0.004 mg was in a boat of tungsten used for

evaporation, which was made by quick evaporation to ensure that no component evaporates before the other. Glass was used as base for deposition. Thin film was oxidized in closed oven with temperature at 350°C for 60 minutes .The weighting method represented To calculate thickness of then film, using equation (1)[7]

$$t = \frac{M_2 - M_1}{A \cdot \rho} \quad (1)$$

Where t: is the thickness

$M_2 - M_1$: weight difference between M_2 and M_1

ρ : Intensity of material

A: area of cell.

LCD cell

The glass was cut in dimensions $(1 \times 1.5) \text{cm}^2$, the aluminum is deposited on one of the edges with a distance 0.3cm for use as ohmic contact . Each LCD cell was manufactured from the same glass . The assembly was done by placing the glass is developing tin oxide by making the oxide layer face-to-face and then move it by 0.5 cm. By placing the glass chip 10um Between the two slices. Then paste it with epoxy. When removed glass chip we were able to get two parallel and parallel panels separating them 10um. Then inject single phase of liquid crystals which used in mobile phone screens. This type of liquid crystals does not react or dissolve metal oxides [8]. Figure (1) shows LCD cell. Silver paste was used to connect the cell to the wire. As well as connecting them to the external circle.

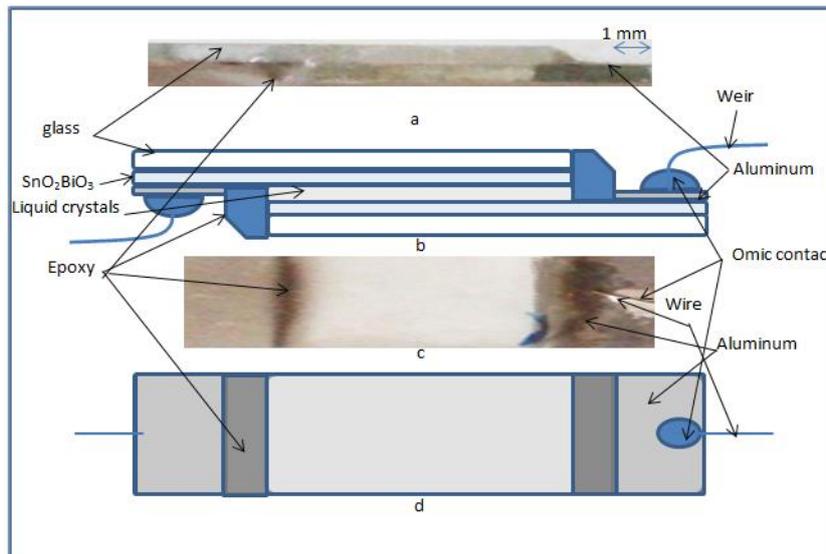


Fig .(1): (a) Vertical image of the cell (b) Vertical chart of the cell (c) horizontal image of the cell (d) horizontal chart of the cell .

Optical Setup

Figure (2) shows the optical tools used in this research. White LED light was used as a light source. To determine the area of light we used window in a distance (1X1) cm² and a polarized panel was also used to polarize the light vertically. Another panel was used to make the light polarized horizontally. The lens then collects the light on the detector. A (BPX65) silicon detector was used, because it has a good sensitivity to the visible range of the electromagnetic spectrum. The polarizing plates were rotated until the detector was given lowest current to ensure that polarization plates are perpendicular, then a LCD cell was placed between the polarizing plates and the optical group was placed in a circular box .

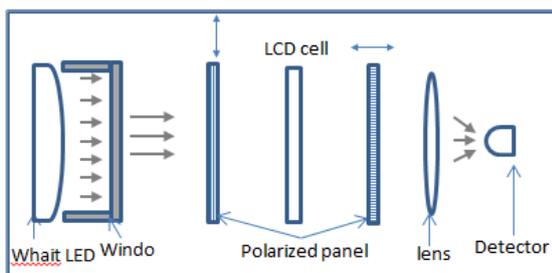


Fig.(2): The system used in the study of optical properties

Electrical measurements Setup

Liquid crystal cells can deal with currents of nano-ampere limits therefore the noise effect will be very large , the current measuring devices cannot measure the actual current of the LCD cell . Figure (3) present the electronic circuit used in this research. The voltmeter used in the search is of a digital multimeter (VICTOR VC97). The operations amplifier IC1 is a current to voltage transformer that has an input impedance equal to zero , with an amplifier factor according to the following equation [9]

$$V = - I R \quad (2)$$

Where . V: is voltage output
I: input current
R: feedback resistance .

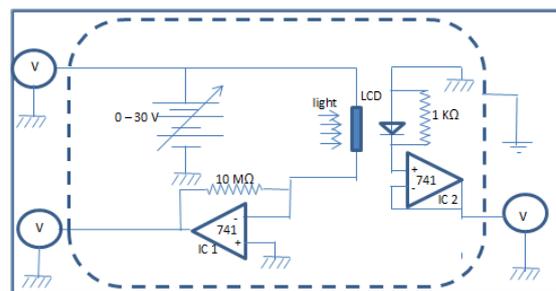


Fig.(3): Electrical measurements Setup

Operations amplifier IC₂ has a very high input impedance therefore the current generated by the detector will only pass through resistance . The current value will be equal to the value of the measured voltages divided by the resistance value .The circuit is surrounded by an aluminum box and then connected to the ground. The noise effect will be very small (>5μV)

Results and discussion

I-V Characters in dark

Fig (4) illustrates the (I-V) characteristics of LCD cell in dark. The results suggested that the cell has two regions. First the insulator zone It stretches from 0V to 4.7V Where the threshold voltage is less than the threshold voltage of the researcher [10] used TiO₂. And the second is ohmic zone in which the relationship is linear between voltages and current. The results also pointed out that the value of the current decreases as the ratio of the addition (Bi₂O₃) increases. Because the (Bi₂O₃) has high resistance to current. These results coincide with those in ref [10].

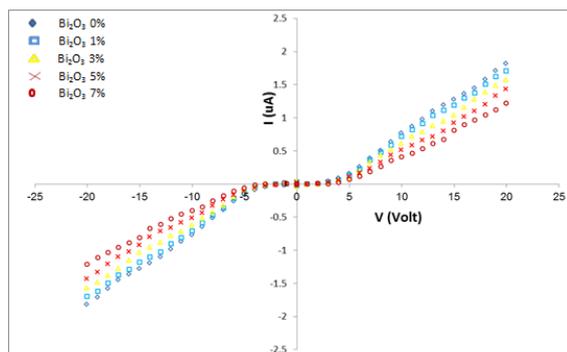


Fig.(4): (I-V) characters of LCD cell in dark

The current decreases in a non-linear way with increasing the additions at the same voltages. This can be seen more clearly in fig (5) which shows a change in the value of resistance with (Bi_2O_3) addition. The value of resistance increased a little when added (1%). Then the value of the increase in resistance multiplies as the added value increases. This means that the energy consumed becomes lower by increasing the added value. They are generally less than the energy of the researcher screens [11] used in windows TiO_2 .

Optical properties

Figure (6) present the relationship between voltages applied to a LCD cell and the current generated by the optical detector. Curves are divided into three zones: the first extends from A to B where the voltages increase from 0V to 4.7V and the optical current increases slightly and decreases again. When the electric field is generated inside the cell the liquid crystals be in the case of thermal movement. Thus, refractive and diffraction coefficients change, leading to an increase and decrease in the passage of light. All cells gave the same curve and did not affect the addition in this region. Second zone extends from B to C where the voltages increased from 4.7V to 7V. It can be observed that the beginning of this region starts with the flow of current in Fig (4). The electric field rotates the liquid crystals in the cell. It works to rotates. The polarized optical axis with 45° allow light to pass through the second polarized plate till arrival at the detector. The results confirmed that the increase in the added ratios increased the intensity of the light current, because the addition of Bi_2O_3 to SnO_2 increases the transitions. These results coincide with those researcher [12]. Third Area extends from C to D where the voltages increase from 7V to 20 V. The electric field increases the rotate of liquid crystals which increase the angle of the optical axis the amount of light decreases falling on the detector. Adding Bi_2O_3 to SnO_2 acts to improve cell function. reducing the dispersion of polarized light thus reducing the effective light of the detector. This means that may can access a blackout with lower voltages and lower current. And de economical in the power. The work of LCD screens depends on Its ability to block light.

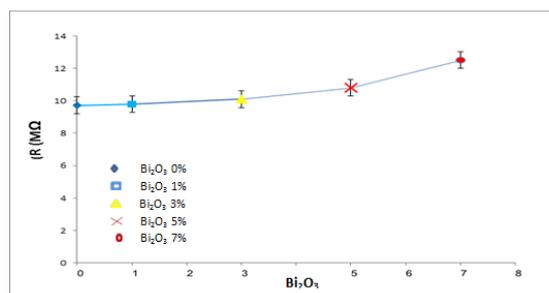


Fig.(5): change the value of resistance with (Bi_2O_3) addition

Capacity characteristics

A Gwinstek LCR-816 device was used to measure the capacitance properties,. Figure (7) explains the relationship between capacity and Bi_2O_3 addition ratios. The value of the capacitance is $3\text{nf} \pm 1\%$ was not affected addition Bi_2O_3 . Because capacitance does not depend on connector quality and the thickness of thin film is 100nm and it does not affect the internal thickness of the cell. And that Bi_2O_3 or SnO_2 does not react or dissolve in liquid crystals. So there is no change in the composition of liquid crystals .

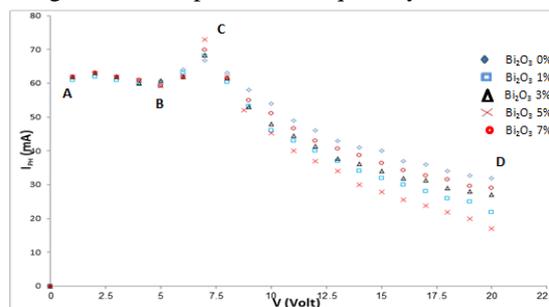


Fig.(6): relationship between voltages and the optical current

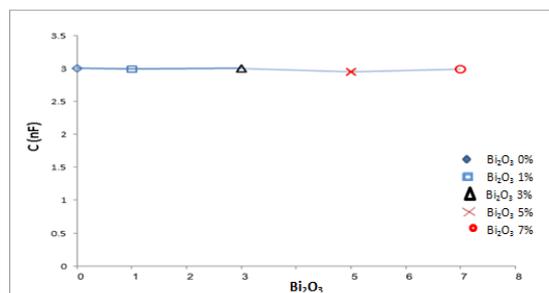


Fig.(7): relationship between capacity and (Bi_2O_3) addition

Conclusion

The Bi_2O_3 added to SnO_2 thin film can be used as a liquid crystal cell that is part of a large display consisting of hundreds of cells. Adding Bi_2O_3 to SnO_2 thin film reduces the value of the current passing through a LCD cell and increase the value of total resistance. Thus, reducing the value of the power required to operate a single cell, which reduces the power required to operate the display made of them . An addition can improve the optical properties of the cell where transitions increases and reduces the dispersion value of polarized light. This means two

cases of light and darkness with lower voltages and

lower power .

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دراسة تأثير اضافة Bi₂O₃ على SiO₂ المستعملة في شاشات LCD

ولاء محفوظ محمد

قسم الفيزياء , كلية التربية للعلوم الصرفة , جامعة تكريت , تكريت , العراق

rahafwlla@gmail.com

الملخص

في هذا البحث جرى تحضير خلية شاشة بلورات سائلة LCD. حيث صنعت من غشاء رقيق مكون من SnO₂ وتمت اضافة Bi₂O₃ بالطريقة الوزنية بنسب % (0,1,3,5,7). درست الخواص الضوئية والكهربائية للخلية وتأثير الاضافة عليها. ولتصنيع غشاء استعملت تقنية الترسيب الحراري بالفراغ. اما الاضافة فتمت بتقنية خلط المساحيق. بينت النتائج انخفاض بقيمة التيار المار بالخلية مما يؤدي الى ارتفاع في قيمة المقاومة من MQ9.7 الى MQ12.5. النتائج بيت زيادة في قدرة الخلية على التحكم في حالي الضوء والتعتيم عند فولتية اقل مما هي عليه قبل التطعيم، مما يعني انخفاض في قيمة القدرة المستعملة لعمل الخلية الواحدة. بينت النتائج ايضا ان قيمة السعة لم تتأثر بشكل محسوس بإضافة Bi₂O₃ وكانت مستقرة عند القيمة (3nf ± 1%).