MATERIALS BEHAVIOUR BASED SOLAR CELL PERFORMANCE ANALYSIS

BY

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This Report Presented in Sectional Gratification of the Requirements of the Degree of Master of science in Electronics and Telecommunication Engineering

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APPROVAL

This research titled **"MATERIALS BEHAVIOUR BASED SOLAR CELL PERFORMANCE ANALYSIS** submitted By Md. Shamim Osman to the Department of Electronics and Telecommunication Engineering (ETE), Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the Master degree in Electronics and Telecommunication Engineering and approved as to its style and contents. The presentation was held on August 2021.

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I hereby declare that this research is my own work and effort under the supervision of **Prof. Dr. A.K.M. Fazlul Haque, Professor and Associate Dean, Faculty of Engineering,** Daffodil International University, Dhaka. It has not been submitted anywhere for any award. Where other sources of information have been used, they have been acknowledged.

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First of all, while attempting to do the job, we would like to express our gratitude to the Almighty for showing us the most effective way.

The true spirit of achieving a goal is through means of competence and realistic discipline. I would not have been able to complete my task without the encouragement, inspiration and advice provided to me by various personalities. Except for support and guidance of Professor **Dr. A.K.M Fazlul Haque**, **Associate Dean and Professor**, **Engineering Faculty**, **Daffodil International University,** Dhaka, under whose supervision i chose this subject and developed the design, this research would not have been achievable. My Network Supervisor's deep expertise and quality interest inspired me to stay out of this venture.

I would wish to specific my heartiest feeling to professor Dr.A.K.M Fazlul Haque, Associate Dean and professor, faculty of Engineering, respect his decision, make it easier for the staff of the ETE Department of Daffodil International University to finish my dissertation and, in addition, for alternative faculty members.

SHAMIM OSMAN

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ABSTRACT

In this research solar cell efficiency has been increased by swapping several type of cell materials with different thickness and materials behaviour has been observed by analyzing consumption of photon by the semiconducting materials. It is possible to increase the efficiency of solar cell by changing materials or layer structure, every material consists of individual characteristics, as a result materials attributes has been analyzed in many ways. In this thesis, all the cell structures consists of seven layer, the material has been changed by layer and thickness, same material used for several example by changing position of the material or thickness and every material characteristic have been showed by graphical illustration. And finally, discussed about a material or a structure model by analysis in several aspects. Setfos software has been used to simulate this task, setfos is very effective software for solar cell and LED analysis and simulation, for his some special attributes like individual layer structured is possible by using setfos with separate parameter for every layer which was very helpful to analysis deeply. In this case, it has been studied about the solar cell structure to analysis efficiency by changing cell materials, tried to observed the material behaviour with individual graphical illustration. Here many types of material behaviour has been showed namely, electrical profile, optical profile and spectral profile. For all the example here simulating software parameters like, humo value, lumo value, incoherent, isotopic, transparent, wavelength, voltage, temperature, polarity, tapping, doping, mobile ions, electrons density, hole density etc never changed, all the values are retains default only cell materials related parameters has been changed to analysis material behaviour which is mention below table with every example.

Keywords: Materials, Thickness, Absorption And position of materials.

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CHAPTER 1

Introduction

1.1 General Overview

Solar energy is the most abundant permanent energy resource on Earth. And it is available for use from solar radiation form, indirect form, wind, hydro, ocean etc. The sun emits energy 380×10^{21} kW every second, only a tiny fraction approximately 180×10^{12} kW intercepted by the earth or 343 W/m^2 which is located about 150 million kilometers from the sun. About 60 percent reaches surface of the earth the rest is reflected back into space and absorbed by the atmosphere. In a single hour, the amount of power from the sun that strikes the Earth is more than the entire world consumes in an year. Each hour, 430 quintillion Jules of energy from the sun hits the earth. Total amount of energy that all humans use in a year is 410 quintillion Jules.

Perovskite solar cells are attracting increasing attention since the initial reports on ≈10% efficiency solid-state cells victimization methylammonium lead halide because the active material.[1] Since then, nice progress has been created in up the efficiency (currently exceeding 20%) by optimizing each material and device design and under- standing the underlying mechanisms of these devices. Compared to the work on up the efficiency, significantly less has been done on understanding the degradation and up the soundness of the devices, even if long run stability is crucial for sensible applications.[2] A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. Solar cells are described as being photovoltaic, irrespective of whether the source is sunlight or an artificial light. Solar array works by permitting photons, or particles of light, to knock electrons free from atoms, generating a flow of electricity. solar panels truly comprise several, smaller units known as electrical phenomenon cells. Photovoltaic merely means that they convert sunlight into electricity.

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Significantly better stability is often obtained for cells keep beneath dark conditions than cells exposed to illumination. But, the stability studies of perovskite films or devices normally include periodic measurements with storage in close while not continuous illumination[3] The degradation in vacuum was attributed to the creation of volatile molecular defects, and it had been planned that such degradation could be reduced by growing compact films with high crystal quality. [4] Solar cells or electrical phenomenon cells are made based on the principle of the photovoltaic effect. They convert light into electrical energy (DC) electricity. Light-weight hanging the crystals induces the "photovoltaic result" that generates electricity. Current flows through the material to cancel the potential and this electricity is captured. The chemical bonds of the material are important for this method, and silicon is employed in 2 layers, one layer being doped with chemical element, the opposite phosphorus. These layers have totally different chemical electrical charges and afterward each drive and direct this of electrons. Additionally to UV illumination, perovskite films and devices area unit terribly sensitive to the exposure to humidness.[5] Consequently, it absolutely was claimed that the presence of a tiny low quantity of unreacted lead halide is beneficial for the perovskite solar cell performance and even essential for achieving high efficiency devices[6,7,8]

Lot of research paper has been developed on solar cell to increase the efficiency in many aspects by several way. One of the most effective way is by changing materials, for instance quantum dot is newly invented atoms which is also called artificial atoms. Which is tried to use in solar cell to increase the efficiency. Many research paper has been developed in this affair and dramatic result has been found. In this research materials characteristics has been discussed in many ways, basically our focus was on light absorption capabilities for several materials as a semiconductor or electrode.

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1.2 Research goal

It is known that global warming is increasing day by day, it has many reason but one of the reason for global warming is production of electrical energy. Solar cell electricity is an environment friendly method to producing electrical energy, as a result the world is now moving toward this approach. Many research have been developed on solar cell to increase the efficiency and other aspects also. Several type of methods are used in many research paper, in this research solar cell efficiency has been increased by analyzing materials characteristics. Which materials can provide us better absorption, light or photons absorption capabilities of a material can express efficiency. The photon absorption capabilities has been analyzed for several material in few examples by various type of characteristic curve and looking for a significant result by organize the materials.

1.3 Organization of this research work:

In this research five example has been explained and compared with each other, where most of the parameters are unchanged except material. In chapter 2 Sio2 used as a electrode, perovskite as a semiconductor and PEDOT as a second electrode. For this materials output has been mentioned by several figure. Similarly, in chapter 3 Sio2 and perovskite multiple semiconductor layer has been used and output has been compared with previous example to analysis the effect of multiple semiconductor layer. Moreover, in chapter 4 also multiple semiconductor layer has been used but in this case Ag for first semiconducting layer, similarly other example has been explained and every example compared with previous one. Finally recommended few materials or model within this all example by analyzing all the materials absorption and current flows.

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CHAPTER 2

Methodology and Material for Perovskite

2.1 Materials parameters:

In this first case, Following solar cell consists of seven layers, and all the materials are mentioned below with required parameters which is thickness and how is used. In this structure perovskite used as a semiconducting device and silicon is first electrode as well as PEDOT is second electrode with first layer is incoherent air and GaAs, TiO2 respectively for thickness 100nm and 80 nm. Moreover seven number layer is ITO for 250nm thickness.

Table No: 2.1 Materials Parameters

Number of layer	Name of layer	Thickness nm	Used as a
1	Air	0	Incoherent
2	GaAs	100	
3	TiO2	80	
4	Silicon	120	Electrode
5	Perovskite	350	semiconductor
6	PEDOT:PSS	250	Electrode
7	ITO	250	

2.2 Materials Familiarization:

Many types of materials has been used to construct the solar structure, specially semiconducting layer and electrode layer is more significant compared with other layer. So most of the case following layer's materials has been changed to analysis the materials characteristic. Other materials has also good impact to calculate absorption of semiconducting layer.

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2.2.1 GaAs:

atomic number 31 compound (GaAs) could be a III-V direct band gap semiconductor with a mineral crystal structure. GaAs is commonly used as a substrate material for the epitaxial growth of different III-V semiconductors, including indium gallium arsenide, aluminum gallium arsenide and others.

GaAs have a right away band gap in contrast to several different semiconductors implying it will emit lightweight with high potency. Being a right away band gap material, it's immune to radiation injury sanctioning its use in optical windows and area natural philosophy in high power applications. GaAs diodes area unit accustomed find X-rays.

2.2.2 TiO2:

Titanium oxide, additionally called titania or titanium(IV) compound, could be a present compound of atomic number 22 with the statement TiO2. the foremost common technique of manufacturing is combination mineral with oil of vitriol that reacts to get rid of the iron oxide cluster within the mineral.

2.2.3 Silicon:

Silicon could be a matter with the symbol Si and number 14. it's a tough, brittle crystalline solid with a blue-gray bimetallic lustre, and could be a power nonmetallic and semiconductor. it's a member of cluster fourteen within the periodic table: carbon is higher than it; and semiconducting material, tin, lead and flerovium,are below it.

2.2.4 Perovskite:

A perovskite could be a material that has a similar crystal structure because the mineral metal titanic oxide, the first-discovered perovskite crystal. ... exploitation this integrative flexibility, scientists will style perovskite crystals to own a good sort of physical, optical, and electrical characteristics.

Perovskite mineral has the capability to soak up lightweight and it utilizes but but of fabric to seizure the similar amount of sunlight compared to different solar cells. Perovskite could be a semiconductor, that is employed to move the electrical charge whenever the

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sunlight hits the material

2.2.5 PEDOT:

Poly phenylethylene salt (PEDOT:PSS) could be a chemical compound mixture of 2 ionomers. One element during this mixture is created from metal phenylethylene salt that could be a sulfonated phenylethylene. a part of the sulfonyl teams area unit deprotonated and carry a charge. the opposite element (PEDOT) could be a conjugated chemical compound and carries positive charges and relies on polythiophene. along the charged macromolecules kind a molecule salt.

2.2.6 ITO:

Indium tin oxide (ITO) is one in every of the foremost wide used clear conducting oxides (TCO) as a result of its 2 main properties: its electrical conduction and optical transparency. it's additionally a comparatively cheap material and is straightforward to be deposited as a skinny film on glass, PET, and different substrates.

2.3 Characteristics analysis:

Materials characteristics has been observed by three part namely, Electrical profile, optical profile and spectral profile. Three types of different profile showed various type of characteristics by four figure for each profile even every individual figure shows a specific attribute for a single profile.

2.3.1 Electrical Profile:

For a single data which is used as a sample, three types of profile has been showed for every sample data. Electrical profile one of them, by analysis electrical profile found four graphs like, band diagram, current, electric field and potential. Where all the graphs shows only for semiconducting material perovskite property by energy level axis to 350 nm thickness.

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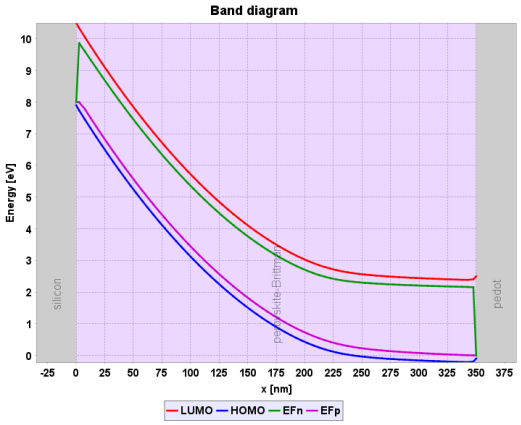

Figure:2.2 Band Diagram

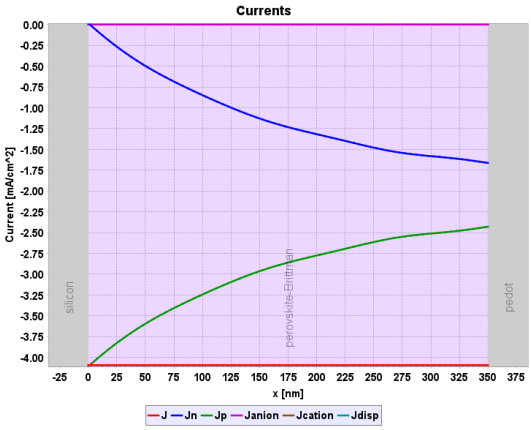

Figure: 2.3 Currents

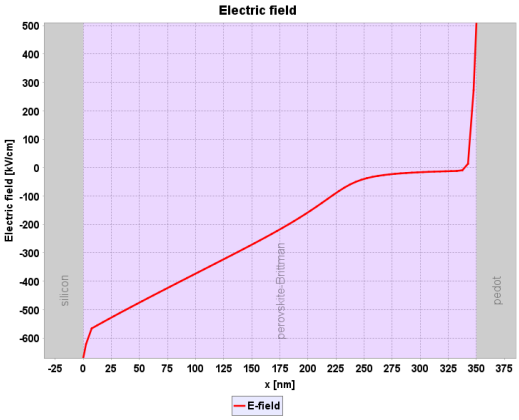

Figure:2.4 Electric Field

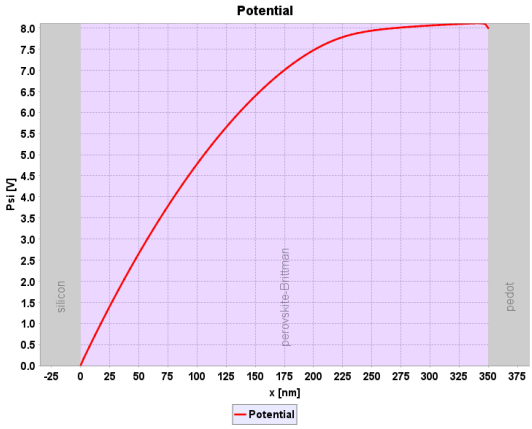

Figure:2.5 Potential

Above mentioned figures shows electrical profile of the manufactured solar cell which is band diagram, currents, electric field and potential. Band diagram shows 0 to 10 eV within semiconducting rang 350nm while higher energy found in first 175nm. Other three figure shows currents, electrical field and potential. Electrical filed shows less than zero kilo volt till 327 nm after that it's increased rapidly to 500 KV. Moreover, potential shows Psi (v) per 25 nm where first 250 nm was enough to rich higher potential using perovskite.

2.3.2 Optical profile:

Optical profile specifically for light absorption or photons by every individual layer.

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Absorption is most important for electrode and semiconducting layer only. From this profile found that first electrode silicon is consumed more photons than other materials where perovskite used as a semiconducting device and pedot as a second electrode.

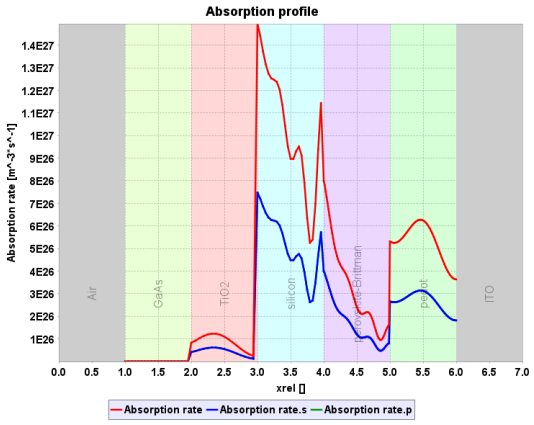

Figure: 2.6 Absorption Profile

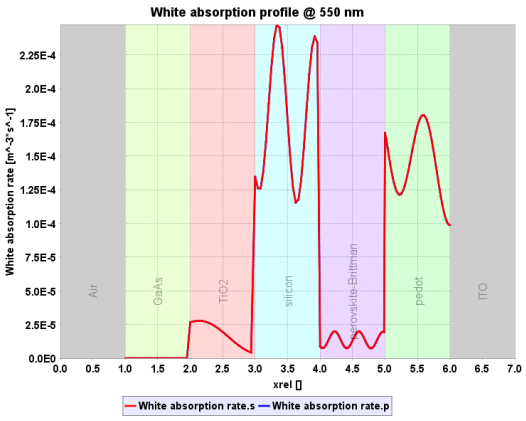

Figure: 2.7 white Absorption Profile

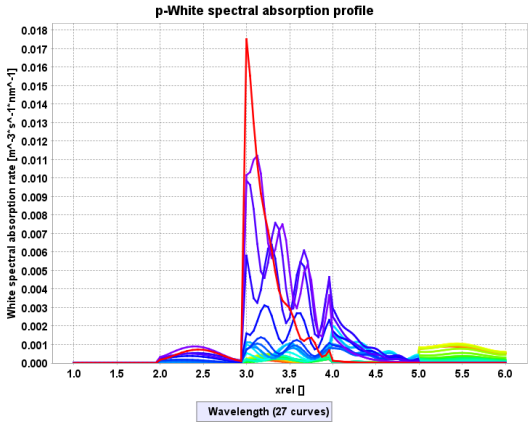

Figure:2.8 P-white Spectral Absorption Profile

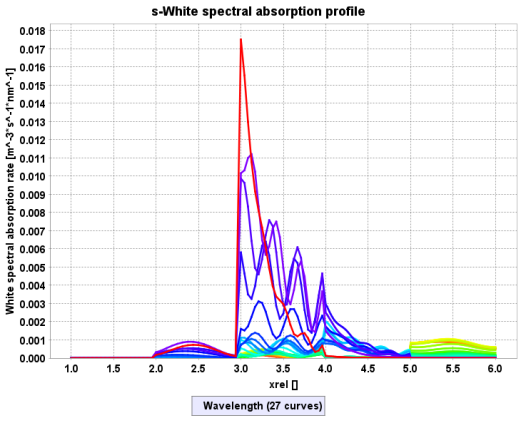

Figure: 2.9 S-white Spectral Absorption Profile

Furthermore, here above illustrated figures shows optical profile of the solar cell, by this figure found that by calculating rate of absorption which also express material absorption capabilities while using as a semiconducting material into solar cell, in this case silicon shows most absorption 1.4E27 while using as a electrode and perovskite shows slightly less absorption compared with silicon 1.1E27

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2.3.3 Spectral profile:

Spectral profile is dedicated to illustrate the absorptance phenomena by wavelength for every layer also. Silicon is higher positioned for first 75 nm for absorptance after that goes down than perovskite for next 100 nm wavelength. Another two graphs also shows about light reflectance and stacked contribution.

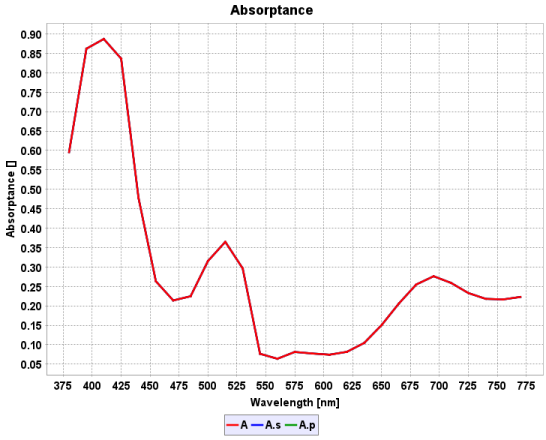

Figure: 2.10 Absorptance

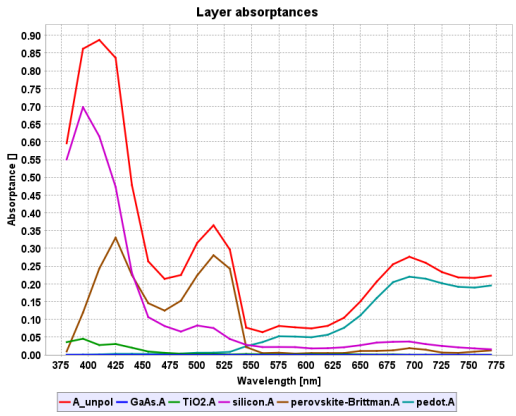

Figure: 2.11 Layer Absorptance

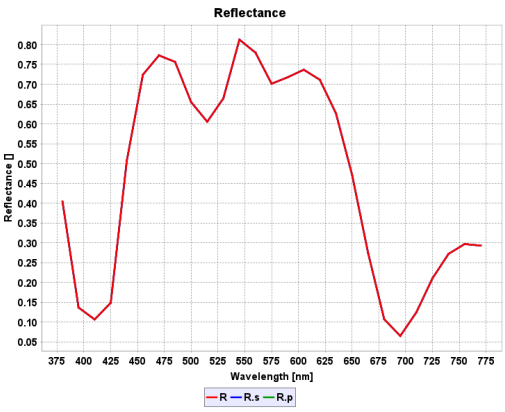

Figure: 2.12 Reflectance

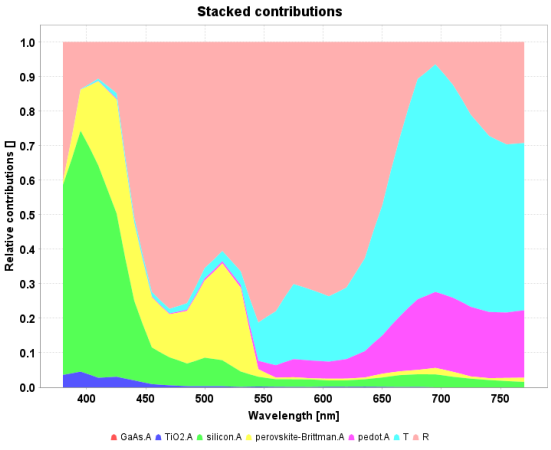

Figure:2.13 stacked Contribution

Spectral profile shows absorptance by individual layer with stacked contribution from where found that most higher absorptance shows for silicon and perovskite 0.7 by 395 nm wavelength respectively 0.34 by 425 nm wavelength.

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CHAPTER 3

Methodology for Sio2

3.1 Materials parameters:

In this case, all the materials are retains same compared with previous one, but it has a big change in material used as semiconductor or electrode. Previous case silicon 120 nm used as a electrode and a single layer semiconductor is used which was perovskite but for example Tio2 80nm is used as a electrode and multiple layer are used as a semiconductor which is sio2 nm and perovskite 350nm to observed the effect of multiple semiconducting layer. Now time to calculate the convenience of multiple semiconducting layer with sio2 and perovskite.

Table No: 3.1 Materials Parameters

Number of layer	Name of layer	Thickness nm	Used as a
1	Air	0	Incoherent
2	GaAs	100	
3	TiO2	80	Electrode
4	SiO2	120	Semiconductor
5	Perovskite	350	semiconductor
6	PEDOT:PSS	250	Electrode
7	ITO	250	

3.2 Characteristics analysis:

Materials characteristics has been analyzed by four different profile which can shows us four different properties by various graphs. Here, observation carried out for using multiple semiconducting layer. What kind of changes comes from previous one where sio2 was not exists into the structure. Other material properties also quite important which is used as a electrode.

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3.2.1 Electrical profile:

Few dramatic changes found in four graphs, by using multiple semiconducting layer. In band diagram while sio2 used as a first semiconducting material then perovskite is less effective which is shown in band diagram. Higher energy shown in sio2 layer than perovskite. Moreover, in currents figure shows no effectiveness in sio2 layer while some changes is visible in perovskite layer. In addition, other two figures shows most electric field and potential in perovskite layer.

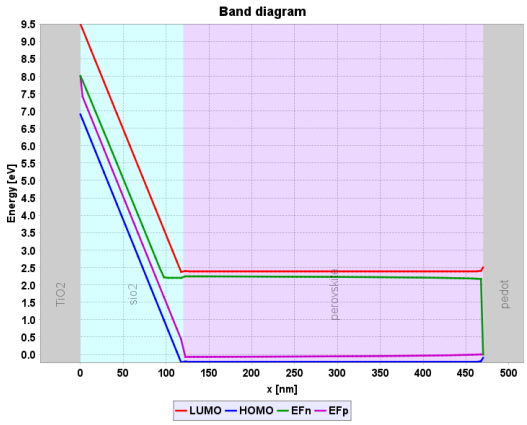

Figure: 3.2 Band Diagram

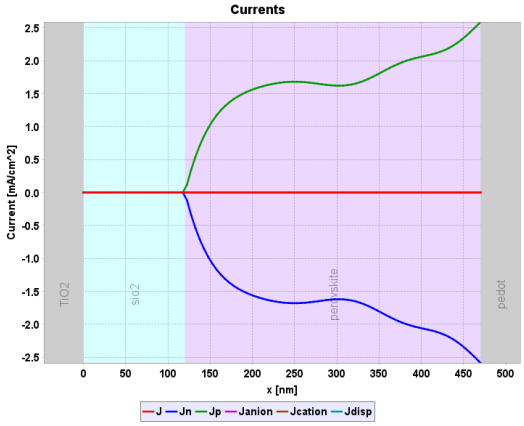

Figure: 3.3 Currents

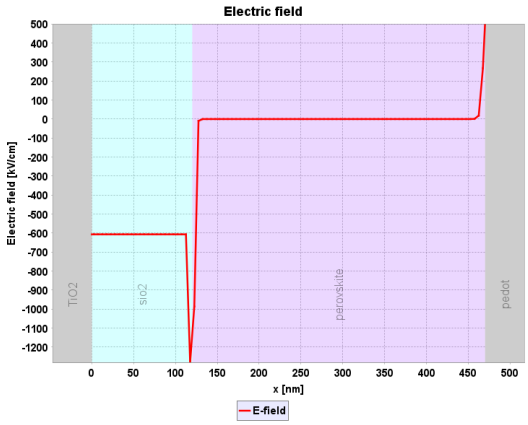

Figure: 3.4 Electric Field

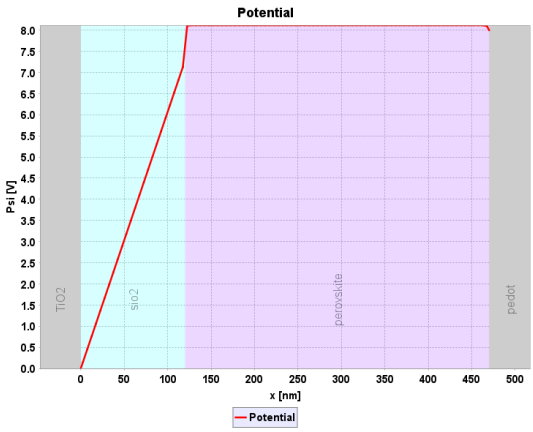

Figure:3.5 Potential

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3.2.2 Optical Profile:

From this below illustrated figure some optical characteristics are clear. Here sio2 and perovskite both are used as a semiconducting material respectively but perovskite absorptions are too high in their half of the layer thickness while sio2 closed to nil absorption throughout the layer thickness.

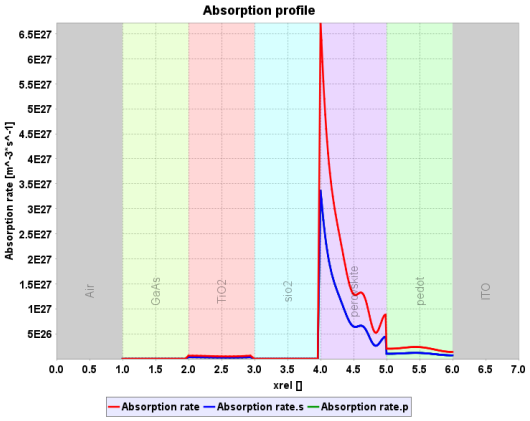

Figure: 3.6 Absorption Profile

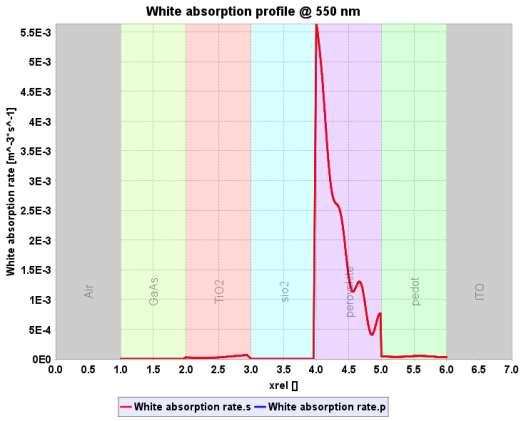

Figure:3.7 White Absorption Profile

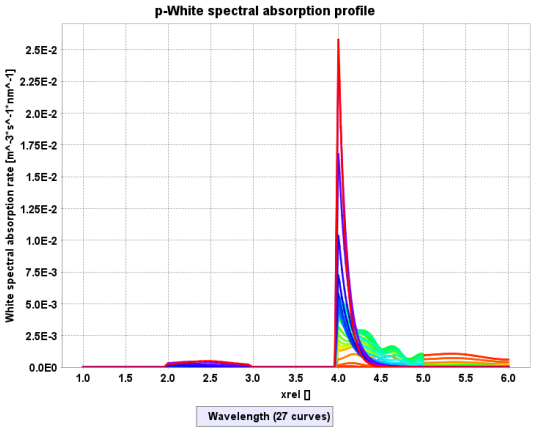

Figure: 3.8 P-white Spectral Absorption Profile

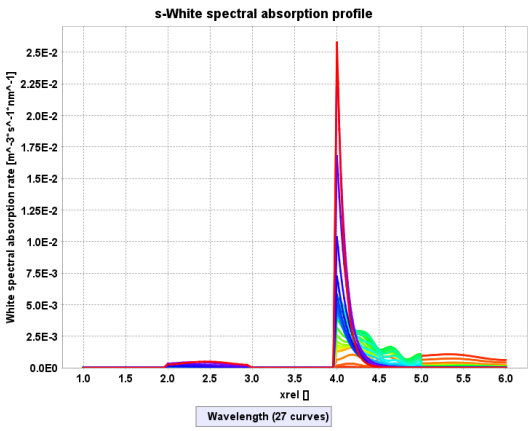

Figure: 3.9 S-white Spectral Absorption Profile

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3.2.3 Spectral profile:

Here, below mentioned figure shows absorptance and reflectance by wavelength, if focused in individual layer absorptance then found that perovskite absorptance is most higher positon to compared with other layers, in fact more absorptance is showed in this case for perovskite than first example while silicon was most peak positon as a semiconductor.

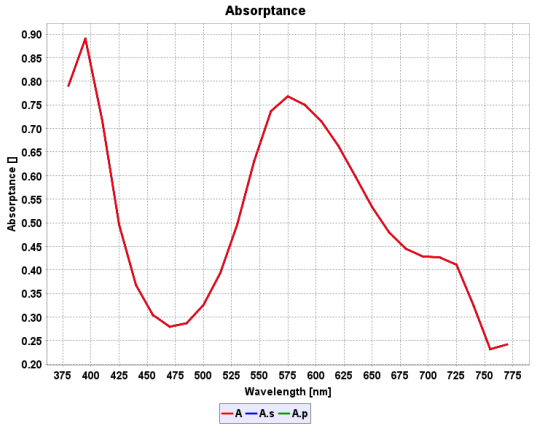

Figure: 3.10 Absorptance

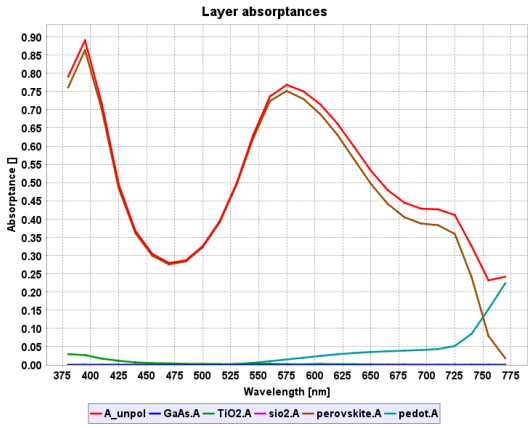

Figure: 3.11 Layer Absorptance

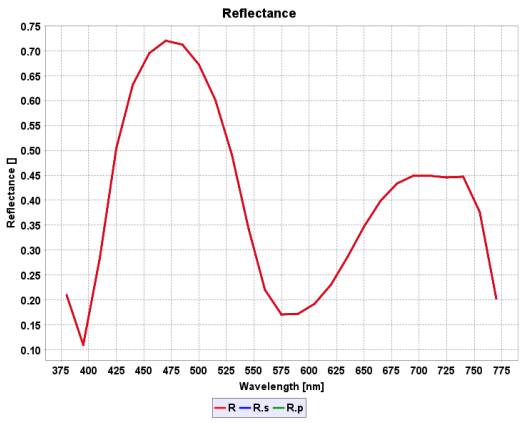

Figure: 3.12 Reflectance

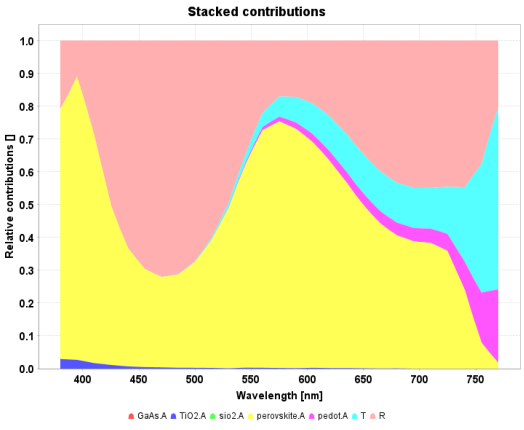

Figure: 3.13 Stacked Contribution

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CHAPTER 4

Methodology for Ag & C60

4.1 Materials parameters:

All the materials are retains unchanged except first electrode and first semiconductor Tio2 and Sio2 has been replaced by C60 and Ag from previous example with same thickness. All the previous example perovskite has been used as a semiconducting device but in this case perovskite-manzoor has been used both are quite similar but manzoor has a some special characteristic. It is known that perovskite has some variation, manzoor one of them.

Table No: 4.1 Materials Parameters

Number of layer	Name of layer	Thickness nm	Used as a
1	Air	0	Incoherent
2	GaAs	100	
3	C60	80	Electrode
4	Ag	120	Semiconductor
5	Perovskite-Manzoor	350	semiconductor
6	PEDOT:PSS	250	Electrode
7	ITO	250	

4.2 Materials Familiarization:

4.2.1 C60:

C60 steel is Associate in Nursing pure medium carbon engineering steel that has 0.57%-0.65% Carbon as per EN10083 customary. It has characteristics kind of like that of C55 steel that has high hardness and high strength when hardening. This steel is mostly provided in Associate in Nursing untreated or normalized condition.

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4.2.2 Ag:

Silver is a chemical element with the symbol Ag (from the Latin argentum, derived from the proto-Indo-European h2 work unit “shiny” or “white”) and number forty seven. A soft, white, lustrous transition metal, it exhibits the best electrical conduction, thermal conduction, and reflectivity of any metal

4.3 Characteristics Analysis :

Materials characteristics has been analyzed by several type of profile, which can shows various type of properties of materials. From this variation we can calculate the required data by analyzing every profile.

4.3.1 Electrical profile:

In electrical profile most significant changes comes from current graphs and band diagram, other graphs may can slightly similar due to their materials properties. If compare with second example by replacing Ag with Sio2 for band diagram, electric field and potential then found that all are closed to similar energy provided for only layer of Ag. But dramatic changed found in current flowing for both layer which is used as a semiconductor.

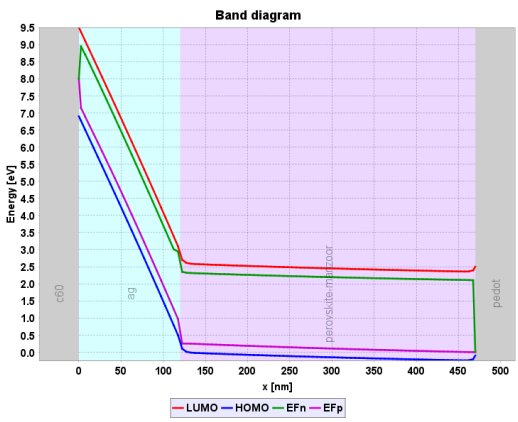

Figure: 4.2 Band Diagram

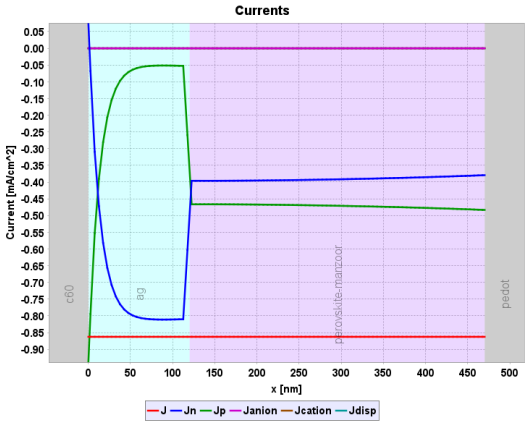

Figure: 4.3 Currents

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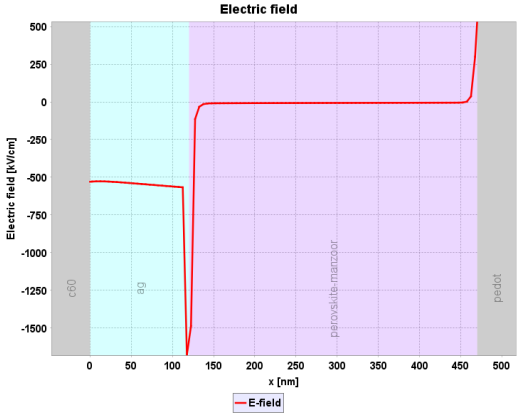

Figure: 4.4 Electric Field

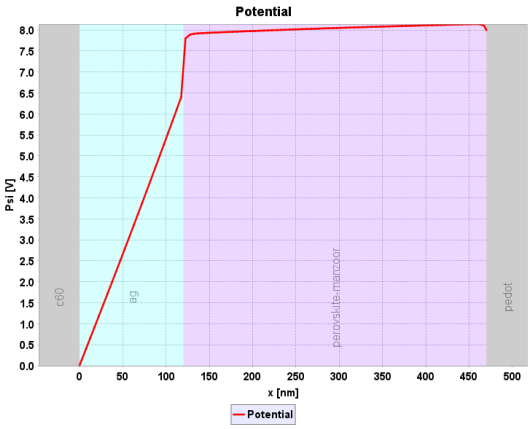

Figure:4.5 Potential

4.3.2 Optical profile:

In this case C60 shows most absorption rate while it is used as a electrode but from previous example it has been found that perovskite layer absorption was most higher while used as a semiconductor. It is very strange to show that first electrode is taken all the absorption figure with most peak position while more two semiconducting layer is quite nil by absorption.

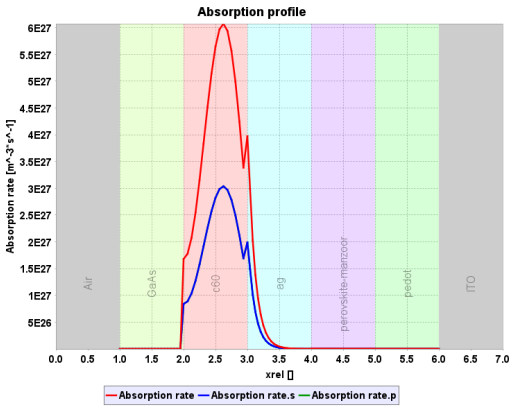

Figure: 4.6 Absorption

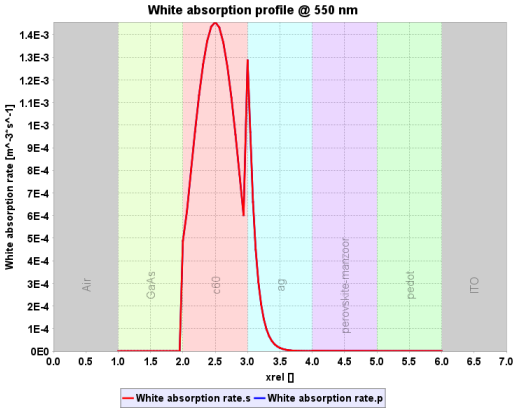

Figure: 4.7 White Absorption Profile

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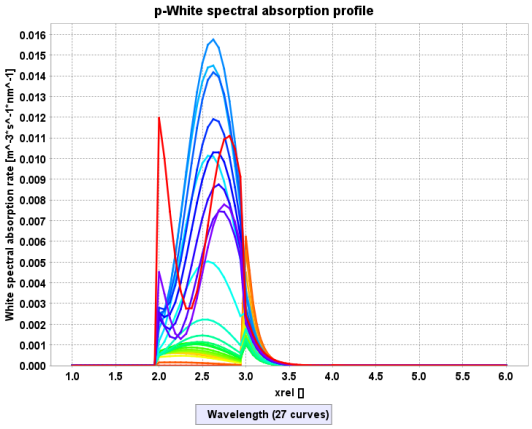

Figure: 4.8 P-white Spectral Absorption Profile

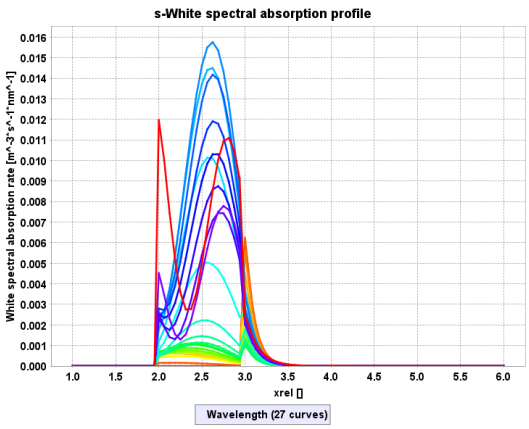

Figure 4.9 S-white Spectral Absorption Profile

4.3.3 Spectral profile:

For this example it is clear that total absorptance peak position is closed to same with first and second example but some changes appeared in stacked contribution and individual absorptance layer by wavelength due to variation of the material have been used in different layer.

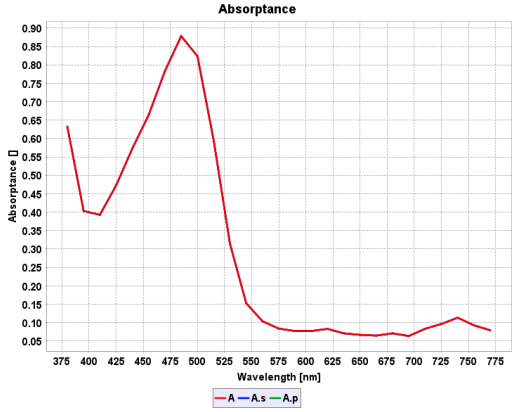

Figure: 4.10 Absorptance

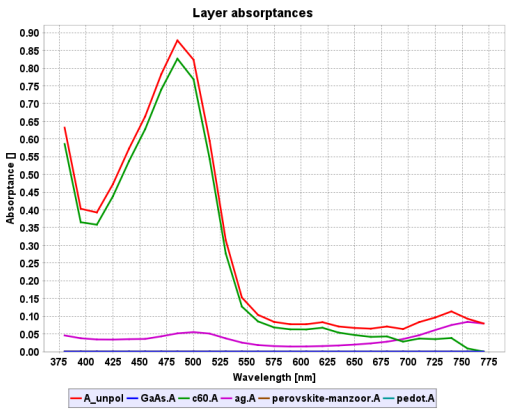

Figure: 4.11 Layer Absorptance

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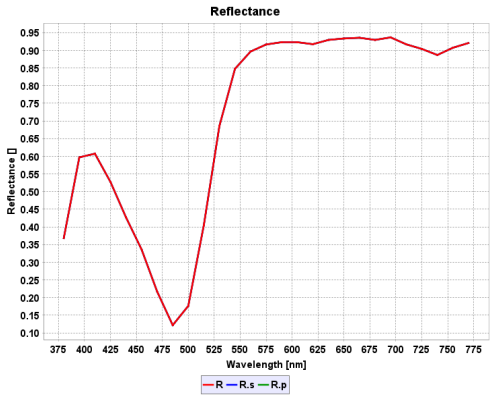

Figure: 4.12 Reflectance

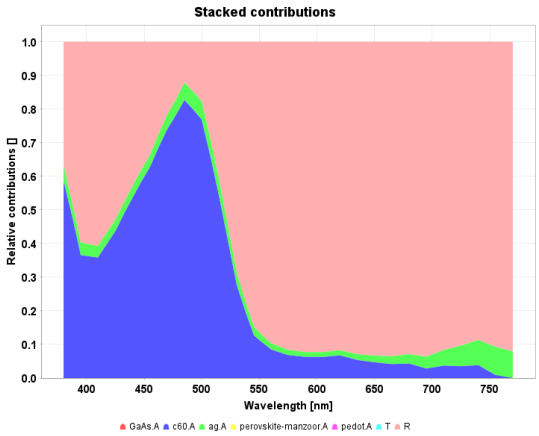

Figure: 4.13 Stacked Contribution

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CHAPTER 5

Methodology for P3HT

5.1 Materials parameters:

In this section polythiophene has been included for first semiconducting materials and another change has comes in second electrode which is TaTm. Polythiophene has some particular conductivity, polythiophene is an ordinary polymer, being a red solid that is purely soluble in most solvent. Upon treatment with oxidizing agent, material become dark color and becomes electrically conductive. Oxidation is referred to as dopping which very crucial for solar cell manufacturing.

Table No : 5.1 Materials Parameters

Number of layer	Name of layer	Thickness nm	Used as a
1	Air	0	Incoherent
2	GaAs	100	
3	PEDOT	80	Electrode
4	P3HT	120	Semiconductor
5	Perovskite	450	semiconductor
6	TaTm	250	Electrode
7	ITO	250	

In this case, if compare with previous example C60 is replaced by PEDOT for first electrode and Ag is also replaced by P3HT for first semiconductor while thickness is unchanged for both. Moreover, second electrode is also changed with TaTm and perovskite thickness is increased from 350nm to 450 nm, now time to observed how characteristic has been changed from simulated figure below.

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5.2 Materials Familiarization:

5.2.1 P3HT:

Poly(3-hexylthiophene) (P3HT) is a polymer with chemical formula $(C_{10}H_{14}S)_n$. It is a polythiophene with a short alkyl group on each repeat unit. It is noteworthy since it is a semiconducting polymer; it can conduct positive charges (holes). It is a common material for studies of organic electronics (e.g. FETs) and for organic photovoltaics (OPV).

Poly(3-hexylthiophene) (P3HT) is widely useful in organic electronics research fields, because it is one representative material of soluble organic semiconducting polymers. Normally performance of an electronics material is sensitive to the quality of the material.

5.3 Characteristics Analysis :

All the characteristic analysis part is consists of three consecutive profile, in electrical profile electric field and potential are quite same for all example due to their electrical properties of material but major difference comes from band diagram and current flows graphs which is mentioned below. Flow of the current into the material shows only for semiconducting layer where is P3HT and perovskite definitely not for other layers, same phenomena happened for band diagram.

5.3.1 Electrical profile:

By changing the materials in first electrode and second electrode with first semiconductor and by increasing perovskite thickness, result shows for band diagram, electric field, potential are slightly similar except current diagram.

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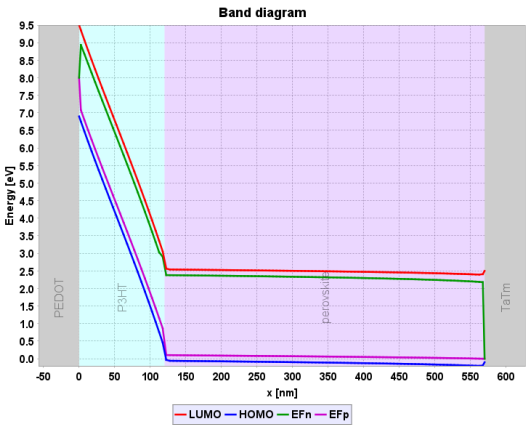

Figure: 5.2 Band Diagram

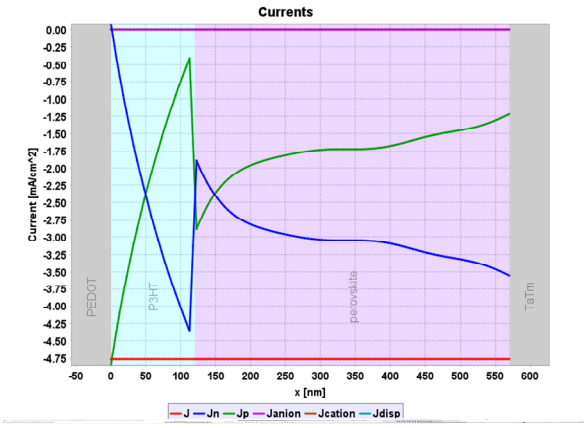

Figure: 5.3 Currents

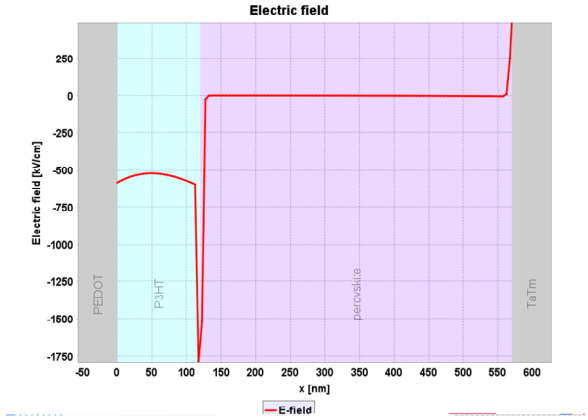

Figure: 5.4 Electric Field

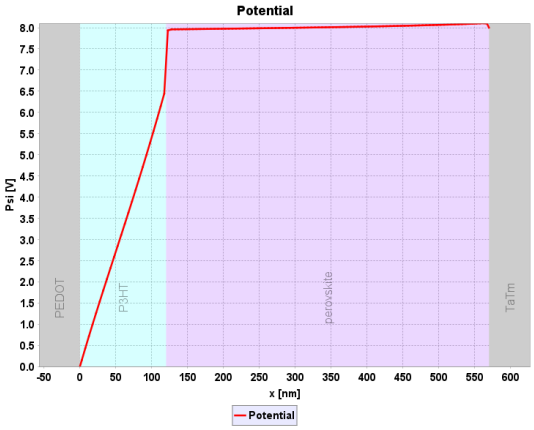

Figure: 5.5 Potential

5.3.2 Optical Profile:

Poly(3-hexylthiophene) is widely useful in organic electronic research field, P3HT is used for first time as a semiconductor material in this example and it has been observed that P3HT has a very high absorption rate with very small thickness layer while it has been showed that in previous example for C60 taken a slightly large space for higher absorption rate but P3HT taken a very small space.

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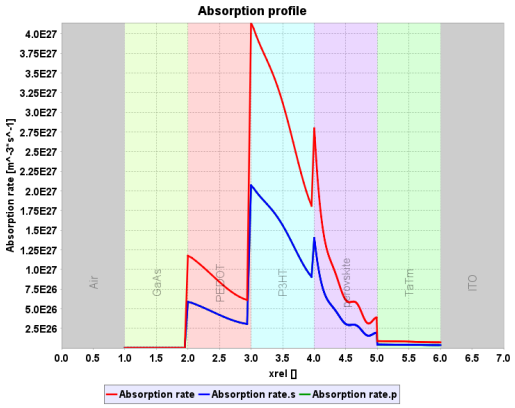

Figure: 5.6 Absorption Profile

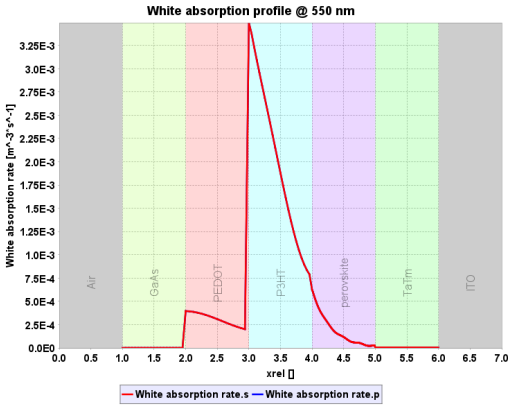

Figure: 5.7 White Absorption Profile

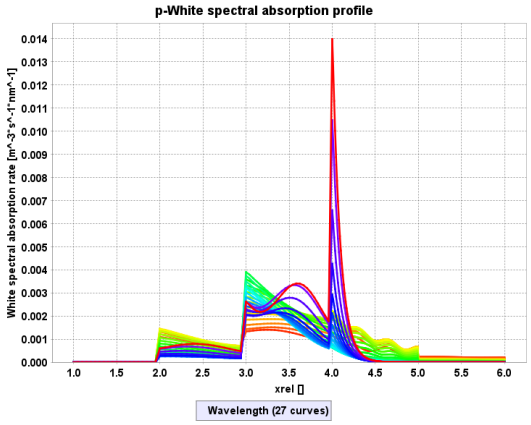

Figure: 5.8 P-white Spectral Absorption Profile

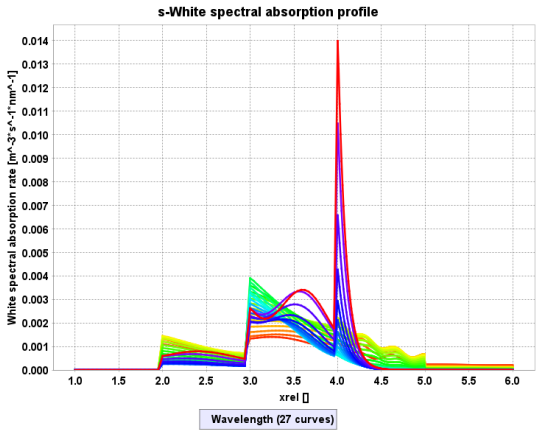

Figure: 5.9 S-white Spectral Absorption Profile

5.3.3 Spectral Profile:

From below mentioned all the figures shows absorptance and reflectance, it has been identified that from layer absorptance that P3HT is higher absorber within all materials as a first semiconductor. In this case reflectance is also higher than other with more wavelength which is also clear from layer absorptance

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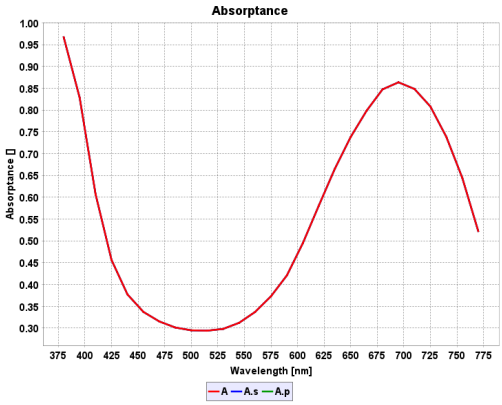

Figure: 5.10 Absorptance

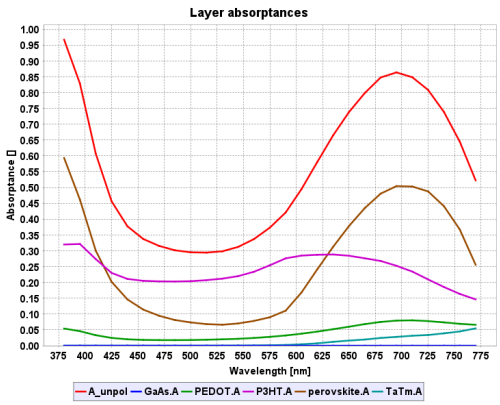

Figure: 5.11 Layer Absorptance

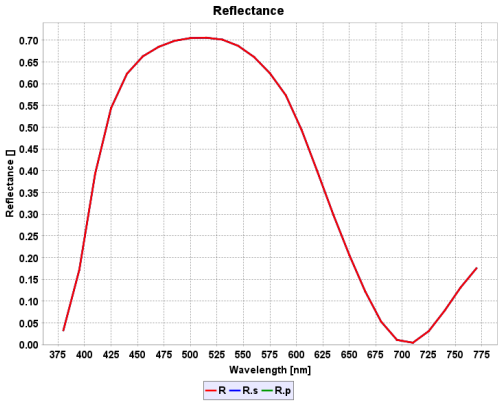

Figure: 5.12 Reflectance

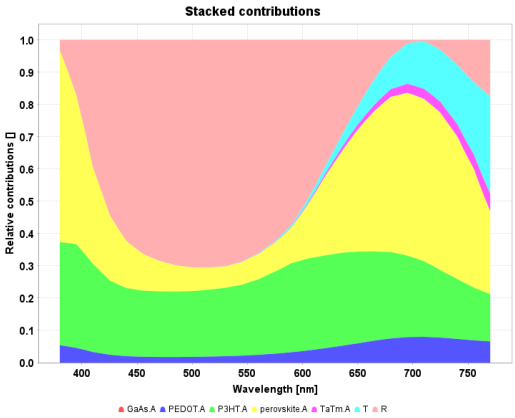

Figure: 5.13 Stacked Contribution

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CHAPTER 6

Methodology for Silicon

6.1 Materials parameters:

Silicon is most commonly used material for solar cell manufacturing, solar cell are build from silicon boules. Which is polycrystalline structure and it has atomic structure of a single crystal. Another common material is used for semiconducting layer which is sio2. For this structure both the semiconducting layer's thickness has been changed also compared with other all structure.

Table No: 6.1 Materials Parameters

Number of layer	Name of layer	Thickness nm	Used as a
1	Air	0	Incoherent
2	GaAs	100	
3	P3HT	80	Electrode
4	Silicon	200	Semiconductor
5	Sio2	450	semiconductor
6	TaTm	250	Electrode
7	ITO	250	

For this last example, first electrode PEDOT is replaced by P3HT while last electrode is unchanged with same thickness if compare with previous example. Moreover, both the semiconductor has been changed by silicon and Sio2 respectively with P3HT and Perovskite that mentioned in previous materials list

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6.2 Materials Familiarization:

6.2.1 Silicon:

Silicon is a chemical element with the symbol Si and atomic number 14. It is a hard, brittle crystalline solid with a blue-grey metallic lustre, and is a tetravalent metalloid and semiconductor. It is a member of group 14 in the periodic table: carbon is above it; and germanium, tin, lead and flerovium,are below it.

6.2.2 Sio2:

Silicon dioxide is better known as glass and is often simply called oxide in the semiconductor industry. The metal-oxide-semiconductor sandwich forms a capacitor, in which a thin layer of insulating oxide called a dielectric separates the metal and semiconductor plates.

6.3 Characteristics Analysis :

In this example most common material silicon and sio2 is used to analysis the characteristic. From the optical profile it has been observed that the first electrode layer is consumed most of the photons or light on the other hand both the semiconducting layer closed to nill by photons consumption which very noticeable phenomena.

6.3.1 Electrical Profile:

It has been showed from above mentioned figures that band diagram, electric field and potential are quite same except current flows into the sio2 that is illustrated in current figure for sio2 layer.

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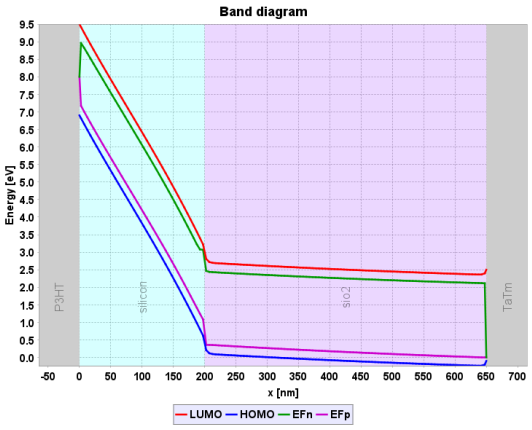

Figure: 6.2 Band Diagram

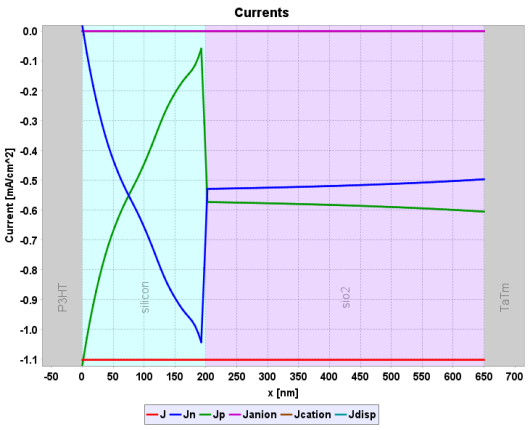

Figure: 6.3 Currents

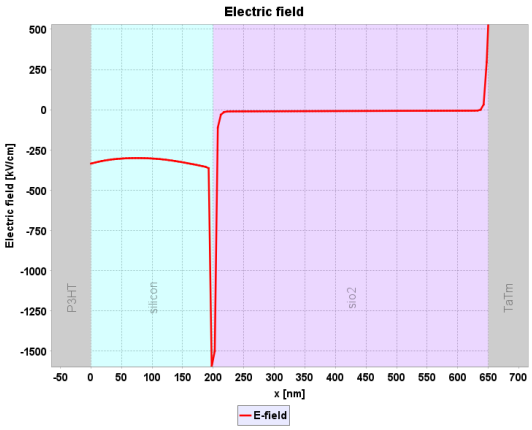

Figure: 6.4 Electric Field

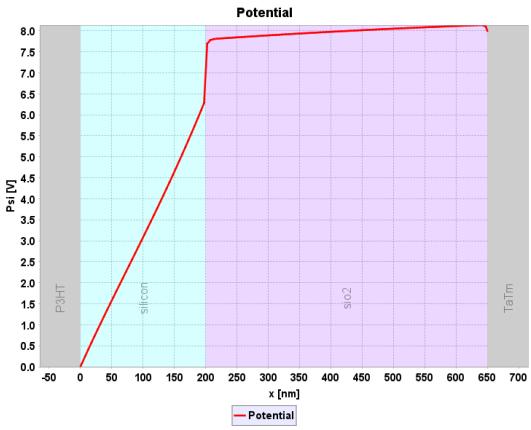

Figure: 6.5 Potential

6.3.2 Optical Profile:

In the previous example P3HT was used as a semiconducting material but in the last example P3HT has been used as a electrode. But it has been observed that in both case P3HT shows most absorption compared with other semiconducting layer or electrode layer.

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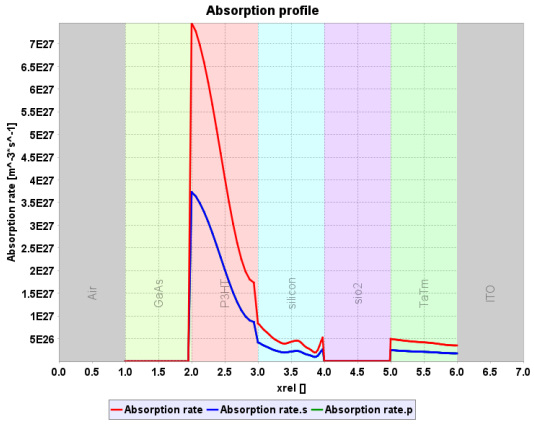

Figure: 6.6 Absorption Profile

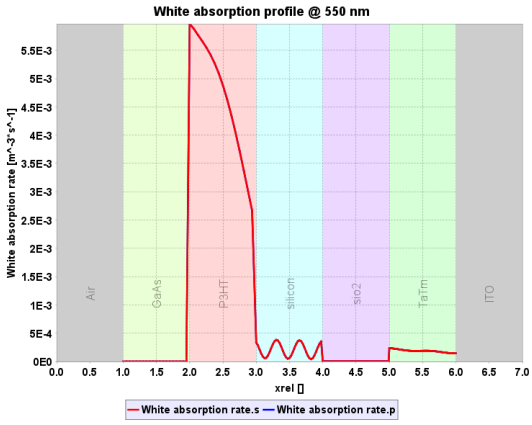

Figure: 6.7 White Absorption Profile

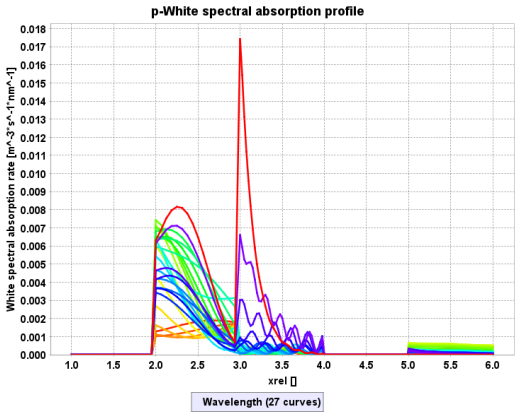

Figure: 6.8 P-white Spectral Absorption Profile

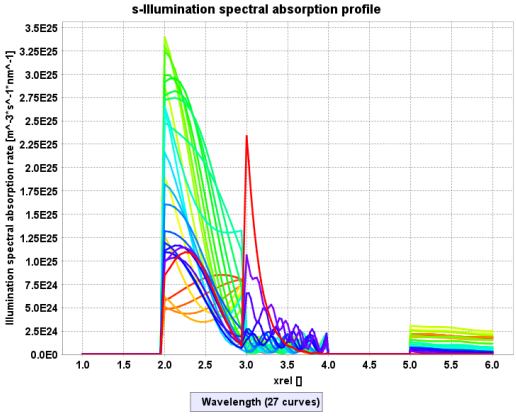

Figure:6.9 S-white Spectral Absorption Profile

6.3.3 Spectral profile:

In the previous example P3HT used as a semiconductor and in the last example P3HT used as a electrode but in both case P3HT staying with better position as a absorber compared with other material in full structure.

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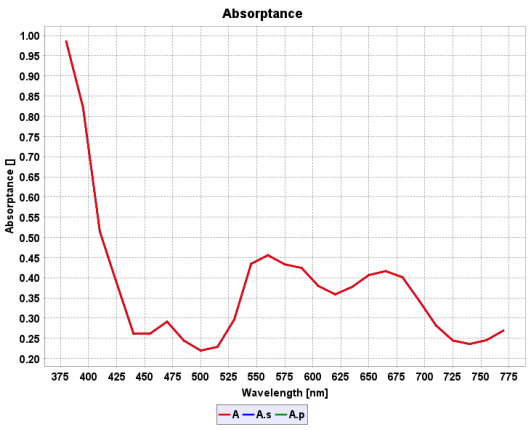

Figure: 6.10 Absorptance

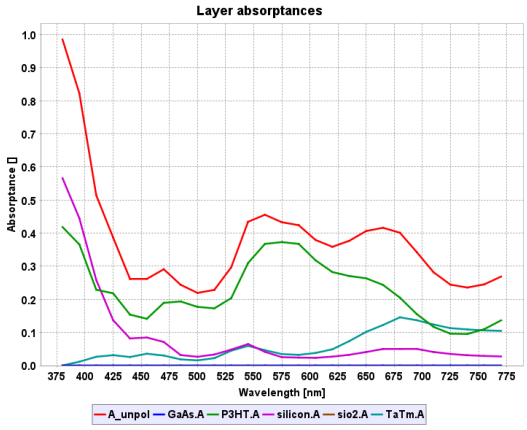

Figure: 6.11 Layer Absorptance

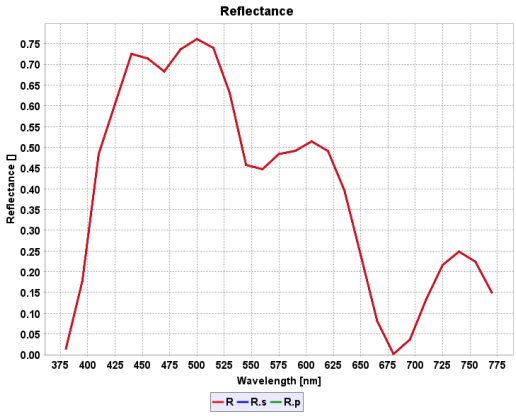

Figure: 6.12 Reflectance

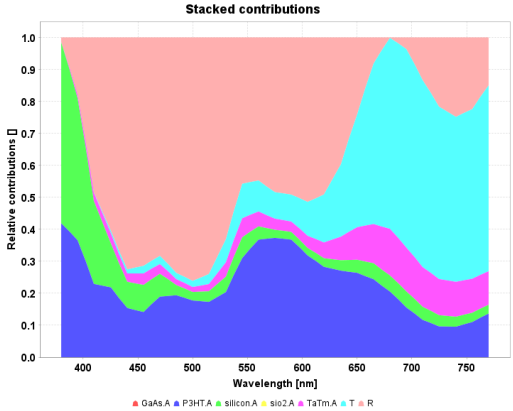

Figure: 6.13 Stacked Contribution

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CHAPTER 7

Result and Discussion

7.1 Result & Discussion:

All the chapter before a solar cell model has been described in each chapter by using various types of materials and parameters. All the examples output consists of three different profile and each profile has four different graphs which is represent the output characteristic about used material in solar structure. In this section, few materials has been mentioned in table below which is used as a semiconductor and electrode only, for this material various type of output characteristics showed by graphs in previous all chapter but in this table few important output parameters has been mentioned to assessment the task.

Table No: 7.1 Output Parameters

Name of material	Used as	Thickness nm	Absorption rate [m^-3*s^-1]	Absorptance	Currents [mA/cm^2]
Silicon	Electrode	120	1.4E27	0.70	
Perovskite	semiconductor	350	0.9E27	0.32	-2.50
PEDOT	Electrode	250	0.6E27	0.20	
Tio2	Electrode	80	Nil	0.3	
Sio2	semiconductor	120	Nil	Nil	Nil
Perovskite	semiconductor	350	6.5E27	0.65	2.5
PEDOT	Electrode	250	0.2E26	0.20	
C60	Electrode	80	6E27	0.80	
Ag	semiconductor	120	4E27	0.05	-0.05
Perovskite	semiconductor	350	Nil	Nil	-0.45
PEDOT	Electrode	250	Nil	Nil	
PEDOT	Electrode	80	1.25E27	0.05	
P3HT	semiconductor	120	4.0E27	0.30	-0.50
Perovskite	semiconductor	450	2.75E27	0.30	-1.25
TaTm	Electrode	250	1.0E27	0.04	
P3HT	Electrode	80	7E27	0.4	
Silicon	semiconductor	200	1E27	0.6	-0.1
Sio2	semiconductor	400	Nil	Nil	-0.6
TaTm	Electrode	250	0.5E26	0.15	

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If it has been observe very closely the mentioned below output table then it can be find that some of the materials output figures are very high compare with other, specially perovskite and P3HT's absorption rate, absorptance and current figure are noticeable.
In second chapter perovskite used as a semiconductor which absorption rate is most higher than all other semiconducting materials within all example which is 6.5E27 moreover, absorptance is also quite good compared with other materials and current flow is 2.5 which is greater then all other materials. Another is P3HT used in chapter 6 as a electrode while absorption rate is most higher (7E27) than all other materials with good absorptance figure also, not only this case same material used as a semiconductor in previous chapter where showed a very good absorption rate which is 4E27. Most commonly used material is silicon for solar cell in conventional structure which output is also mentioned in table below, which is not enough noticeable as a semiconductor. After analyzed this output parameters a transparent idea has been found about materials attributes for a solar cell. Perovskite and P3HT's working capabilities are quite better than other materials which is used in conventional solar cell structure. So end of our analysis it has been said that in third chapter mentioned solar structure model with semiconducting material perovskite provide us quite better output than all other structure or materials.

7.2 Graphical Illustration:

Below mentioned bar graph shows graphical representation of output result, in table mentioned above shows all the semiconductor and electrode materials with few output results which used in throughout the research. But in the bar graph, only semiconducting material's output showed by bar chart where it has been observed that perovskite has taken most highest position compared with other materials.

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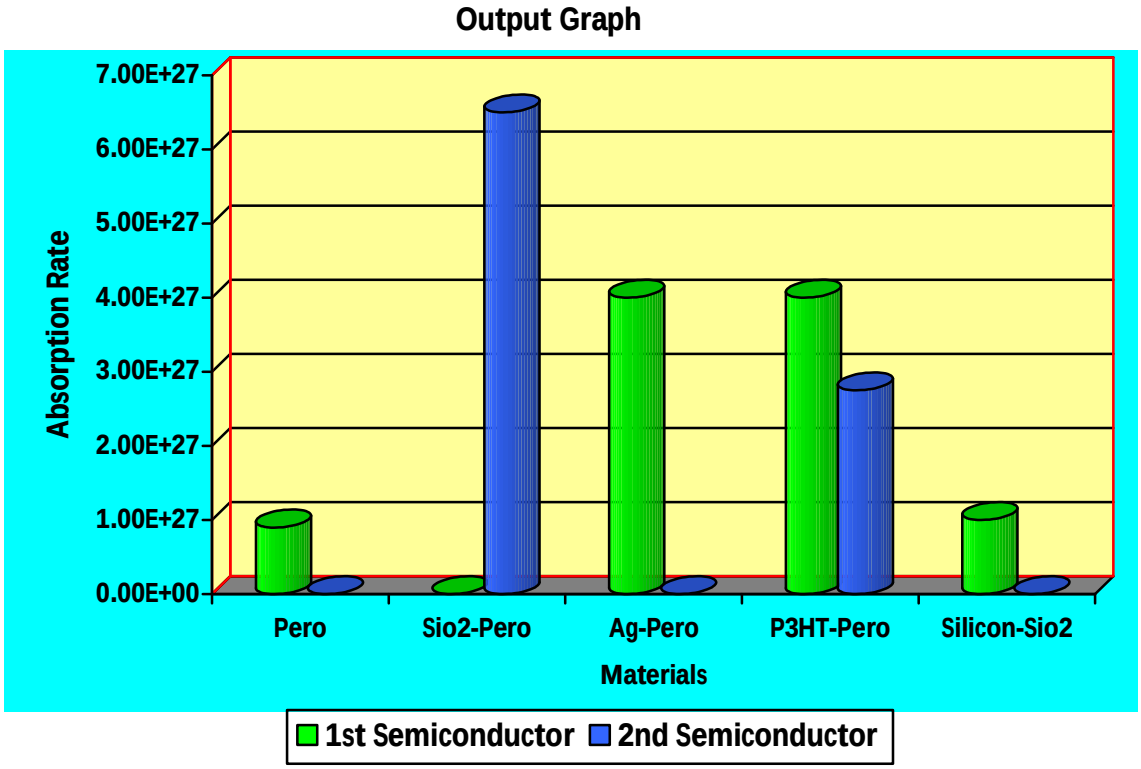

Figure No: 7.1 Graphical representation of output result

All the absorption rate measured by [m^-3*s^-1], perovskite has been taken more than 6.00E+27. Moreover, other two materials P3HT and Ag are also quite good position which is closed to 4.00E+27. End of the analysis it has been cleared that perovskite is better light or photon absorber than other materials that is used in this thesis as a cell materials and also better than silicon which is most used material in solar cell structure in conventional method.

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CHAPTER 8

Conclusion

8.1 Conclusion:

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After reviewing varied studies, it's revealed that some of the materials specialty and attributes has been analyzed in various aspects. Which is showed by two ways first is showed in output table where all the output parameters has been mentioned by several ways, second one is output result expressed by graphical illustration by bar chart which also gives a transparent ides about the research output. Furthermore, all the cell structure result and output throughout the research also has been showed by individual profile with separate graph for electrical profile, optical profile and spectral profile. The consumption of photon capabilities can express efficiency of solar structure for a material as a result absorption rate is mention clearly in every cell structure and result and discussion part. By using this materials a solar cell structure has been proposed by assessing various type of features which can may susceptible to increase the efficiency of a solar cell.

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