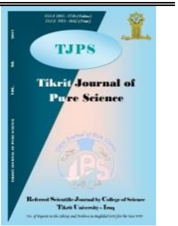
IASJ
المجلات الاكاديمية العراقية

Tikrit Journal of Pure Science
ISSN: 1813 – 1662 (Print) --- E-ISSN: 2415 – 1726 (Online)

Journal Homepage: http://tjps.tu.edu.iq/index.php/j



Study the effect of thickness and reflectivity on (n-ZnSe / p-MASnI3 / p-CuSCN) solar cell properties using SCAPS-1D

Tariq A. Mohammed , Ayed N. Saleh

Department of physics, Collage of Education for pure Science, Tikrit University, Tikrit , Iraq

https://doi.org/10.25130/tjps.v24i7.463

ARTICLE INFO.

Article history:
-Received: 2 / 6 / 2019
-Accepted: 24 / 6 / 2019
-Available online: / / 2019

Keywords: SCAPS-1D, $MASnI_3$, n-ZnSe, p-CuSCN, Solar cell, Conversion efficiency (η) Fill factor (**FF**), Quantum efficiency (**QE**), Materials for the transport of holes(**HTM**), Materials for the transport of Electron(**ETM**)

Corresponding Author:
Name: Ayed N. Saleh
E-mail: ayed.ns@tu.edu.iq
Tel:

ABSTRACT

The effect of the absorption layer ($MASnI_3$) within the range (200nm-900nm) was studied with the thickness of each layer HTM and ETM (10nm) for each. After completion of the study we found that the best thickness of the absorption plate is at (400nm), note that the cells used in the program is not perfect it contain defects, to be closer to the practical reality, after completing this study In the framework of this study was added a filter mirrors (95% mirro) from the library of the program (Scaps) and that the studied solar cells (n-ZnSe / p-$MASnI_3$ / p-CuSCN) Reflectivity (R) ranged between 0.11-0.99 and the best reflective range at 0.99 was (η) 20.98 filler (FF) 68.55% short circuit current (Jsc) 34.040 mA/cm^2 and volt circuit (Voc) 0.894 V. The default illumination spectrum has been set to the AM1.5 global standard.

1- introduction

The Earth receives an great amount of solar energy. The sun provides enough energy per minute to supply the energy needs of the world for a full year, and one day provides more energy than population consumption. In fact, the amount of solar radiation that strikes the earth over a period of three days is equivalent to Energy is stored in all fossil energy sources. Solar energy is a free source. The first solar cell has been in operation for more than 30 years and the solar cell has been extended in terms of efficiency. The biggest efficiency leaps have come with the emergence of transistors and semiconductor technology. There are many advantages of solar PV if it is one of the sources the world's most promising renewable energy [1]. A solar cell is a device that converts photovoltaic energy into an electric current, and can convert light into electrical energy using sunlight or any other industrial light. The development of low-cost, easy-to-use, high-efficiency, long-term solar cells (solar cells) has continued. Solar cells are a type of semiconductor that contains a biophysical compound, often organic or inorganic Lead-based halide material is often used as an energetic layer to collect energy. Pyrophosphate materials such as methylammonium lead halides and cesium lead halide are inexpensive to produce and simple to manufacture. The efficiency of solar cells for devices using these materials increased from 3.8% in 2009 to 22.7% in late 2018 due to internal cell substitutions. [2] The perovskite compound was known for many years but the first solar cell based on perovskite was manufactured in 2009 Before the researcher Miyasaka and her group. The structure of this cell was based on sensitive dye cells and gave energy conversion efficiency of 3.8% using the perovskite layer and the TiO2 layer as a collector of electrons, as well as using a liquid part of the cell, so the cell was only briefly stable. Researcher Park and his group developed this cell in 2011 using the same principle and also get the efficiency of conversion of energy 6.5% [3]. Later in 2012, researcher Henry Snaith and researcher Mike Lee of Oxford University demonstrated that perovskite were constant if they were in contact with a rigid carrier of gaps and there was no need to use the TiO2 layer to transport the electrons. It was found that the efficiency level had risen to more than 10%. In 2013, both sensitive and flat cells were subjected to several improvements. Burschka and her group [5] demonstrated that the repositioning technique for sensitive dyes had increased efficiency to 10%. At the same time, Olga and her group [5] demonstrated that a flat cell by thermal evaporation could be made with an efficiency of 12% to 15% in both the pin and nip models, respectively. [6] Organic matter and the bottom layers of the layers of the electrons at the top of the perovskite layer. In 2014, using the re-positioning of the layers, 19.3% efficiency was achieved by Yang Yang [7] in a flat cell model with a thin membrane. In December 2015, the efficiency of 21.0% was recorded by some researchers, in 2016 efficiency was reached 22.1%, and finally in 2018 the efficiency of 23.3% was registered at the Chinese Academy of Sciences.

- The aim of study :

1-The main objective of the research is to obtain high efficiency of the solar cell (n-ZnSe / p-$MASnI_3$ / p-CuSCN) using the computer simulation method of solar cells

2. Simulation method

Is a one-dimensional program that simulates solar cells, developed in the Department of Electronic and Information Systems at the University of Gent / Belgium. The program is available free of charge to researchers and runs on Windows systems, where it takes 50MB of hard drive.

(2-1) Characteristics that describe solar cell performance:

The main factors used to describe the performance of solar cells are the maximum power of p_{max}, the short circuit current of J_{sc}, and the open-loop voltage of the V_{oc} , *and* Fill factor FF. These factors are determined by the bright J-V property curve. The conversion efficiency η is determined by these factors. Here are some explanations and brief versions of these factors for the simple n-p link:

(2-1a) Short circuit current density J_{sc} :

The short circuit J_{sc} current is the maximum current generated by the solar cell when the solar cell ends are in contact with one another (ie, short circuit). The solution can be obtained J_{sc} from the net current density J-V Solar system and from the following equation [8][9]:

$$\boldsymbol{J(V)= J_{sc} - J_{dark}(V)} \;..(1)$$

Where: $\boldsymbol{J_{dark}}$ the density of the dark stream is given by the following equation:

$$\boldsymbol{J_{dark}(V) = J_o\,(\,e^{\,qV/K_BT} \;-1\,)} \;..\,(2)$$

Under solar lighting, solar cell behavior is described using the ideal diode equation (12-2) and an additional source of current $\boldsymbol{J_{sc}}$ due to illumination, thus giving the equation of the bright solar cell by compensating equation (2) in equation (1):

$$\boldsymbol{J(V) = J_{sc} - J_o\,(\,e^{\,qV/K_BT} \;-1\,)} \;..\,(3)$$

Similarly, the short circuit current is given by the following equation:

$$\boldsymbol{J_{sc}(V) = J(V) + J_o(\,e^{\,qV/K_BT} \;-1\,)}..\,(4)$$

Since v is the voltage across the junction, T is the absolute temperature. $\boldsymbol{J_o}$ The density of the saturation current is during darkness.

(2-1b) Volttge Open Circuit:

V_{oc} Is the voltage in which no current flows through the outer circle when the solar cell ends are not connected to each other. This is the maximum voltage that the solar cell can provide. Depends V_{oc} on the optical current density J_{ph} of the simple p-n connection, and is given by the following equation [9].

$$V_{oc} = \frac{K_BT}{q}\ln\left(\frac{J_{ph}}{J_o} + 1\right) \ldots (5)$$

It is obtained from equation (5) by adjusting the net current $\boldsymbol{J(V)}$ to zero. This results in a compensation effect between the dark current and the photovoltaic current:

$$\boldsymbol{V = V_{oc}} \textit{ and } \boldsymbol{J_{sc} = J_{ph}}\;,\; \boldsymbol{J(V) = 0}$$

(2-1c) Fill factor FF:

The fill factor is the ratio between the maximum capacity $\boldsymbol{P_{max} = J_{mp} \times V_{mp}}$ generated by a solar cell and the output $\boldsymbol{V_{oc}}$ and $\boldsymbol{J_{sc}}$ describes the FF "squared" J-V curve

$$FF=\frac{\boldsymbol{J_{mp}\times V_{mp}}}{\boldsymbol{V_{oc}\,J_{sc}}} = \frac{\boldsymbol{P_{max}}}{\boldsymbol{V_{oc}\,J_{sc}}} \;\ldots\; (6)$$

$\boldsymbol{J_{mp}}$ ***and*** $\boldsymbol{V_{mp}}$ Is the maximum voltage point and the current density can not be generated by the solar cell.

(2-1d) Conversion efficiency η:

Conversion efficiency is described as the ratio between the maximum capacity generated by the solar cell and the ability to fall on it. This is given by the following equation:

$$\eta = \frac{\mathbf{P_{max}}}{\mathbf{P_{in}}} = \frac{\mathbf{J_{sc}\;V_{oc}\;FF}}{\mathbf{P_{in}}} \;\ldots.\, (7)$$

Radiation and value $\boldsymbol{P_{in}}$ The 1000 W/ m^2 of the 1.5AM spectrum has become a standard for measuring the conversion efficiency of solar cells. Where the radiation capacity $\boldsymbol{P_{in}}$ is a measure of falling power as a function of the space of the solar cell.

(1-2-1e) Quantum Efficiency Q_E :

Quantitative efficiency is defined as the percentage between the number of electrons generated to the number of photons absorbed per unit wavelength falling on the surface of the device, expressed in the following mathematical relationship:

$$Q_E = \frac{(I_{ph}/q)}{(P_{in}/h\nu)} \;\ldots.(8)$$

*Where as:

*(Iph / q) Number of carriers generated.

*(Pin / hυ) The number of photons dropped

Quantitative efficiency can be calculated in terms of promoter length and response.

$$Q_E = R_\lambda \frac{hc}{q\lambda} \;\ldots(9)$$

Where: $\frac{\mathbf{hc}}{\mathbf{q}}$ constant and equal to1.24 thus simplifying the equation and written as follows:

$$Q_E = 1.24\frac{R_\lambda}{\lambda} \;\ldots..\,(10)$$

Whereas:

$\mathbf{R}_\lambda$ *: Response in units (A / W)*

$\boldsymbol{\lambda}$: wave length units in (nm)

If the number of electrons generated (9) is equal to the number of absorbed photons, naturally the reflected light will be reflected at the semi-conductor surface and not all that remains absorbed within the depletion zone so that the amount of efficiency can be increased by reducing the reflectivity of its surface As well as increase the survival time of the carriers by reducing the structural defects and increase the life span and increase absorption within the depletion zone, and the main key, which plays a prominent role in quantitative efficiency is the absorption coefficient, which depends on the cycle on the wavelength [10,11].

Table (1) The parameters of the solar cell used in the SCAPS-1D program

Prameter	symbol (unit)	ZnSe	CuSCN	MASnI3
Bandgap	Eg (ev)	2.9	3.6	1.3
Electron affinity	χ (ev)	4.1	1.7	4.2
Dielectric permitivity	$\epsilon/\epsilon r$	10	5.1	10
CB effective density of states	$N_C(cm^{-3})$	1.8E+18	2.50E+20	1.0E+18
VB effective density of states	$N_V(cm^{-3})$	1.8 E+19	2.50E+20	1.0E+18
Electron thermal velocity	V_n(cm/s)	1.0 E+7	1.0 E+7	1.0 E+7
Hole thermal velocity	V_P(cm/s)	1.0 E+7	1.0 E+7	1.0 E+7
Electron mobility	$\mu_n(cm^2/v.s)$	1.000E+2	25	1.600E+0
Hole mobility	$\mu_p(cm^2/v.s)$	2.500E+1	25	1.600E+0
Coefficient absorption	$\alpha(cm^{-1}ev^{1/2})$	1 E+5	1 E+5	1E+5

* URL of SCAPS–1D program :
https://users.elis.ugent.be/ELISgroups/solar/projects/scaps/SCAPSinstallatie.html

3. Effect of thickening on the absorption layer (Absorber layer)

The effect of the absorption layer ($MASnI_3$) within the range (200nm-900nm) was investigated with the thickness of the HTM layer and the ETM at10nm. After completion of the study we found the best thickness of the absorption plate is(400nm) and Fig (1) shows the characteristic (I-V) of cell ZnSe / $MASnI_3$ / CuSCN, with increasing the thickness of the absorption layer the increases characteristic curve(I-V).

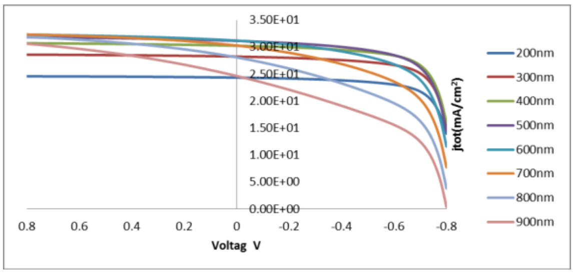


Fig.1: I-V characteristic of *(*ZnSe/$MASnI_3$/CuSCN*)* cell the

The density of the short-circuit current (Jsc) increases by increasing the thickness of the P-$MASnI_3$ from 24.306 (mA/cm^2) at 200 nm to 30.231 (mA/cm^2) at 400 nm, It then drops to its value at 24.655(mA/cm^2) at a thickness of 900 (nm) and as in Fig.(2). The reason for their rise is the ability of the material to absorb more photons and, in turn, to make the highest contribution to the generation of electron-gap pairs that lead to their elevation. The reason for their decrease is the result of the union of the surface that leads to the depletion of the electrons [12,13] as well as the voltage of the open circuit (Voc) at 0.892 V at 200 nm to 0.801 V at 900 nm as shown in Fig. (3) due to the parallel impedance leading to a decrease in the voltage of the open circuit [14,15].

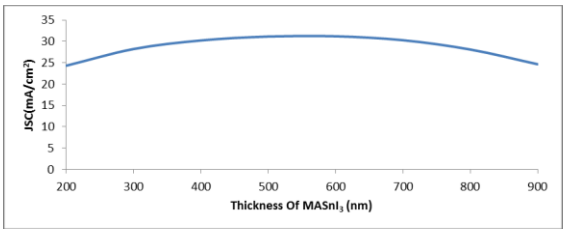


Fig. 2: Effect of thickness of the absorbent layer p-$MASnI_3$ on J_{SC}

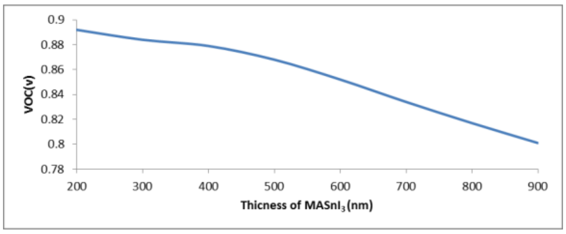


Fig. 3: Effect of thickness of the absorbent layer p-$MASnI_3$ on Voc

As for the filling factor (FF), the height of the thickness of 200 (nm) and 70.27%, and then decrease at a thickness ranging from (nm) 400 - 900 and their value is 70.11%, 47.51% respectively as shown in Fig (4). The increase of the absorption thickness and therefore because the increase of the interface of the interface, which generates a constraint that works on the capture of electrons and reduces the current depletion environment that negatively affects the values of the filling factor and because of the high process of the union at the interface The laws capture electrons and reduce the current and thus lead to the drop filling factor, The filling factor is affected by the increase of the resistivity respectively because the higher the thickness the greater the value of the capacitor Respectively, which blame lead to a reduction of overfilling factor[16].

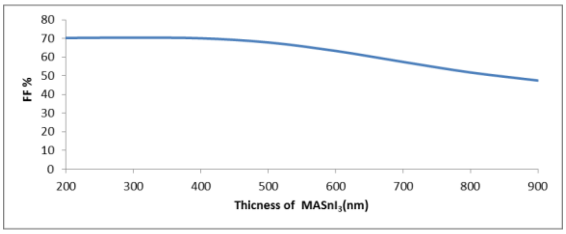


Fig. 4: The effect of thickness of the absorbent layer p-MASnI3 on FF

The efficiency of the cell (η) increases by increasing the thickness of the MASnI$_3$ from 15.32% at 200 nm to 18.63% at 400 nm and then decreasing to 9.79% at 900 nm. As in Fig (5), the efficiency of the bottom decreases with the thickness if the thickness of the absorber absorbs the largest the length of the spread of the transport of the ship is the possibility of exposure of the Union even before reaching the poles metal cannot avoid the process of restoring the Union is not only by reducing the thickness of its absorption, Fish will increase the rate of re-union, which reduces the efficiency of the family and that the decrease in thickness leads to a reduction of the rate Which was reintroduced by the Union, thus increasing the efficiency of the Chalets [17,18].

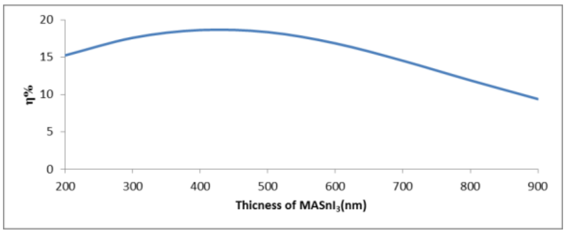
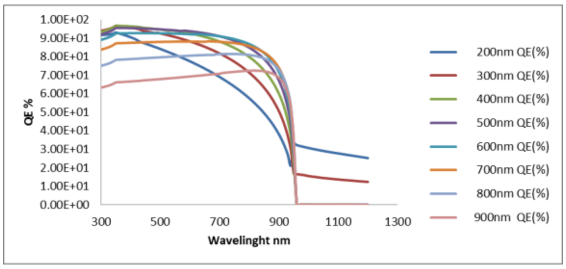


Fig (5) Effect of thickness on the absorbent layer p-MASnI3 on the efficiency 0f the cell

Quantitative efficiency (QE) was 93% at 200 nm to 97% at 400 nm and then decreased to 64% at 900 nm. This means that the quantity efficiency decreases with the increase of fish and as Fig (6) where quantitative efficiency (QE) does not stop at the distance of p-n from the surface because the semi-conductor material with the large power gap was used as a window layer allowing the photons with less energy E_{g1} to pass through them, the photons that were energy E_{g1} and E_{g2} In the retail p-n [19]. Photons with long wavelengths will absorb deeply into the absorption layer p-MASnI$_3$ and thus the quantum efficiency of the electrons generated there will be large and dependent on propagation length, thus increasing the value of V_{OC} and Jsc [20]. The decrease in the efficiency value at long wavelengths is due to the low absorption coefficient, which leads to a decrease in the rate of carrier generation and increase the re-union rate at the back surface of the cell, which leads to a decrease in the length of propagation of the carriers and thus decreases the number of electrons generated for each absorbed photon [20].



Fig(6) QE with wavelength at different thickness variation

4. Effect of inactivation on the cell (ZnSe / p-MASnI3 / p-CuSCN n)

In the framework of this study, a mirror filter (95% mirro) was added from the library of the program (SCAPS) and the best cell of the studied cell nucleus (n-ZnSe / p-MASnI$_3$ / p-CuSCN) (0.11-0.99). The best range of reflectivity was 0.99 and the efficiency of the cell (η) was 20.89%, the(FF) 68.55% and the short circuit current (Jsc) 34.048 (mA / cm^2) and the open circuit volt (Voc) 0.894 V where the increase in reflectivity Increase the energy absorption as the electron-gap generation rate increases as shown in Fig(7).

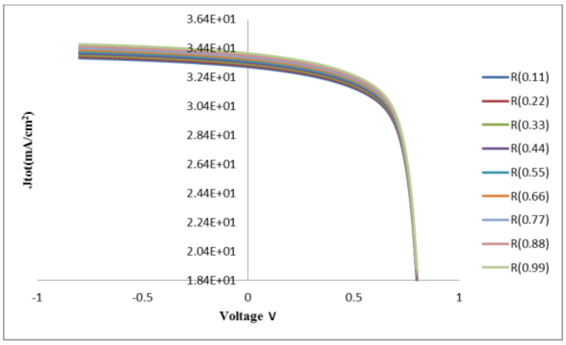


Fig (7) (I-V) characteristic of the n- ZnSe/p-MASnI3/p-CuSCN cell with different reflectivity

The density of the short circuit current (Jsc) increases with the increase of the reflectivity concentration of the ZnSe n- mA / cm^2 (33.115) for the reflective material of the reaction material 0.11 to 34.045(mA / cm^2) at a reflective concentration of 0.99. As in Figure (8). The V-volt increases slightly from 0.890 V at concentration of 0.11 to 0.890 V at the concentration of 0.99 as shown in Fig(9). This is due to an increase in the concentration of the anxiety in the background layer increasing the electric field (MASnI$_3$), leading to increased separation between the gap and electron carrier (Exton), which results in an increase in the performance of the solar cells and the high value of Jsc Voc, as well as on the basis of equations (5), (4).

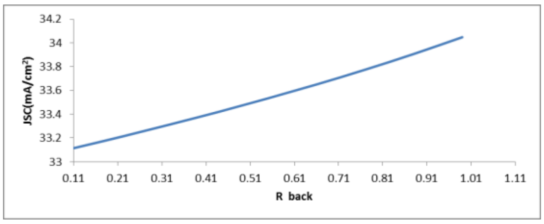


Fig (8) Effect of reflective cell concentration (n- ZnSe / p-MASnI3 / p-CuSCN) on J_{SC}

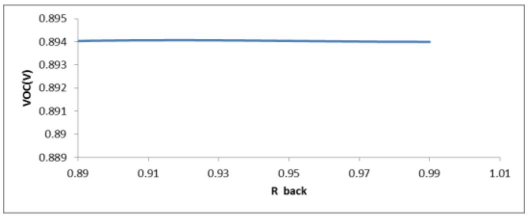


Fig (9) Effect of reflective cell concentration (n- ZnSe / p-MASnI3 / p-CuSCN) on Voc

As for the filler factor, it was reduced by an increase of the reflectivity concentration of the ZnSe n- from 68.80% at the concentration of reflectivity 0.11 to 68.55% at 0.99 as reflected in Fig(10). As a result of the barrier, Of the cell resistance of the cell and a decrease in the filling factor. As well as on the basis of equation (6).

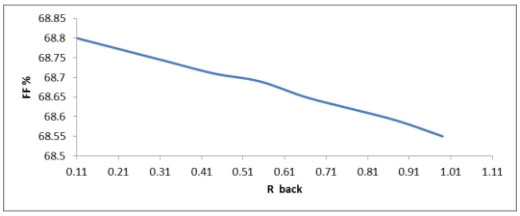


Fig (10) Effect of reflective cell concentration (n- ZnSe / p-MASnI3 / p-CuSCN) on FF

The efficiency of the cell was increased from 20.30% at a reflective concentration of 0.11 to 20.89% at a refractive concentration of 0.99 as shown in Fig. 2d-1. The reason for this increase is due to the ability of the material to absorb more photons to generate an electron based on its equation (7).

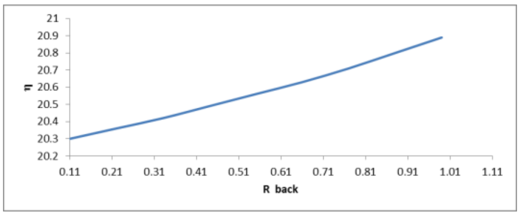


Fig (11) Effect of reflective cell concentration (n- ZNSE / p-MASNI3 / p-CUSCN) on η

As for the efficiency of quantity QE, Fig (12) shows that there is a slight decrease in the reflection rate of the spectroscopy on the efficiency values at the wavelengths due to the absorption of this application which reduces the rate of generation of electron-gap pairs, The value of the efficiency quantity. As long as the photogonal longitudinal lengths will be absorbed deeply into the P-MASnI3 absorption layer, there will be a significant reduction in quantum efficiency at the length of the cutting waveguide and based on the amalgamation (10) [19].

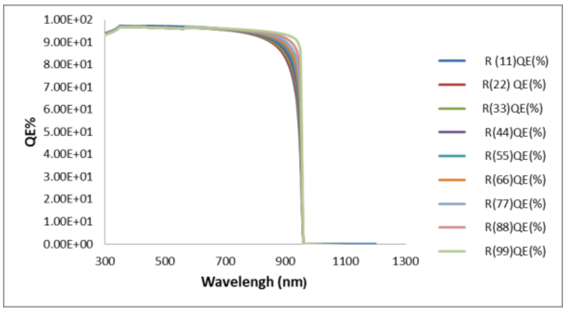


Fig (12) Effect of reflective cell concentration (n- ZnSe / p-MASnI3 / p-CuSCN) on QE

5. Conclusions

The study of the ETM / $MASnI_3$ / HTM solar cell through the effect of thickness as well as the cell reflection of the I-V curve and the quantitative efficiency curve (QE) on the cell showed that the use of software computer in the simulation process to facilitate the process of manufacturing solar systems and reduces:

1- We estimate that the thickness of the absorption layer (400 nm) will increase the properties of I-V and QE and the best cell obtained is ZnSe / MASnI3 / CuSCN. The efficiency value was 18.63% (Voc) 0.879 V, short circuit current (Jsc) 30.231 (mA / cm^2).

2- The value (ZnSe / $MASnI_3$ / CuSCN) showed that the increase in reflectivity increases the bending properties (I-V) and slightly reduces the quantitative efficiency (QE) and the best cell obtained is (ZnSe / MASnI3 / CuSCN), Where the efficiency value was 20.89%, the value of the open circuit voltage (Voc) 0.894 V, the short circuit current value (Jsc) 34.048 (mA / cm^2) and the value of the fill factor (FF) 68.55%.

6. References

[1] Fang, H.; Li, X.; Song, S.; Xu, Y.; and Zhu, J. (2008). Fabrication of slantingly-aligned silicon nanowire arrays for solar cell applications. *Nanotechnology*, ***19*****(25):** 255703.

[2] Babayigit, A.; Boyen, H. G.; and Conings, B. (2018). Environment versus sustainable energy: The case of lead halide perovskite-based solar cells. *MRS Energy and Sustainability*, **5**.

[3] Im, J. H.; Lee, C. R.; Lee, J. W.; Park, S. W.; and Park, N. G. (2011). 6.5% efficient perovskite quantum-dot-sensitized solar cell. Nanoscale, **3(10):** 4088-4093.

[4] Lee, M. M.; Teuscher, J.; Miyasaka, T.; Murakami, T. N.; and Snaith, H. J. (2012). Efficient hybrid solar cells based on meso-superstructured

organometal halide perovskites *Science*,. ***338*** **(6107)**: 643-647.

[5] Liu, M.; Johnston, M. B.; and Snaith, H. J. (2013). Efficient planar heterojunction perovskite solar cells by vapour deposition. *Nature*, **501(7467):** 395.

[6] Docampo, P.; Ball, J. M.; Darwich, M.; Eperon, G. E.; and Snaith, H. J. (2013). Efficient organometal trihalide perovskite planar-heterojunction solar cells on flexible polymer substrates. **Nature communications, 4:** 2761.

[7] Zhou, H.etal.(2014). Interface engineering of highly efficient perovskite solar cells. *Science*, **345(6196):** 542-546.

[8] Amu, T. L.; Abuja, N. (2014). performance optimization of tin halide perovskite solar cells via numerical simulation .

[9] Ahemad, M.;and kibret, M.(2014).Mechanisms andapplications of plant growth promoting rhizobacteria: current perspective *Journal of kind saud university-science*, **26 (1)**:1-20.

[10] Vardhanan, R. V.; Zhou, L.; and Gao, Z. (1999). Schottky and heterojunction diodes based on poly (3-octylthiophene) and poly (3-methylthiophene) films of high tensile strength. *Thin Solid Films*, ***350*****(1-2)**: 283-288.

[11] Pronko, P. P.; Van Rompay, P. A.; Horvath, C.; Loesel, F.; Juhasz, T.; Liu, X.; and Mourou, G. (1998). Avalanche ionization and dielectric breakdown in silicon with ultrafast laser pulses. *Physical Review B*, ***58*****(5)**: 2387.

[12] Anwar, F.; Mahbub, R.; Satter, S. S.; and Ullah, S. M. (2017). Effect of Different HTM Layers and Electrical Parameters on ZnO Nanorod-Based Lead-Free Perovskite Solar Cell for High-Efficiency Performance. *International Journal of Photoenergy*, 2017.

[13] Correa, Baena, J. P.etal. (2016). Unbroken Perovskite: Interplay of Morphology, Electro optical Properties, and Ionic Movement. *Advanced Materials*, **28(25):** 5031-5037.

[14] Tan, K., Lin, P.etal. (2016). Controllable design of solid-state perovskite solar cells by SCAPS device simulation. *Solid-State Electronics*, **126:**75-80.

[15] Iefanova, A.; Adhikari, N.; Dubey, A.; Khatiwada, D.; and Qiao, Q. (2016). Lead free CH3NH3SnI3 perovskite thin-film with p-type semiconducting nature and metal-like conductivity. *AIP Advances*, **6(8):** 085312.

[16] Dixit, H.; Punetha, D.; and Pandey, S. K. (2019). Improvement in performance of lead free inverted perovskite solar cell by optimization of solar parameters. *Optik*, **179:**969-976

[17] Saidaminov, M. I. etal. (2015). High-quality bulk hybrid perovskite single crystals within minutes by inverse temperature crystallization. *Nature communications*, **6:** 7586.

[18] Yuan, M.; Voznyy, O.; Zhitomirsky, D.; Kanjanaboos, P.; and Sargent, E. H. (2015). Synergistic doping of fullerene electron transport layer and colloidal quantum dot solids enhances solar cell performance. *Advanced Materials*, **27(5)**:917-921.

[19] Donald, A. N. (1992). Semiconductor Physics and Devices: Basic Principles. Irwin.

[20] Peijie L.; etal. (2014). Numerical Simulation of Cu2ZnSnS4 Based Solar Cells with In2S3 Buffer Layers by SCAPS-1D. *Journal of Applied Science and Engineering*, **17(4):**383-390

دراسة تأثير سمك وانعكاسية على خصائص الخلية ألشمسي(n-ZnSe/p-MASnI$_3$/p-CuSCN)باستخدام SCAPS-1D

طارق أديب محمد ، عايد نجم صالح

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

الملخص

تم دراسة تأثير طبقه الامتصاص ($MASnI_3$) ضمن مدى(200nm-900nm) مع ثبوت سمك كل من طبقه المواد الناقلة للفجوات(HTM) وطبقه المواد ألناقله للالكترونات (ETM) عند سمك (10nm) لكل منهما وبعد أكمال الدراسة وجدنا أفضل سمك لطبقه الامتصاص هي عند(400nm), علما أن خلايا ألمستخدمه في البرنامج غير مثاليه تحتوي على عيوب ,لكي تكون اقرب من الواقع العملي , وبعد أكمال هذه دراسة للخلايا ألشمسيه وفي أطار هذه الدراسة تم أضافه فلتر مرايا (95%mirro) ألمقتبسه من مكتبه البرنامج (Scap) و أن خليه ألشمسيه التي تم دراستها وهي(n-ZnSe/p-MASnI$_3$/p-CuSCN) وضمن مدى انعكاسيه(R)يترواح بين (0.11-0.99) وكان أفضل مدى انعكاسيه عند (0.99) وكانت كفاءة ألخليه(η)هي (20.89) وعامل الملئ (FF) (68.55) وتيار الدائر القصيرة (Jsc) $34.040\ mA/cm^2$ وفولتيه الدائرة المفتوحة (Voc) 0.894 V وقد تم تعيين طيف الإضاءة الافتراضي إلى المعيار AM1.5 العالمي ,