SHUNT RESISTANCE IN ORGANIC BULK-HETEROJUNCTION SOLAR CELL

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ABSTRACT

Shunt resistance is one of the key parameters affecting the performance of organic photovoltaic solar cells. Ideally it should be infinite. It is primarily due to defects that provide a forward leakage path of minority carriers. Grain boundaries are also responsible for the same in particularly polycrystalline solar cells. Several electronic mechanisms arising from different structures within the solar cell can contribute to decreasing it. It indirectly reflects the leakage properties of semiconductor – polymer solar cell structure. i.e. it gives an idea about the losses of charge carriers during the charge transport mechanism across the semiconductor-polymer interface. It implies that the loss mechanisms like the absorption of charge carriers exists at the interface, which leads to a poor charge transport across the interface. The efforts have been made to characterized polymer/semiconductor solar cells. Therefore it was observed that MoSe2/polypyrrole solar cell having photovoltaic behavior. Usually Rsh (shunt resistance) is estimated from the current–voltage (I→V) curves at V=0 using slope method. It has been observed that shunt resistances at different intensities to be ranging from 25 kΩ to 50 kΩ, which not good as expected. This might be one of the reasons for lower conversion efficiency of MoSe2 based polymer solar cell.

Keyword: - **MoSe2, Polypyrrole**

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1. INTRODUCTION

Now today is the time to use maximum solar energy because of extinction of energy resources, and fast growing of technology. So in this era solar energy is the life line. One of today's most promising tools to make use of solar energy is its direct conversion into electrical energy in photovoltaic cells.[1]

$MoSe_2$ material is chosen because it belongs to layered structure, which can be easily cleaved to obtain samples with thickness of few microns. It possesses band gap of around 1.4 eV, which matches with the maxima of solar radiations. It involves d→d transitions for photo generation of carriers by photo irradiation, which do not disrupt the normal covalent bonding in the polymer solar cells based on $MoSe_2$ have been found to possess high stability.

$MoSe_2$ possess interesting optical and photo-absorption properties [2-4].These semiconducting materials belong to TMDCs group and are found to possess layered structure. Several studies, mainly on the optical properties have been carries out in the past few years [5-11].

The grown crystal of **$MoSe_2$** is investigated by UV-VIS-NIR spectroscopy technique. These investigate have been used to study direct and indirect energy gaps, the dielectric constant, extinction co-efficient etc. The value of direct and indirect band gap of $MoSe_2$ is 1.402 eV and 1.256 eV respectively.[12,13]

polypyrrole (PPy) especially promising for commercial applications because of its good environmental stability, facile synthesis and higher conductivity than many other conducting polymers. PPy coatings have an excellent thermal stability and are good candidate for use in carbon composites **[14].**By UV-Visible study, absorption peak of PPy exhibits at 446 nm(2.77eV)[15].

2 EXPERIMENTAL SET-UP

For the fabrication of MoSe2 /ppy solar cell, the back contact of $MoSe_2$ crystal has been taken, than on front side of it the polypyrrole pest is deposited. All this process is done by spin coating technique. The speed of it is 100 rpm per min at room temperature. After that let it to dry and then contacts on it were taken.

Using a standard experimental setup, the $MoSe_2$/ppy solar cells have been illuminated by an incandescent lamp for different intensities. The intensity of incident illumination was measured using solar meter. The photo voltage obtained from the cell under different illuminated intensities has been measured using a digital multi meter (RISH multi ,18S) with an accuracy of 0.1 mV and the photocurrent was measured using a digital multi meter (Protek ,506) with an accuracy of 0.1 μA. To vary the power point on the photo voltage (V_{ph})→ photocurrent(I_{ph}) characteristics, a series of variable resistances of different values has been used.

3 RESULTS AND DISCUSSION

Photo conversion characteristics under illuminated conditions of $MoSe_2$/ppy hetero structure was investigated. In Fig.1, the I_{Ph} → V_{Ph} characteristics of this structure have been shown. Fig.1 represents the photo conversion characteristic at different polychromatic intensities of incident illuminations. From Fig.1, it can be seen that the photo generation of carriers in MoSe2 and their subsequent transport across the $MoSe_2$ / polypyrrole interface increases with increase in intensities (I_L) [16]. This clearly reveals the fact that $MoSe_2$ / polypyrrole interface does exhibit the characteristics of solar cells. Here, the results of only one MoSe2 / polypyrrole structure (used as solar cell) have been discussed.

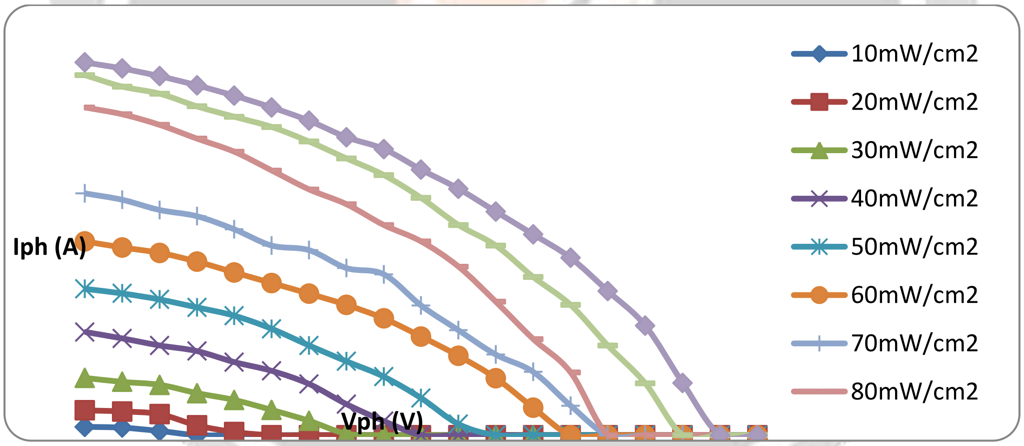

Fig.1 Iph →Vph characteristics of $MoSe_2$ / ppy solar cell at different polychromatic intensities of incident illuminations

Coutts in 1978 **[17]** has discussed various reasons leading to the occurrence of shunt resistances. Shunt resistance is primarily due to defects that provide a forward leakage path to minority carriers. Grain boundaries are also responsible for this, particularly in polycrystalline solar cells.

4 EVALUATION OF THE SHUNT RESISTANCE BY SLOPE METHOD

The shunt resistance can be evaluated by the slopes of the I-V curves at I=0 and V=0, using the equations,

$$R_{sh} = -\left(\frac{dv}{dI}\right)_{V=0}$$

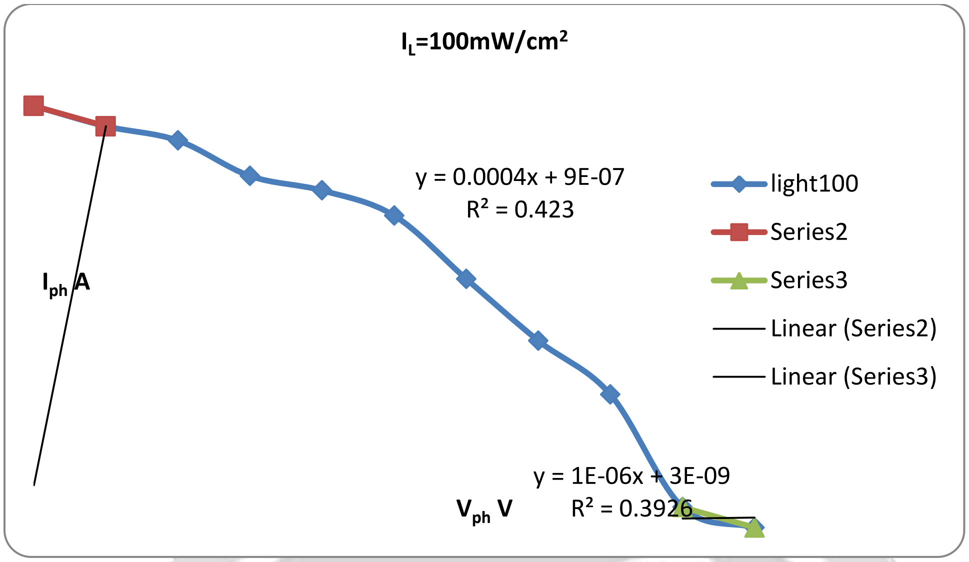

Fig -2 $V_{ph} \rightarrow I_{ph}$ characteristics of $MoSe_2$ /PPy based solar cell at I_L = 100mW/cm^2

From these I –V curves, using the slope method, the shunt resistance have been investigated .The results of shunt resistance have been given in table 4.1 to 4.3. It has been observed the shunt resistance of the solar cells at different intensities lie in a range from 0.1 kΩ to 4 kΩ .The shunt resistances with the same intensities have been found to be ranging from 0.4 kΩ to 3.73 kΩ which match with the reports seen with literature **[18-20].**

Table: 1 Shunt Resistances for 3 solar cells.

I_L mW/cm^2	R_{sh} (Ω)	R_{sh} (Ω)	R_{sh} (Ω)
10	3.33E+04	2.50E+06	5.00E+05
20	3.33E+04	1.67E+05	3.11E+05
30	5.00E+04	1.00E+05	1.00E+05
40	2.00E+04	1.00E+05	5.00E+04
50	1.67E+04	5.00E+04	1.00E+05
60	1.25E+04	1.00E+05	1.00E+05
70	1.25E+04	3.33E+04	5.00E+04
80	2.00E+04	5.00E+04	5.00E+04
90	2.50E+04	3.33E+04	3.33E+04
100	1.00E+04	5.00E+04	1.00E+05

5 CONCLUSIONS

In present investigations the efforts have been made to check the photosensitivity and photovoltaic behavior of MoSe2/ppy interface. From the above results, it found that the parameters of solar cells evaluated in present case shows poor photovoltaic behavior, but, efforts are in progress to enhance by improving the

(i) Characteristics of semiconducting $MoSe_2$
(ii) Doping of polypyrrole and
(iii) The characteristics of the interface between $MoSe_2$ and ppy.

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