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Polymeric Solar Cells: A Mini-Review of Fabrication Techniques

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ABSTRACT

Organic solar cells was refer to photo voltaic cells and it was a kind of green energy source of great potential application due to low production costs, mechanical flexibility devices. The aim of our work was to focus on the evolution of the polymeric solar with comparing studies for the period 2007-2015.

KEYWORDS: | solar cells | polymer | Indium tin oxide |

1. INTRODUCTION

The sun is the main natural source of energy.it providing the earth with great amount of energy in spite of that we exploits a little part of it. The sun's light cannot be used directly there is many device that can exploits these type of natural energy. These devices can be consider very attractive because it will convert sun's light to many type of energy which is useful for heating water (house warming and other different application)[1], Also there is another type of these devices which convert the optical energy to electrical energy which is a part of our work. The solar cell which is the most commonly used for purpose of saving and converting energy. [2] The solar cell can be divided to many types such as silicon solar cells, dye solar cell, Polymer solar cell.[3] In another study, some researchers compared the polymeric solar cell and their electrical and optical properties. Polymer solar cell, has low cost and also very flexible.[4] In particular compared to the limited solar light absorption of fullerenes (electron acceptor)for the polymer :fullerene solar cells ,the polymer: polymer solar cells have an advantage in enhancing the light absorption efficiency because electron- accepting polymers can be tuned to absorb more sun light in visible region and that was useful for solar cell device.[5,6] Indium tin oxide (ITO) is the material-of-choice for transparent electrode in hetero junction solar cells (PSCS) it is used to generate a built-in electrical field due to the difference in the metals' work functions. This electric field is used dissociate the exactions, which are created from the absorption of the light by the active layer of the polymeric solar cell, then pull the charge carrier out of the active layer [7]. Poly (3,4-ethylenedioxythiophene): poly(styrenesulfonate)(PEDOT:PSS) have many advantages because of that advantages it widely use in polymer solar cells, (PEDOT: PSS) work function can be vary in controlling the amount of PSS [8], the layer of (PEDOT:PSS) polymer can decreasing the roughness of ITO surface, high conductivity and low-temperature solution process ability [9]. To enhance the polymer solar cells catalyzed Al2O3 and TiO2 nanoparticles and laser. Utilizing nanoparticles made clarify change in the conductivity and absorption of polymer solar cell because it represents electron transport material (inorganic material) in photo voltaic device while the conjugated polymer consider as hole transport material[10,14].

2. EVALUATION SURVEY

There are many researches in the field of enhancing polymer solar cell due their importance in saving energy.

2007-2008

Need for developing inexpensive renewable energy sources does the scientific research more efficient, low cost Photovoltaic devices. The workers focuses on many part the material,working principle sensitive parameter ,conjugated polymer / fullerene bulk heterojunction solar cell, organic hybrid solar cell. In another study the hetero junction solar cell consist of many layers (ITO.PEDOT/MDMO-PPV/PCBM/AL).the layers was coated by using spin coating method. The efficiency of the prepared heterojunction solar cell 2.5%_10%.[15].

2009-2010

An efficient solar cell should have a large absorb spectrum .the material with multiband can be good choice , with small gap and high hole mobility so P3HT:PCBM was used in order to rise the amount of the power conversion efficiency to 5%.The construction of heterojunction was (ITO/PEDOT:PSS/P3HT:PCBM/Ca/Ag)the construction was made by using spin coating method.[16]

2011.

Recent enhancement in organic solar cell,s efficiency in polymers with low band gap In Peh,s work the spray coating was used. The spray coating is high through put coating technique that is suitable for organic photovoltic_making. In organic layers to on sure of the uniform coating the surface tension, The wettability, boiling point of solvent and drying time must be optimized. The layers of the heterojunction solar cell that was fabricated (ITO/ZNO/P3HT: PCBM/PEDOT: PSS). Where all the Layers was coated by using spin coating technique except PEDOT:PSS Which was coated by using spray coating method. The highest power conversion efficiency received was 3%.[17]. Also, in 2011, some researchers studied the polyaniline(PANI) thin films with nano_islands on their surface which are electro chemically synthesized where the polyaniline thin film with nano.islande was used as buffer layer in organic solar cell based on mixing of (MDMO – PPV) and PCBM. The organic solar cell work has structure as (ITO/PANI/MDMO_PPV: PCBM/ZNO/AL). the structure of the organic solar cell was made by using spin coating method. Also Furui tan and coworkers changed the thickness of the PANI thin film and the best efficiency they reached 0.68% [18].

2012

Investigated the effect of the amount of phenyl C 61 butyric acid methyl ester (PCBM) on anthracene-containing poly (p-phenylene-ethynylene)-alt-poly(p-phenylene-vinylene)(PPE-PPV) polymer(AnE-PV stat) solar cell. For this heterojunction solar cell the efficiency was enhanced by increasing PCBM content. In another study solar cell consist of many layers (ITO/ PEDOT:PSSL AnE-PVSTAT:PCBM| ca/Al). The layers were coated by spin coating method. The highest efficiency reached was 2.13% for AnE-Pvstat [19]. Also, in 2012, some researchers the resolve of problems of polymer heterojunction solar cell was introduced. This way was explained including the effect of the donor /acceptor ratio and the annealing on the charge generation, collection and recombination kinetics: novel low band gap conductive polymer with band gap less than 1.8ev named (PCBM). In these work life time of polymer was discussed, the problem of degradation was solved and the stability was enhanced by using height amount of Tg polymer. They also discussed the processing of large area and increasing the efficiency of polymeric heterojunction solar cell. The heterojunction polymer that fabricated consist of many Layers (ITO, PEDOT: PSS/Copolymer:PCBM;Al) [20]. Some researchers a high Performance and cost effective polyaniline by adding a camphorsulfonic acid (PANI:CSA). These exhibited high conductivity of 843 s/cm and high optical transparency of 86%at 550nm and the thickness is less than 200nm ,the film prepared in spin coating methode ,the heterojunction consist of many layers (PET,ITO,PEDOT:PSS,P3HT:PCBM,Lif and Al), In another study the change in conductivity with thickness.[21]

2013

The solar cells electrode consisting of layer of aluminum doped zinc oxide and a very thin silver layer.in the solar cell that was fabricated the active layer was coated by using spin coating method the layer of the hetero junction solar cell (AZO/SILVER/AZO/PTB7:PC71BM/MOO3/SILVER) the highest amount of efficiency that Kohlstädt and coworker's reached is 6.1% we was noticed that the solar cell free from (ITO, PEDOT: PSS) [22].

2014

PEDOT:PSS is remain one of the most power full material because of its high conductivity , suitable work function and low amount of temperature process ability. Inkim,s and his coworker's work compared between Reference solar cell which consist of the following layer(ITO/PEDOT:PSS/P3HT:PCBM/AL)and other solar cells with structure(ITO/WOX/PEDOT:PSS/P3HT:PCBM/AL) in different concentration of W_PTA compared with the reference device the efficiency of the reference device 3.07 % and it decreasing (the highest value of efficiency 1.48% and the smallest value 0.0002%). In another study the solar cell was built using spin coating method.[23]. In another study nano particles was used with polymer the nano particles BHTF-CO.BT was generated through polymerization process. These layer (polymer+BHTF-CO.BT) was used in structure of solar cells which was fabricated in normal structure and inverted structure the normal structure (ITO/PEDOT:PSS/P3HT:BHTF-CO-BT/Al) and the inverted structure (ITO/ZNO/P3HT:BHTF-CO-BT/PEDOT:PSS/Al) And the (PCE) power conversion efficiency for the fabricated devices 0.1% because of VOC and FF values are very good. The layer of heterojunction was made by using spin coating technique.[24]. In another study, organic solar cell was fabricated free from PEDOT:PSS utilizing buffer and node integrated Ta-doped In2O3 (ITaO) films. The (ITO) electrode was similar in electrical nd optical propertes with (ITao) electrode films. The power conversion efficiency for heterojunction have ITao anode 3.348% and it similar to those have

(ITO) electrode the PCE 3.541%..The structure of built solar cell was (ITao/P3HT:PCBM/Ca/Ag) the method that was used to made the solar cell structure co-sputtering method.[25]. In another study organic solar cell was prepared by using P3HT and PCBM with nano polyaniline layer and there was an increasing in the efficiency (2.76%) when we compare with the solar cells lacking to these buffer layer. The fabricated layer consist of (ITO/PANI/PEDOT:PSS/P3HT:PCBM/Al) the structure of the solar cell was obtained by using spin –coating method.[26]. In another study large area device was fabricated with power conversion efficiency close to small area device .the inverted structure of tandem solar cell was built by putting PEDOT: PSS in the top of active layer as hole transport layer. The power conversion efficiency was enhanced by using alcohol treatment from 2.19٪ to 7٪ .the fabricated solar cell consist of the following layer (ITO/ZnO/P3HT: ICBA/PEDOT: PSS/ZnO/PTB2:PC71BM/MOO2/Ag) all these layers was coated by using spin coating method.[27]. Fabricated inorganic /in organic hybrid solar cell using SMPO4 Nps doped TiO2/P3HT bulk heterojunction solar cell(BHJ) the SMPO4 enhanced the power conversion efficiency from (1.98 ٪)for solar cell without SMPO4 to the power conversion efficiency (3٪) for solar cell containing SMPO4.the layers of heterojunction solar cell consist of (FTO/ SMPO4 Nps:TiO2/P3HT/PEDOT:PSS)the SMPO4 Nps:TiO2 was coated on FTO glass by using adoctor blande technique while PEDOT:PSS was coated by using spin coating technique.[28]. In another study a MoO3/Au/MoO3 structure was used and a thin film of Al2O3 was used as protective barrier between MoO3 and PEDOT:PSS in order to protect the MoO3 from the acidic. The efficiency was increasing from 2.77٪ to 2.89٪. The structure of fabricated solar cell was (MoO3/Au/MoO3/Al2O3/PEDOT:PSS/PCBM:P3HT/LiF/Al) the first three layers was coated by e-beam evaporation and Al2O3 was coated by using (ALD)atomic layer deposition and the other layers was coated with spin coated method. [29]

2015

The power conversion efficiency of polymer solar cell was reached to 8.7٪ with non.chlorinated solvent .the solar cell was made from many layer by using spin coating method. The layers was (ITO/PEIE/PTB7:PCBM/MoO3/Ag).[30]. Recently the power conversion efficiency 7.06٪ the device structure consist of their device structures were :ITO/Al/PCDTBT:PC71BM/ with or without CIL/Al and ITO/PEDOT:PSS/PCDTBT:PC71BM/ with or without CIL/MoOx/Al ,respectively .the device structure was built by using spin coating technique. [31].

3. CONCLUSION

This work represent how to guide researcher to knowing how to prepare polymeric solar cell with high efficiency according to recently studies.

4. ACKNOWLEDGEMENT

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دراسة مرجعية حول الخلايا الشمسية البوليمرية

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الملخـــــص:

الخلايا الشمسية العضوية تشير إلى خلايا فولطائية ضوئية، وهي نوع من انواع مصادر الطاقة الخضراء و وتتميز بتطبيقاتها الواسعة نظرا لانخفاض تكاليف الإنتاج، المرونة الميكانيكية. ان الهدف من عملنا هذا هو التركيز على تطور انتاج الطاقة من قبل الخلايا الشمسية البوليمرية مع مقارنة الدراسات للفترة 2007-2015

الكلمات المفتاحية: | الخلايا الشمسية | بوليمر | انديوم تن اوكساید |