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Fabrication (PANI-CSA) /n-Si) solar cell from nano conducting polymers PANI doped with CSA

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Fabrication (PANI-CSA) /n-Si) solar cell from nano conducting polymers PANI doped with CSA

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Abstract. Polyaniline (PANI) doped with CSA was synthesis by chemical polymerization method using ammonium persulphate as oxidizing agent. Thin films of (PANI-CSA) have been prepared by spin coating method and characterized by (FTIR) spectra. Morphology and diameters of the nanoconducting polymer were measured by Atomic Force Microscope (AFM). Solar were fabricated by depositing thin films of polyaniline (PANI) doped with CSA acid onto n-type Si wafers using spin coating method. The J-V characteristics of this hybrid solar cell were studied in the dark and under illumination and photovoltaic activity is clearly demonstrated. The PANI-CSA /n-Si solar cells obtained in this work have yielded a conversion efficiency $\eta = 4\%$ with short circuit current (Jsc) of 1.86 mA/cm^2 and open circuit voltage (Voc) of 202 mV under AM 1.5 solar simulator (100 mW/cm^2).

1. Introduction

Polyaniline (PANI) and its derivative are considered as the most important conducting polymers [1]. Conducting polymers have an immense advantage of being simple to synthesis, with their chemical structure tailored to alter their physical properties, such as their band gap. They exhibit an extensive range of electrical conductivity and can exhibit metallic to insulator property (10^{-9} - 10^{5})S/cm. Further to their ease of synthesis and with lower cost, they are known to have low poisoning effects[2,3].It has attracted great attention in the field of active materials for applications such as in organic light emitting diodes (OLEDs) [4], field-effect transistors(OFETs) [5] and solar cells [6-10].

In recent years, the development of thin film plastic solar cells, using polymer-fullerene, or polymer-polymer bulk heterojunctions as an absorber (and transport layer at the same time), has made significant progress. Efficiencies between 1% and 2.5% for laboratory cells under AM1.5 illumination conditions have been reported [10,11].

Tariq et al, synthesis Nanofibers of PAni.CSA/PEO by using electrospinning, then polyaniline heterojunction Solar Cell, were fabricated by deposition of PAni.CSA/PEO nano fibers on TiO2 n-type layer [8]. Kareema et al., fabricated PANIi/n-Si solar cell, conversion efficiency in the range of 0.3% [9].

In the present work, (PANI) doped with CSA was prepared by chemical polymerization. The functional group and the morphology of preparation material were examined by FTIR spectra and Atomic force microscope AFM respectively. The current density-voltage (J-V) characteristics have been measured for solar cell devices, prepared from the organic polymer PANI doped with CSA acid deposited onto n-type silicon substrates. These studied were used to determine solar cell parameters such as short circuit current density (J_{sc}), open circuit voltage (V_{oc}), and solar cell efficiency(η).

2. Experimental

2.1. Material

Aniline provided by (fluka), Ammonium persulphate $(NH_4)_2\ S_2\ O_8$ provided by (Aldrich), Silicon wafers n-type (100) with resistivity of (2-8 Ω cm).from University of Sheffield Halam ,Uk , Hydrochloric acid provided by (fluka), Chloroform ($CHCl_3$) provided by (BDH td. CO). Aceton $(CH_3)_2$ CO provided by (GCCL td. CO).

2.2 The PANI-CSA Preparation

Polyaniline emeraldine base EB was synthesized by the chemical polymerization of aniline in acidic media using $(NH_4)_2S_2O_8$ APS as oxidizing agent,. Using a method similar to the reported by [8,9]. 100 mg of PANI emeraldine base was dissolved in 10 ml CHC13 and mixture with 80mg of camphor sulfonic acid (CSA), provided by (Fluka) .each ratio of mixture put under stirring for 8-9 hours. The resulting green solution of PANI-CSA. Spin coating method was used to prepared the thin films of (PANI-CSA) on n- type silicon wafer substrates.

2.3 .Preparation of Au/PANI-CSA /n-Si/Al solar cell

The thin films of (PANI-CSA)) was synthesized by using spin coating method .The polymer was dissolved in chloroform and deposited on n-Si wafers using spin coating method. Then gold (Au) contacts was thermally evaporated onto the polymer film, with the thickness of about 20 nm evaporated through a suitable mask which provides device area of about 3x10-2 cm2 . Similar procedure was followed for the deposition Aluminum (Al) contact also was thermally evaporated with a thickness 92 nm onto a back (unpolished side) of the Si substrate. Solar cell device shows in figure 1.

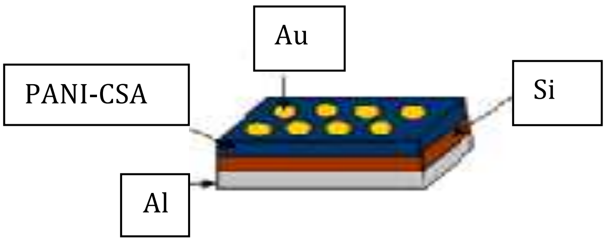

Figure 1. Hetrojunction AU/ (PANI-CSA) / n-Si/ AI solar cell fabrication

3. Results and Discussion

3.1. The Morphology of material

The morphology, nanofibers diameters and alignment of the PANI-CSA was examined using AFM. AFM image of PANI-CSA shows in Figure 2. The image size of PANI-CSA is (1537.03 nm X 1537.03nm) and the roughness about 0.53nm,that was nearly smooth. The histograms of the diameters distributions of of PAni-CSA are displayed in Figs 3.The figure shows the diameters distributions were founded close to the Gaussian distribution. The average diameters of PANI-CSA about 90.7 nm.. It can be also seen from these image that there is nanoconducting polymer, and which is free from defects such as beads . This result argument with [8,12].

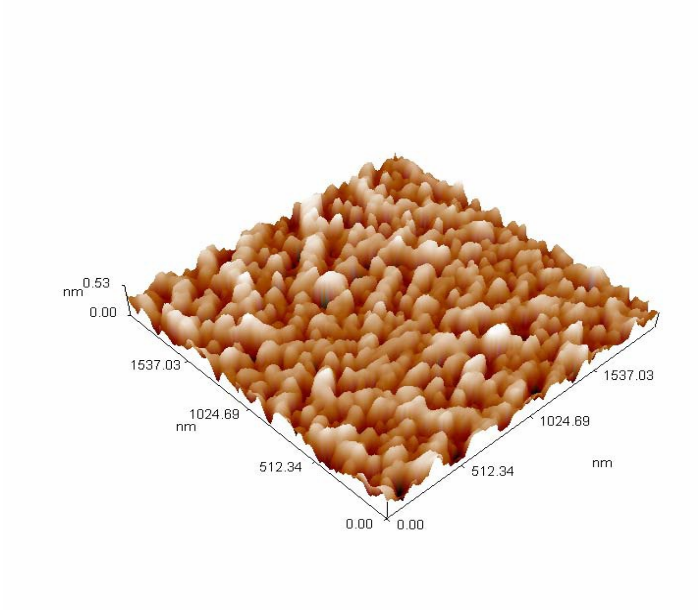

Figure. 2. AFM of PANI-CSA

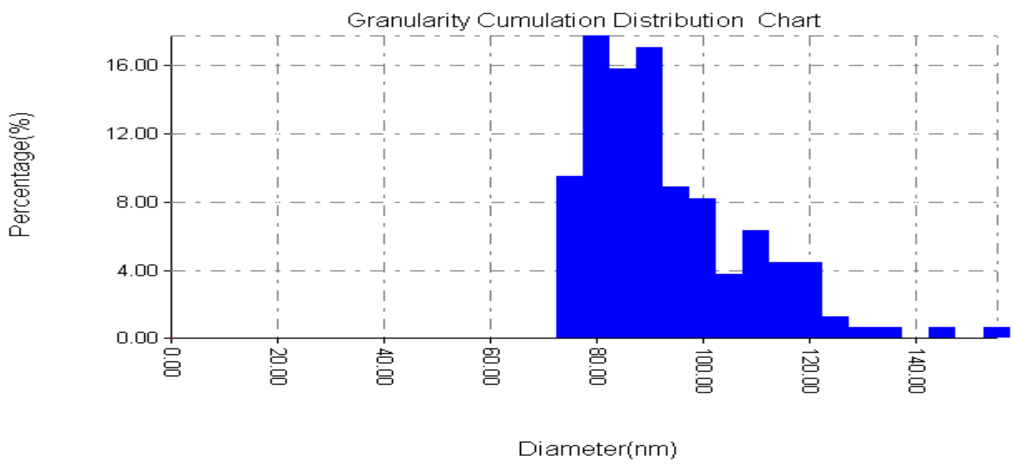

Figure 3. Size distribution of diameters in PANI-CSA

3.2. FTIR Spectroscopy of materials

The functional groups of undoped and doped polyaniline were characterised by FTIR spectroscopy. Fig. 4 shows FTIR spectra of the undoped PANI(EB). characteristic peaks of this material at 3217 cm-1 and 3439 cm-1 shoulder N-H stretching [12,13], The band at 1568,1504 cm-1 may be attributed to C=C and C=N stretching modes of vibration for the quinoid (–N =Q= N– where Q =quinoid ring) and benzoid units [14], while band at 1309 cm-1and 1118 cm-1 may be attributed to the C–N stretching of mode of benzoid unit [15]. The band at 815 cm-1 represents the C–C stretching for benzoid unit of polyaniline, [13,15]. Finlay the band at 698 cm-1 refers to out of plane C–H vibration [14,15]. The effect of CSA doped on PANI structure confirmed by FTIR spectra Figure. 5, which show the appearance of peaks at typical carbonyl group wavenumbers, the C=C stretching vibration of benzoid and quinoid units became stronger at 1514 and 1760 cm-1 [16]. Moreover, careful analyses of FTIR spectra show evidence of additional processes: doping (decrease of the intensity of N-H and C-N stretching band at 3441 and 1290 cm-1). Two new peaks appear at 1045 and 1645 cm-1 refer to SO-3 and C=O respectively [17].

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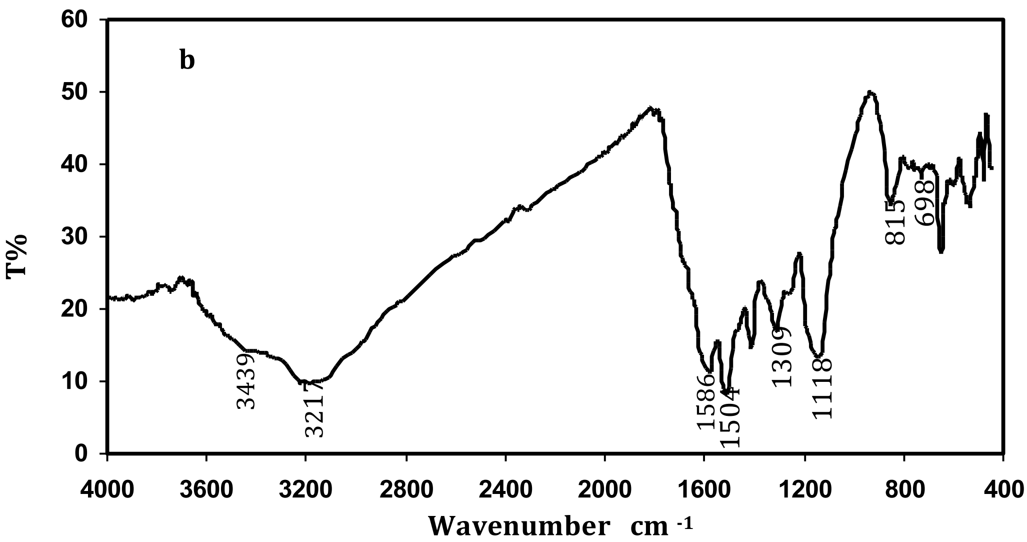

Figure 4 . The FTIR spectra of PANI .

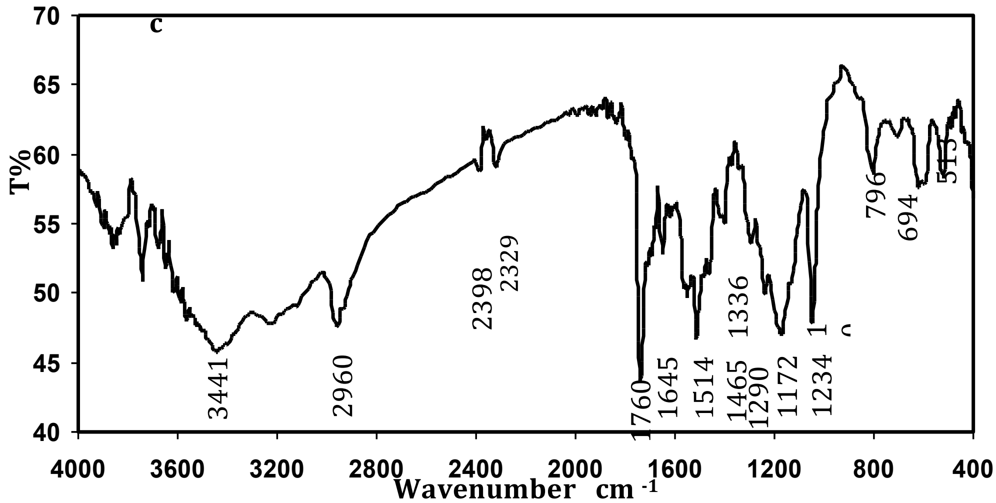

Figure 5. The FTIR spectra of PANI-CSA.

3.3 PANI-CSA/Si solar cell

Figure (6) shows the J-V characteristics of the fabricated PANI/n-Si solar cell structuresmeasured both in dark and under illumination. The polymer film thickness for this particular result is 35nm as determined by spectroscopic ellipsometry measurements. . The rectifying junction is found at the interface between the silicon substrate and the polymer film. The parameter of Solar cells, i.e., short circuit current density (J_{sc}), open-circuit voltage (V_{oc}), and fill factor (FF) have been determined. The solar conversion efficiency η is given by the formula [1]:

$$F.F = \frac{P_{\max}}{V_{oc}.I_{sc}} = \frac{V_{\max}.I_{\max}}{V_{oc}.I_{sc}} \qquad \text{---------(1)}$$

where P_{max} is the maximum electrical power obtained and a Vmax Imax maximum voltage and cureent , respectively .The efficiency of a solar cell η is determined as the fraction of incident power which is converted to electricity and is defined as[18]:

$$\eta = \frac{V_{oc}.I_{sc}.FF}{P_{in}} \qquad \text{-------(2)}$$

Where P_{in} is the power of the incident light

The result of solar cell show V_{oc} =202 mV, J_{sc} =1.863 mA/cm^2, and FF=0.315. The solar conversion efficiency of 4% has been obtained, which is greater than that obtund from PANI-HCl /n-Si which was found to give efficiency 0.3[9].and POT/n-Si which has efficiency 0.88[19].The series resistance Rs and shunt resistance Rsh can be obtaind from the slope in the first and third quadrant. At first quadrant the curve theses 98 Ω and at the third quadrant 2802 Ω. High values for RS may produce from electrode contact resistance and high Rsh is associated to morphology of the film [8]

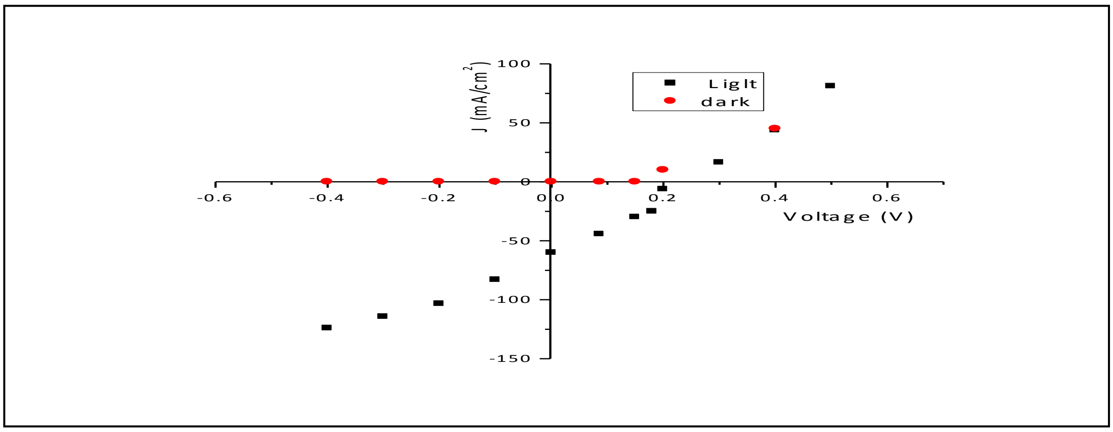

Figure 6. Current density as function of voltage for Au/(PANI-CSA)Ln-Si/Al solar cell The white light illuminator intensity was (100mW/cm2).

Table 1. The parameters of solar cell Au /(PANI.CSA) / n-Si/ Al.

ANI-CSA/n-Si	V_{oc} (mV)	J_{sc} (mA/cm^2)	V_{max} (mV)	J_{max} (mA)	P_{max} (mW/cm^2	R_s ohm	R_{sh} ohm	F.F	η%
	202	1.86	98	1.215	119.07	91	2802	0.315	4%

4. Conclusion

Doped polyaniline PANI-CSA have been prepared successfully by chemical method using ammonium persulphate as oxidizing agent. From Al/PANI-CSA/Si/Au solar cell Characteristics find the open circuit voltage V_{oc} is about 202mV and t short circuit current about (1.863 mA/cm). The fill factor (f.f) obtained is about (0.3152 and yielded a conversion efficiency is about 4%.

5. Acknowledgements

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